As Needs Must

A Qualitative Study of Motorists' Habitual Traffic Behaviour in a Situation of Reduced Road Capacity

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A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements of a degree except as fully acknowledged in the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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Date:

Abstract

This study is concerned with the manner in which motorists react when part of the road network is reduced in capacity. It is concerned with the habits associated with finding a route and choosing a mode.

Knowledge of motorists' responses is important in light of the increasing incidence of reductions in road capacity, due to road capacity being reallocated to other modes. Examples include pedestrianization, and the installation of bus lanes or street running light rail. Capacity is also reduced when infrastructure fails because of natural or man-made actions or lack of action. Authorities must ensure that traffic can cope with the disruption that reducing capacity brings, whether caused intentionally or unexpectedly. It has been noticed that traffic reduces after an incident of reduced road capacity, but only to the extent it needs to do so. The results of this study suggest a hypothesis to explain this observation.

The field study described in this thesis consisted of a qualitative survey of motorists who drove along Epping Road in Lane Cove, Sydney, Australia, both before and after the reduction in capacity which occurred after the opening of the Lane Cove Tunnel in 2007. The motorists described their travel behaviour in relation to Epping Road. From their descriptions of their propensity to switch routes during the course of their trip, two hypotheses were developed, which offer a potential explanation for the disappearing traffic.

The route switching hypothesis posits that a minority of motorists have a habit of changing routes to avoid the delays they encounter. They may change their route before the journey starts or while the journey is underway. The minimal chaos hypothesis states that:

> Route switching by a percentage of motorists, in combination with other motorists leaving the route or changing their time of travel, results in changes which tend towards the minimum necessary required to avoid on-going disruption.

The variations in the motorists' mode use habits can be explained by their level of travel competence, which is defined by this study as the ability to make informed choices between the available modes. This is achieved by acquiring both trip planning competencies and trip execution competencies. The thesis gives examples of the range of competencies required for the modes in widespread use in Sydney. It also gives an example of how enhanced travel competence affected travellers in a incident of reduced road capacity in Brisbane.

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Illustrations

Photographs

- **State Library of New South Wales**: George Street West;
- **KimR:** video of Epping Road shared use path;
- **Ben Short** (www.benshortphotography.com): Tasman Bridge, Hobart; and
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Maps

- **Google:** traffic map of Lane Cove;
- **Roads and Maritime Services:** map of Sydney Orbital Network; and
- **John Huff and Open Source Maps:** maps of Lane Cove and surrounding areas, Melbourne, Auckland and Hammersmith.

Publications

Peer reviewed conferences

Sharples, R. 2009, 'Reducing road capacity to change travel behaviour', paper presented to the *32nd Australasian Transport Research Forum (ATRF)*, Auckland, 29th September - 1st October http://www.patrec.org/web_docs/atrf/papers/2009/1810_paper148-Sharples.pdf .

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Sharples, R. 2010, 'Travel competence: a requirement for transport sustainability', paper presented to the *33rd Australasian Transport Research Forum (ATRF)*, Canberra, 30th September http://www.patrec.org/web_docs/atrf/papers/2010/1922_198%20-%20Sharples.pdf .

Sharples, R.A. 2013 'There is more to it than public transport', poster presented at the *Climate Adaptation 2013* conference, Sydney, 25th – 27th June

Sharples, R.A. 2013 'Route finding as a consequence of a reduction in road capacity', paper presented to the *36th Australasian Transport Research Forum (ATRF)*, Brisbane, 2nd-4th October http://www.atrf.info/papers/2013/2013_sharples.pdf

Sharples, R. 2014, 'Supporting a retrospective qualitative survey with social media', paper accepted for the *10th International Survey on Transport Survey Methods*, Leura, Blue Mountains, 16th -21st November

Other conferences

Sharples, R. 2009, 'Can public transport, cycling and walking cope with the anticipated growth?', paper presented to the *AITPM 09 National Conference: Traffic Beyond Tomorrow*, Adelaide, 5th-7th August http://epress.lib.uts.edu.au/research/handle/10453/12916 .

Student conferences

Sharples, R. 2008, 'Road reallocation? Shaping sustainable transport futures', paper presented to the *Postgraduate Research Students' Conference*, University of Technology, Sydney, 12th September.

Sharples, R. 2014, 'Switching routes to prevent excessive traffic', paper presented to the *Conference of Australian Institutes of Transport Research (CAITR)*, University of New South Wales (UNSW), 18th February.

ALICE was beginning to get very tired of sitting by her sister on the bank and of having nothing to do: once or twice she had peeped into the book her sister was reading, but it had no pictures or conversations in it, "and what is the use of a book," thought Alice, "without pictures or conversations?"

Lewis Carroll, *Alice's Adventures in Wonderland*

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Note: All maps are from 2014, unless otherwise indicated.

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Definitions

AADT (average annual daily total) – the total annual flow of traffic divided by the number of days in the year to give the average flow per day.

affective – relating to feelings or emotions

bus only lanes – for the exclusive use of buses

bus lanes – lanes open to taxis, hire cars, motorcycles, cycles, emergency vehicles and special purpose vehicles operated by or under the direction of Roads and Maritime Services.

CBD – central business district

Cityrail – operator of passenger rail services in Greater Sydney at the time of the study

Connector Motorways Pty Ltd (formerly Lane Cove Tunnel Company) – consortium of companies which won the right to build, maintain and operate the Lane Cove Tunnel for 30 years.

Cross-City Tunnel (CCT) – road tunnel passing under the central business district of the City of Sydney, linking the western edge of the CBD and the eastern suburbs.

cycle lane – on-road lane for the use of cyclists

EIS (Environment Impact Statement) – *Lane Cove Tunnel and Associated Road Improvements: Environmental Impact Statement*; published by Sinclair Knight Mertz in October 2001; contained a proposal for a scheme, which was accepted with slight amendments; and an explanation of the history of the concept.

EM1-EM18 – codes assigned to people who responded by e-mail to publicity in the press local to Epping Road about the field study.

Epping Road corridor – the combination of the Lane Cove Tunnel and the stretch of Epping Road in Lane Cove between the Gore Hill Freeway and the Lane Cove River.

expressway – divided roadway with full or partial access control, and traffic signals or grade separated interchanges. Designed for a running speed of 40-50 m.p.h. with interruptions to free-flow kept to a minimum. Does not carry as much traffic as a freeway, nor have as wide a right of way. Pedestrian traffic and access from abutting property prohibited. Primary purpose is to carry long distance traffic (SATS, vol. 1, p. III-2).

FEIT – Faculty of Engineering and Information Technology (at the University of Technology, Sydney)

freeway – divided roadway with complete access control, and grade separated interchanges. Designed for large volumes of free-flowing traffic at speeds of 40-60 m.p.h. Pedestrian traffic and direct access from abutting property prohibited. Primary purpose is to carry long distance traffic (SATS, vol. 1, p. III-2).

HCR report – *Traffic Impact of Highway Capacity Reductions: Assessment of the Evidence*. This is the report produced by the Transport Studies Unit of the Economic and Social Research Council of the United Kingdom government for the Department for Transport and London Buses. It is the seminal report in this field.

Hillsbus – bus operator which services the Hills district in north-west Sydney.

IN1-IN10 – codes assigned to motorists who were interviewed for the field study.

Joint Select Committee on the Cross-City Tunnel (JSCCCT) – parliamentary committee made up of members of both the upper and lower houses of the parliament of NSW, drawn from Labor, Liberal and independent groupings, whose job it was to look into the problem with the Cross-City Tunnel. The committee also looked into the Lane Cove Tunnel (*q.v.*).

Lane Cove Tunnel (LCT) – final link in the Sydney Orbital Network (*q.v.*). It was built by Connector Motorways Pty Ltd (*q.v.*) but did not achieve the predicted flow of traffic and was sold to Transurban Ltd (*q.v.*).

Lane Cove Tunnel Action Group (LCTAG) – coalition of 15 groups drawn from the residential, commercial and industrial sectors of Lane Cove lobbying in regard to the Lane Cove Tunnel.

Lane Cove Tunnel Transition Working Group (LCTTWG) – working group announced by the Minister for Roads in June 2006, which became the Lane Cove Tunnel Integration Group (LCTIG). It consisted of representatives of the Premier's Department Infrastructure Implementation Group, the RTA, Connector Motorways and, as required, NSW Treasury, the Ministry of Transport and the State Transit Authority.

motorway - a divided road with two or more lanes for traffic travelling in each direction, with no at-grade intersections and with full control of access from abutting property.

NRMA (National Roads and Motorists' Association) – body representing motorists in NSW.

NSW – New South Wales

peak hours - for the purposes of this study, the peak hours are defined as

- a.m.: 7.00 - 9.00;
- p.m.: 16.30 -19.00.

PMV – private motor vehicle (car, light goods vehicle or motorcycle)

RMS (Roads and Maritime Services) name adopted when the RTA (*q.v.*) was reorganized in 2011.

RRC – reduction in road capacity

RTA (Roads and Transport Authority of New South Wales) – NSW government authority whose responsibilities included non-local roads and bridges in NSW, driving and motor vehicle licences, and road safety. Now known as Roads and Maritime Services (*q.v.*).

SKM (Sinclair Knight Merz) – consultants who prepared the environmental impact statement for the Lane Cove Tunnel scheme.

SUP (shared use path) – off road path for shared use by pedestrians and cyclists.

Sydney – Sydney, New South Wales, Australia

Sydney Buses – state owned bus operator, which runs services along Epping Road.

Sydney Orbital Network (SON) – motorway ring road in Greater Sydney. It consists of the following stretches of motorway:

- M1 (Eastern Distributor);
- M2 (Hills Motorway);

- M5 (South Western Motorway);
- M5 East;
- M7 (Westlink);
- Gore Hill Freeway;
- Warringah Freeway;
- Sydney Harbour Tunnel; and
- Lane Cove Tunnel.

Extensions to the motorway network in Greater Sydney have been proposed.

TP1-TP2 – codes assigned to people who responded by telephone to publicity in the press local to Epping Road about the field study.

traffic – people and vehicles passing to and fro along a way. This may be one or more of pedestrians, cyclists, motorists, buses, trams/light rail and heavy goods vehicles.

transit lane – a lane reserved for high occupancy vehicles, including cars and buses.

- a T2 transit lane is for vehicles carrying at least two (2) people;
- a T3 transit lane is for vehicles carrying at least three (3) people.

transport – unless specified otherwise, this means urban passenger transport, public or private

Transurban Ltd – private owner and operator of the Lane Cove Tunnel, with an interest in four other elements (M1, M2, M5 and M7) of the Sydney Orbital Network.

UTS – University of Technology, Sydney

CHAPTER 1

Introduction

Section 1.1 of this chapter introduces the concept of reduction in road capacity, defines it and gives examples of what is meant by reduced road capacity. Section 1.2 explains the problems associated with a reduction in road capacity and discusses their significance. Section 1.3 explains the researcher's interest in the subject. Section 1.4 discusses briefly the changes that have occurred in Australia since the first report on this subject was written. Section 1.5 describes the research questions. Section 1.6 explains how this thesis is structured.

1.1 Reductions in road capacity

1.1.1 Introduction

The problem of congestion and some possible solutions

Congestion on the road is an on-going problem for motorists and transport planners (e.g. Buchanan 1964; Mogridge 1990; Goodwin 1997, Twiney & Rudd 2005). It creates delay and more pollution than is normally emitted from motor vehicles (Whitelegg 1993, p. 128).

The simplistic solution is to build more roads or add extra lanes to an existing road. In recent years, authorities have also been encouraging greater use of non-car modes (such as walking, cycling and public transport) (NSW Government 1998). However, infrastructure solutions have not provided an enduring answer. Congestion still occurs (Weinstein 2006).

This is not surprising, in view of the increase in population and prosperity, which create more demand for travel and, as a result, fill any new spaces that are created on roads. There is also the possibility of inducing extra trips from existing motorists (SACTRA 1994).

The opposite course of action – that is, removing capacity – is less frequently considered. However, this happens already in a variety of ways. Examples include excising road space in order to create bus lanes or pedestrianized areas. Capacity is also reduced in emergency situations (e.g. earthquakes). Figure 1.1 illustrates how reduced road capacity (RRC) can come about.

The empirical evidence, based principally on traffic counts, is that when road capacity is reduced, traffic (that is, private motor vehicles) disappears (Cairns *et al* 1998). However, the mechanisms by which this happens are not clear. That is:

- How does it happen?
- Why does it happen?
- When does it happen?
- Where does it happen? and
- Who makes it happen?

Understanding motorists' behaviour

To answer those questions, it is necessary to consider motorists, the dominant users of the road, and their behaviour. In particular, it is necessary to better understand how motorists make decisions about travel:

- why they do and don't make trips[1];
- how and when they decide on trip parameters such as route, time of travel and mode; and
- other factors they take into account when they undertake (or don't make) trips.

To a large extent, the question of travellers' behaviour has been approached in the past by looking at aggregate behaviour, such as the number of people using the roads and when road use occurs. On that basis, it can be said that, for example, motorists' route choice can be explained as drivers minimizing the time it takes to make a journey and the (monetary) cost of that journey. However, Outram & Thompson (1977, cited by Ortuza & Willumsen 1990, p. 245) found that a combination of time and distance (the latter assumed to be proportional to monetary cost) could only explain 60-80% of routes observed in practice. Thus, 20-40% of motorists' route choice must involve another factor or factors.

However, there are limitations to the aggregate approach. Although a great deal of data on those subjects has been collected and it is known where traffic congestion occurs, this knowledge does not prevent the congestion. As an alternative, it is possible to consider disaggregate behaviour – that is, the individuals' behaviour – and explore possibilities which might (for example) explain the remaining 20-40% of the route choices which are not related to time or cost. To find out what these other factors might be, and explore the responses, it is necessary to talk to motorists. That is, it is necessary to conduct qualitative research to explore motorists' attitudes and needs, whether in respect of route choice, choice of origin and destination, or choice of mode.

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[1] For the purposes of this study, 'trip' is defined as a movement between an origin and a destination using one or more modes, for a specific purpose. There may also be subsidiary purposes, such as dropping off passengers en route. The words 'trip' and 'journey' are used interchangeably.

Explanation for trip making

It has been noted that traffic (that is, private motor vehicles) disappears when road capacity is reduced (Cairns *et al* 1998). That is, it appears that some trips that used to exist, no longer exist after there is a change in the environment caused by reduced road capacity. One potential explanation is that the trip did not need to exist in the form it originally took.

One of the things that can be asked is why people make trips. There are some obvious answers, in that transport is usually considered to be a derived demand and people need to travel from their home to school, college, workplace, shops and friends so that they can undertake the activity associated with that destination. But following on from the idea of 'need', the question can be asked as to whether travellers really need to make trips in the way they do, or whether they are making them:

- because they are in the habit of doing so; or
- because that is the 'normal' (or 'socially acceptable') way; or
- they have not thought about alternative ways of carrying out the errand.

That is, is it a situation in which the manner in which an errand is carried out, is a matter of 'want' rather than 'need'? As such, it may be useful to investigate whether transport really is a rational activity, as is assumed for the purposes of transport planning models (Ortúza & Willumsen 1990, p. 245). There may be other motivations for transport as a non-derived demand (e.g. Lyons & Urry 2005; Redshaw 2008).

The doctoral study on which this thesis is based was concerned with the habits associated with trip making, in the context of RRC. As such, the concept of life events is relevant. Life events are events which cause people to reconsider their behaviour (see s.3.3.2). This study considers whether, and how much, RRC acts as a life event and how this affects trip making for motorists.

1.1.2 Definitions

A reduction in the road space available to all motorists occurs when all or part of a road is closed: for example, when a street is pedestrianized or part of the carriageway is reallocated to a particular class of traffic such as buses or turning vehicles (see s.1.1.4 and Figure 1.1). A reduction in road space at one place in a network does not necessarily lead to a reduction in the overall capacity of the network, either for motorists or in terms of the number of people to whom access is made available. Network (or road) capacity, which refers to the ability of the road network to accommodate vehicles, is primarily dependent on the capacity of junctions (O'Flaherty 1986), but other factors, including motorists' manner of driving, also have an influence (see s.4.4.9). When road space is reduced, other changes made to the road network may compensate for the disappearance of road space and this may affect the overall capacity. For example, the reduction in capacity in one place may be compensated for by:

- motorists changing their style of driving (e.g. space between vehicles) so that there is no net effect;
- improving the network efficiency by closing minor roads or separating vehicle flows to minimize conflicts between opposing flows;
- policy changes such as not allowing car parking on the network, in order to free up road space; or
- using alternative capacity: changing route or time of travel (Cairns *et al* 1998, pp. 24-29).

In this thesis, reduction in road capacity refers to a reduction in overall capacity. It is necessary to distinguish between capacity for motor vehicles and capacity for people. There is potentially more capacity for people who are walking, using buses or rail, or cycling, in a given space, than capacity for motor vehicles. This study is primarily concerned with capacity for motor vehicles. Road capacity in the rest of this thesis should be understood to refer to capacity available for private motor vehicles (cars, light goods vehicles (LGVs) and motorcycles) in order that they may progress along the road.

1.1.3 Synonyms

In the UK the phrase 'highway capacity reduction' is used for this phenomenon, since under the English legal system the word 'highway' refers to a road or other way (e.g. footpath) over which the public may pass and repass as of right (Martin 1994). However, if the concept is to become more widely used, it was felt that the word 'highway' would be confusing, since it has different meanings in different jurisdictions.

Other phrases which are used to refer to this phenomenon include 'traffic evaporation' and 'traffic degeneration'. However, it was felt preferable to use a precise description of the phenomenon being discussed, since traffic does not necessarily disappear when capacity is reduced. Situations where capacity is reduced but traffic does not disappear are still of interest.

1.1.4 Types of reductions in road capacity

Reductions in road capacity fall into three general groups. The traffic authority can create the situation which reduces the capacity deliberately, by physically restricting the road space or restricting the groups of motorists who may use that space. Alternatively, it may have to deal with unintentional incidents which restrict the capacity for one or more groups. The reductions may be of a permanent or a temporary nature. This is summarized below and depicted graphically in Figure 1.1. Examples of RRC, using a combination of physical restrictions and restrictions on the vehicles allowed onto the road, are shown in photographs:

- Figure 1.2 shows a link to which access is restricted because of the weakness of the structure;
- Figure 1.3 shows an example of RRC due to road space being reallocated to another mode (light rail);
- Figure 1.4 shows a road that is unusable because of damage (owing to an earthquake); and
- Figure 1.5 shows a link that has been pedestrianized and where motor vehicle access is only permitted for three hours per day.

Restrictions on use of the road by group:

- (complete) lanes restricted to particular modes or groups within that mode;
- (portions of) space taken for use by particular groups;
- roads/bridges closed to certain groups; and
- restrictions on selected parameters of the user group.

Deliberate physical reduction in road space:

- insertion of physical features into the road space;
- road closures, either temporarily or permanently;
- traffic calming features; and

- flow-on from kerbside uses.

Unintentional physical reduction in road space:

- damage to roads, bridges and other infrastructure;
- incidents which make part of the road space unavailable; and
- incidents which affect the progress of vehicles.

No study which gives the comparative frequency of these incidents has been sighted. However, an examination of the literature suggests that the following are the most frequent causes of reductions in road capacity on a permanent or temporary basis:

- reassignment of lanes/links to other modes (e.g. bus lanes, pedestrianization);
- assignment of links to special groups of general traffic (e.g. high occupancy vehicles, turning traffic);
- restrictions on speed/weight/height because of deficiencies in infrastructure;
- road traffic accidents;
- road work;
- traffic calming features;
- closure of bridges because of road works or damage; and
- natural and man-made disasters affecting infrastructure.

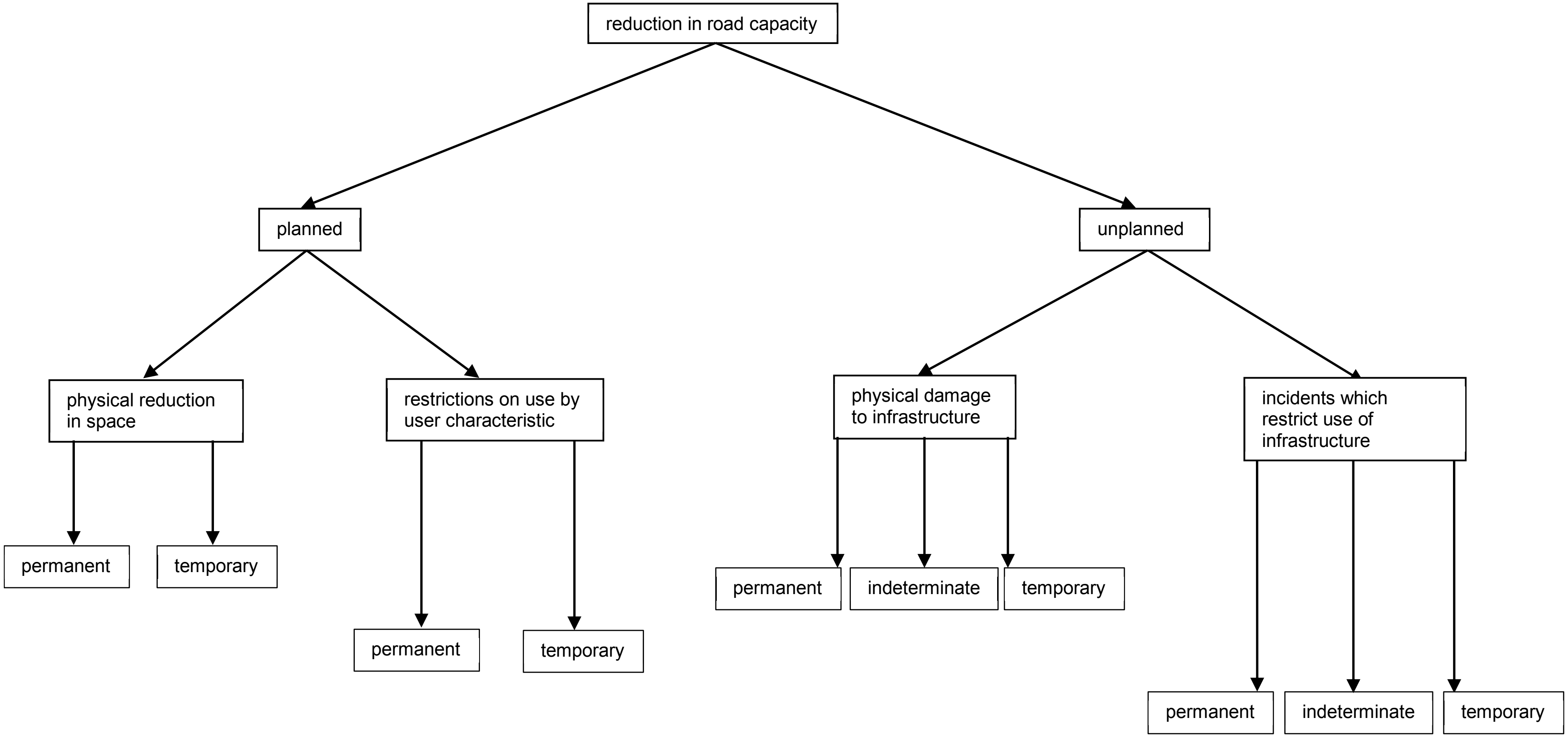

Figure 1.1 Categories into which an incident of reduction of road capacity may fall

Figure 1.2 Iron Bridge, Exeter, England
(November 2012, looking south-west) – use of the road (bridge) is restricted to vehicles up to 6ft (1.8 m) wide and 3 tonnes in weight.

Figure 1.3 Hay Street, Sydney
(August 2013, looking west) – vehicular use of the street at this point is restricted to light rail.

Figure 1.4 Earthquake damage on Bridge Street, Christchurch, New Zealand
(2011) –– route impassable to motor vehicles. Source: Martin Luff, Flickr

Figure 1.5 Pitt Street Mall, Sydney
(September 2013, looking north) – vehicular use is restricted to the hours 5-8 a.m.

1.2 Statement of the Problem

1.2.1 What is the problem?

While individual cases may be controversial, the general principle of building new roads is well accepted. The opposite situation, of closing roads, is not so common. Nevertheless, reductions in road capacity occur for a variety of reasons. A breakdown of the situations leading to a reduction in road capacity is given in Figure 1.1.

Some of the most common situations which relate to reduced road capacity are those associated with:

- alterations in road infrastructure, including dealing with its finite life span;
- alterations in land use and the associated need for infrastructure;
- a desire to change travel behaviour that is causing problems in the current traffic situations; and
- the occurrence of natural disasters and human interventions which damage road infrastructure.

The evidence, to be discussed further in Chapter 2, is that after some initial confusion, (motor) traffic adjusts to the new situation after road capacity is reduced. As part of the process some of the (motor) traffic will disappear, although it is not possible to specify how much. The process can be of concern to people who do not understand how the road system will cope with the reduced capacity. Although there is some knowledge of where disappearing (motor) traffic goes (see Table 2.1) and the causes, the phenomenon is not yet well enough understood to be able to answer all people's concerns in a way that will reassure them. Therefore, this study aims to increase understanding of motorists' behaviour in a situation of reduced road capacity.

In order to deal with reduced road capacity (in particular, those situations listed above), it would be useful to have a specific knowledge of how motorists react to reductions in road capacity. This would allow responses to be better tailored to each situation and maximize the range of possible responses to the situations listed above, rather than applying a 'one size fits all' solution.

1.2.2 Significance of the problem

If the real capacity is reduced, the empirical evidence is that the volume of (motor) traffic in the treated road or area is reduced. This may be only at times of high demand, or in demand overall.

There are a number of consequences that can follow from reducing road capacity, and hence the amount of motor traffic. They depend on the precise response made by each individual motorist, and include migration of traffic to:

- other parts of the network; or
- other times of day; or
- other modes of transport; or
- trips being suppressed altogether.

This is discussed in greater detail in s.2.3.5.

If there is a change from motor traffic to more sustainable modes, or trips are in some way suppressed or eliminated, the consequences can include:

- reducing the amount of congestion, and pollution emitted, in the area;

- changing land use. The land formerly occupied by roads may be used for other purposes, such as retailing, housing or as social spaces. A sufficiently large decrease in motor traffic might permit new modal corridors (such as bus lanes, cycle lanes or space for light rail) to be created, although generally new modal corridors precede any reduction in traffic; or
- changing the practicable land uses to ones which do not necessarily require access to the street by private motor vehicles[2] (PMVs) at all times.

These changes may in turn affect people's health and the local economy.

There are several reasons why more needs to be known about this subject. If a reduction in road capacity is to be used to achieve these outcomes, then it is essential that:

- the community understands what it means,
- the benefits are publicized and emphasized; and
- any drawbacks are understood and dealt with.

These will contribute to ensuring that the process is acceptable, and therefore accepted and used when appropriate.

For example, while there may be short term disruption after a road is closed, there will be longer term benefits to the motorists whose road has been made inaccessible (assuming no growth), in terms of less motor traffic on the network (and therefore less potential for congestion, pollution and road traffic accidents), and to the wider community in terms of an improvement in the environment.

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[2] Cars, light commercial vehicles and motorcycles

Road authorities need to know the ways in which groups of motorists are most likely to respond to an instance of RRC. This will help them decide the most appropriate interventions and the timing and precise nature of any interventions.

1.2.3 Selected areas of concern

Introduction

A better understanding of people's reactions to network events such as RRC would be of benefit in at least six areas:

1. decisions about the most efficient use of road space;
2. decisions about the future of roads and other transport infrastructure;
3. programmes of transport demand management;
4. transport modelling;
5. the aftermath of natural and man-made disasters, such as earthquakes and infrastructure damage; and
6. decisions about handling passenger transport because of a changing climate and declining oil supplies.

1. Efficient use of road space

The reallocation of road space to favoured (i.e. non-PMV) modes could help to make more efficient use of road space (in terms of number of people carried) and improve the attractiveness of non-car modes. This could increase accessibility to specific locations. It has the potential to bring about environmental improvements, enhance street attractiveness and improve (road) safety (Goodwin 1998).

2. Future of transport infrastructure

Some of the **roads** built in the 1950s and 1960s are now reaching the point where the road authorities must decide whether they should be rebuilt, repaired or demolished (Siegel 2007). This applies to local roads as well as major routes (e.g. Jeff Roorda & Associates 2013). In order to make a balanced judgement on the appropriate course of action, the authorities need to be able to predict how motorists would react to each course of action (e.g. Hendrickson *et al* 1982; Bullard 1987; Meyer 1988; Khattak & de Palma 1997; Cairns *et al* 1998; Rees & Williams 1998; Hunt *et al* 2002; Shin & Lee 2006; Ye *et al* 2010; ITDP 2012).

Figure 1.6 Electric trams on George St West, Sydney
(November 1931, looking east) – photo shows the junction with Glebe Point Road
Source: NSW Government Printer, *City Views*, State Library of NSW

From the late nineteenth century into the twentieth century, some major roads carried trams as part of their normal traffic (for example, the section of George St West

(Broadway) between Railway Square and the University of Sydney was the busiest section of Sydney's tram network at one time (*Report of the Royal Commission for the Improvement of the City of Sydney and its Suburbs* 1909)) (see Figure 1.6). Many tram systems were phased out in the 1940s, 1950s and 1960s (e.g. Laird *et al* 2001, p. 6; Spearritt 1978, pp. 154-155; Hylton 2010, p. 246). Trams or light rail have now been reintroduced in a number of cities, including Sydney (see Figure 1.3) (e.g. Knowles 1996). There are calls for more light rail (Christie 2010). If so, an alignment would need to be found; one possibility would be to use roads where tram lines used to run.

Roads, bridges and other transport infrastructure are likely to be affected by rising sea levels in the future. The first pass national assessment of climate change risks to Australia's coastline (Australian Department of Climate Change 2009, p.120) states that 1,800 bridges are within 200m of the Australian coastline. This is in addition to many kilometres of roadway. The report lists some of the impacts that climate change will make on infrastructure, including accelerated degradation of materials used in infrastructure due to rising sea levels, increased ground movement, changes in groundwater and increased temperature, solar radiation and humidity. All these factors must be taken into account when deciding how to adapt to climate change at a particular location – whether to protect, retreat or accommodate. When making that decision, it will be necessary to consider the consequences of each action. This study will cast light on what is likely to happen to traffic currently using the infrastructure if the chosen option is retreat.

In addition, there are a variety of groups whose opinions and attitudes are relevant to any decision on the future of transport infrastructure. They include (potential) users of the infrastructure, politicians, planners and residents of the area through which the road runs.

Better knowledge of how the network would operate under conditions of reduced road capacity means that it would be possible to give these groups better information about projected changes.

3. Travel demand management

In the current situation in urban Australia, some authorities wish to influence traffic to reduce the number of trips and to change mode from car to public transport, cycling or walking (Nicholson 1998; James 2002; NSW DoP 2010).

Travel demand management (TDM) is concerned with changing people's travel behaviour.

> The keys to effective TDM intervention are, on the one hand, understanding .... 'triggers' which lead individuals to deliberately reappraise their travel decisions and to change travel behaviour, and then influencing the variables that create the necessary circumstances that prompt decisions leading to the desired pattern .... and on the other, understanding which groups are most susceptible to change so that TDM measures might be targeted .... most effectively. (Behrens & del Mistro 2010)

Work has been carried out on changing people's travel habits in several countries. In Australia, the TravelSmart/Indimark® and travel blending approaches (e.g. Ampt & Rooney 1998; James & Brög 2003; TravelSmart Australia 2009) have been used to enhance people's competence in the use of non-car modes. Help is provided to travellers to allow them to determine whether their trips are being done in the 'best' way. Sometimes this involves a change of mode. This has been shown to be effective, but it is also labour intensive, costly and time consuming (although its proponents point out that it is cost effective when compared with approaches such as improvement of public transport or new infrastructure).

RRC, on the other hand, affects the travel behaviour of many people simultaneously. There is no need to wait for many separate events to prompt changes in many individuals' travel behaviour. Instead, a single event is substituted which affects all the users of the capacity reduced link. A percentage of the changes will involve moving to a different mode but other responses, such as trip suppression, are possible (Cairns *et al* 1998, p. 58). The size of that percentage is likely to be affected by the way the RRC event is handled and the travellers' existing knowledge of the use of other modes. Therefore, in order to make effective use of RRC as a tool to enhance sustainability, it is necessary to understand how a network event such as RRC can influence travel behaviour.

Furthermore, an understanding of which trips disappear may prove useful in understanding the economic and social effects on an area subject to an event of RRC.

4. Transport models

A knowledge of the trips which might be amenable to change could allow transport planners to better tune transport models. In an attempt to reflect current reality on the road network, these rely on assumptions about the behaviour of motorists during 'normal' trips and their reactions to events such as congestion. The models can have large margins of error (Mackett 1998; Flyvbjerg *et al* 2006; Bain 2009; Veitch *et al* 2013) (e.g. over 10% can be acceptable, because of the errors in the data (Matzoros *et al* 1987)). This is in part due to the fact that the models usually use fixed trip matrices and therefore assume (erroneously), that if capacity is reduced in one area, the only response of the (motor) traffic is to change route, instead of allowing, for example, for changes in time or mode, or the suppression of trips. If the network is operating close to capacity, such behaviour could lead to significant problems of congestion and hence delay and increased journey time (MVA Ltd 1998). Gärling and his colleagues (1998, p. 14) note that: 'The predictive ability of existing travel choice models are [*sic*] in fact not impressive'. Other authors are less kind: 'It is known that traffic forecasts are guesstimates at best' (Chung 2008). The ability to better tune models would give transport planners and their clients greater confidence in them.

The importance of accurate forecasting has been demonstrated in several cases in recent years where models were substantially in error in their predictions of motor traffic on new infrastructure projects. In some cases, such as the Cross City Tunnel in Sydney (Phibbs 2008), the projections exceeded (by a large margin) the actual flow the road attracted. Phibbs reports investors saying that they would be more sceptical of (motor) traffic forecasts (for infrastructure investments worth millions of dollars) in the future.

The opposite also occurs. In 1992 the Metrolink light rail system in Manchester (England) was opened. The initial phase involved the replacement of two heavy rail lines by light rail. Several city centre streets were closed so that the gap between the (former) heavy rail lines could be filled by street running light rail. The expectations of where the traffic would come from were incorrect. Patronage exceeded the forecasts, but was not composed of all the users of the heavy rail lines, nor as many bus users as anticipated. Only about half the former rail users moved across. However, the line attracted people from cars and generated leisure trips (Knowles 1996). Further expansion of the light rail network has since taken place.

5. Natural disasters and human errors

As well as natural disasters such as earthquakes and land slips, human error can cause damage to road infrastructure so extensive that it is no longer usable by motorists (e.g. Scott 1978; Giuliano & Golob 1998; Cairns *et al*1998). In such cases, motorists have to find alternative ways of performing their errands. The empirical evidence is that in such cases motorists adapt to the situation in ways which include changing mode and suppressing trips (*ibid.*). Administrative officials can learn how to best manage the situation from the experience of other cities in similar situations. A better understanding of how the problems associated with such emergency situations have been handled elsewhere will allow better recovery from both planned and unplanned incidents.

6. Climate change and declining oil supplies

The lessons from the situations described above can be applied on a broader scale in the case of climate change and declining oil supplies (Lee & Wood 1978a; Sharples 2013).

1.3 Researcher's personal interest

1.3.1 Tasman Bridge

Sometimes roads are closed and capacity reduced unexpectedly. This happened in Hobart, Tasmania, in early January 1975, when a large ship travelling up river veered off course. Instead of passing under the central (navigation) span of the Tasman Bridge, it swung eastwards and collided with the bridge, destroying two piers and three spans (Director of Public Works Department 1976). As this was the only bridge over the Derwent River in the urban area, it prevented direct road travel between the eastern and western shore suburbs of Hobart. The damage took almost three years to repair and during this time the residents of Hobart had to find alternative ways to cross the river (Scott 1978).

My interest in this subject stems from my experience as a teenager living on the eastern shore of Hobart at the time of this incident. My family and friends, along with the other residents of Hobart, particularly those on the eastern shore, had to make adjustments to the way we lived and travelled, in order to cope with this. For us, it was impossible for this incident to be undone. We had to learn to live with travel restrictions and the attendant inconveniences while government and engineers mended the bridge.

Figure 1.7 The Tasman Bridge in Hobart
This shows the damage after a ship collided with it in January 1975. The inset shows the cars that were left dangling over the edge when the piers and spans collapsed. This view is looking north-west from the eastern shore.
Source: Photograph courtesy of Ben Short (www.benshortphotography.com)
http://www.flickr.com/photos/vk7ben/6839903193/

1.3.2 Highway capacity reduction report

As a result of an interest in the subject, engendered by personal experience, I took note when I saw the call for information for a study of highway capacity reduction in 1997 (If new roads generate traffic, what happens when capacity is reduced? 1997). I suggested that the Transport Studies Unit (TSU) of the Economic and Social Research Council (ESRC) in the United Kingdom use the Tasman Bridge as one of their case studies, which they did. The report of that study (the HCR report) was published in 1998. It noted that there was much more research that could be done (Cairns *et al* 1998).

This doctorate presented an opportunity to study the subject further.

1.4 Changes since 1998 in Australia

It is a commonplace observation to note that the world, including Australia, has changed in the years since the HCR report first appeared (1998). There are many changes which could be explored, including population trends, amount of travel done, patterns of employment, patterns of land use, need for action on climate change and changing attitudes to transport. However, the only change that will be mentioned here is the enhancements to electronic route planning technology.

Since 1998 the range, availability and use of electronic aids to travel have expanded. However, only aids to PMV trip planning will be considered in this thesis. From radio traffic reports and variable message signs, the use of electronics in road transport has now expanded to include on-board navigation systems such as global positioning systems (GPS) as well as Internet journey planners and TV channels with traffic information. There are sites on the Internet that can supply live traffic information for some locations (see Figure 1.8). This extra information provides motorists with possibilities for exerting more control over the timing of their journeys and the amount of congestion they are likely to meet along the way.

1.5 Research questions

1.5.1 Objectives

The objective of this research was to study, using qualitative methods, the manner in which motorists' traffic habits affected their responses to a situation of reduced road capacity.

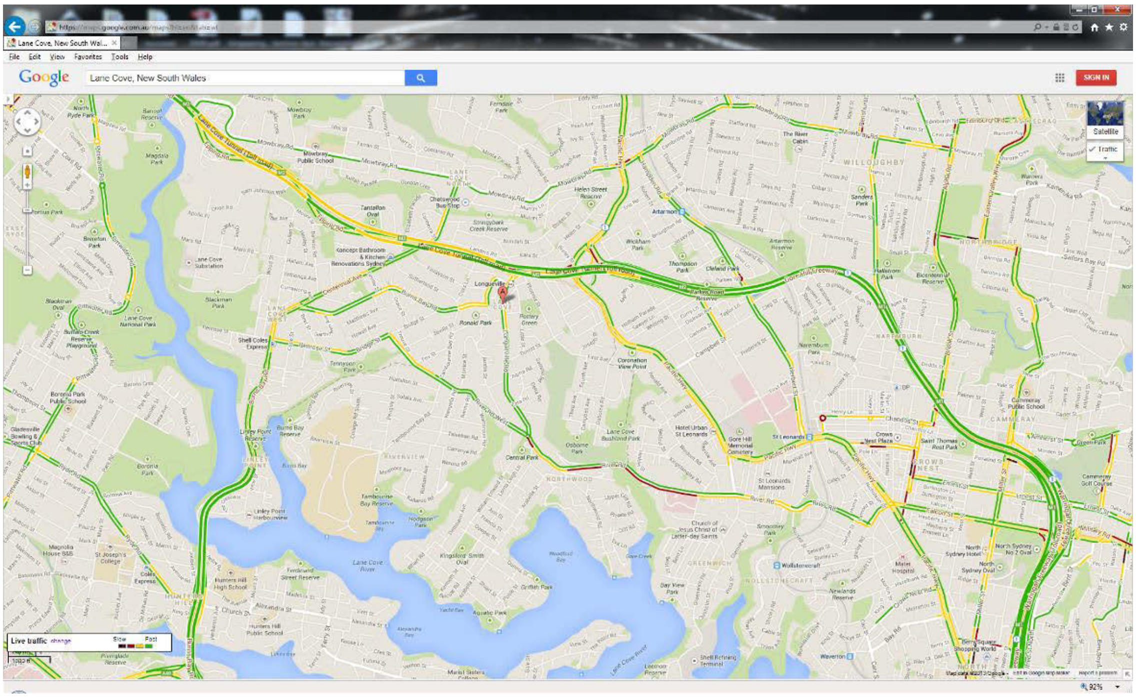

Figure 1.8 Google Maps live traffic report for the Epping Road corridor, Sydney (25/9/2013)

1.5.2 Research questions

The study sought to answer the following questions:

1) How do motorists' reactions (in terms of travel behaviour) in a case of RRC relate to their existing travel habits?

2) How can the trips be identified, which, in order to reduce the volume of motor traffic to acceptable levels, are most likely to disappear after a network event such as RRC?

3) How can RRC contribute to a sustainable urban future, particularly in the context of travel demand management?

These three questions are answered in Chapters 6, 7 and 8 respectively.

1.5.3 Limitations

The data gathering element of this study consisted principally of qualitative surveys of motorists who had used Epping Road in Lane Cove both before and after it was reduced in capacity. Because it was a qualitative study, it did not produce results of a statistical nature.

The panel of motorists interviewed was a convenience sample. Although both genders were represented and there was a range of income bands, types of households and employment situations, all the interviewees either lived in Lane Cove or worked in the adjacent areas. Thus, all the interviewees had some knowledge of Epping Road and the nearby roads. It is possible that motorists who only used Epping Road occasionally, as a small part of their journey, and who therefore did not know the area well, may have reacted in a different manner to the drivers interviewed for this study.

Finally, it should be noted that this was a study of motorists only. The behaviour of bus users, cyclists and pedestrians was not considered (except incidentally).

1.6 Structure of thesis

1.6.1 Introduction

This thesis is organized as follows:

- review of the literature and traffic situation on Epping Road;
- methodology and data collection;
- analysis;
- contribution to sustainability; and

- conclusion.

1.6.2 Review

The literature review component of this thesis is principally contained within Chapter 2 (reduction in road capacity in the literature) and Chapter 3 (three particular aspects of travel behaviour). The traffic situation on Epping Road is reviewed in Chapter 4.

The principal discussion in **Chapter 2** is concerned with the report on capacity reduction produced in the UK in 1998 (the HCR report). The chapter also discusses further studies on the subject which have taken place since 1998, the limitations of the methodologies used and the gaps in the knowledge of this subject.

Chapter 3 discusses several aspects of behaviour that are relevant to this thesis. They are the need to make trips, the concept of a life event and planned and unplanned behaviour, especially habits.

The traffic situation on Epping Road as it was before the Lane Cove Tunnel was constructed, after the tunnel opened, and when the interviews were undertaken, is discussed in **Chapter 4**.

1.6.3 Data collection

Chapter 5 discusses the choice of site for the field study, the methodology and the manner of collecting the attitudinal data that was used for this study.

1.6.4 Analysis

Chapters 6 and 7 present an analysis of the data that was obtained from all sources.

Chapter 6 first presents brief travel biographies of the interviewees. This is followed by a presentation of quotations regarding the 11 main themes that were of interest to the interviewees. Interviewees' reactions are supported by opinions from the e-mails, social forums and websites. Chapter 6 concludes with a discussion of life events and habits as they relate to the interviewees' behaviour.

Chapter 7 is concerned with the habit of route switching that some of the interviewees displayed and the implication that this holds for an incident of reduced road capacity. Two hypotheses are proposed which together may explain why (motor) traffic disappears only to the extent that it needs to, in a situation of reduced road capacity.

1.6.5 Contribution to sustainability

Chapter 8 proposes the phrase 'travel competence' to cover travellers' knowledge of, and ability to make, optimal use of the transport system. Examples are provided of the travel competencies that are needed to use common private and public modes from Greater Sydney. The chapter concludes with a description of an occasion where enhanced travel competency made an incident of reduced road capacity less disruptive than it might otherwise have been.

1.6.6 Conclusion

Chapter 9 summarizes the findings from this study and suggests areas for further study.

CHAPTER 2

Reducing Road Capacity in the Literature

This chapter constitutes the first part of the literature review for this thesis.

Section 2.1 introduces the chapter with a statement of the scope of this literature review. Section 2.2 gives a brief historical introduction to the topic, including several examples of reduced road capacity taken from the earlier part of the twentieth century. Section 2.3 discusses some of the studies of reduced road capacity that have been undertaken prior to this doctoral study. Section 2.4 discusses one report in particular: the UK report on highway capacity reduction (HCR) produced in 1998. Section 2.5 discusses methodological problems associated with the study of reduced road capacity, including those noted in the HCR report. Section 2.6 gives a series of illustrative examples of reduced road capacity from around the world, chosen to illustrate the qualitative studies that have been conducted in instances of reduced road capacity. Section 2.7 discusses what is known about reduced road capacity and points out some of the topics for which further investigation remains to be done. Section 2.8 summarizes the chapter.

2.1 Introduction

As described in Chapter 1, road capacity can be reduced in a number of ways, including physical removal of space and reallocation of road space to specific groups. These two categories are the ones which will be considered in this thesis as they can be expected to have long-term effects.

Road capacity may also be reduced because of incidents on the road which make a part of it unavailable for a short period. Examples of this include road traffic accidents or buses or trams stopping to pick up or allow passengers to alight. Such changes are short term. As this study is principally concerned with long term changes in motorists' behaviour, they will not be considered.

Because of the limitations in documentation, this study will only consider in any depth incidents of reduced road capacity (RRC) from the 1970s onwards, which have appeared in the English language literature.

Although an incident of RRC is sometimes used as a plot device (e.g. Wilder 1941; Lewis 1951; Pratchett 1989; Rowling 2005), fictional cases will not be considered here. Neither films, poetry nor songs will be considered.

2.2 Historical examples of reducing road capacity

Reducing road capacity is not a new phenomenon. There are examples throughout history of capacity being reduced deliberately, either for environmental reasons or because, for example, transport infrastructure was damaged or destroyed in an act of aggression (e.g. Hayden 1976, pp. 27, 33, 35-36).

2.2.1 Road closures for environmental reasons – pre-twentieth century

Ancient Rome

Closing roads to improve the environment is not a new response by authorities to traffic problems. For example, in ancient times Julius Caesar (ruled 49-44 BCE) banned most wheeled vehicles from the centre of Rome during daylight hours because of the congestion they created (Figure 2.1). The ban was extended to other Italian cities by Claudius (ruled 41-54 CE) and by Marcus Aurelius (ruled 161-180 CE) to every city in the Roman empire (Carcopino 1956, pp. 61-63; Le Glay *et al* 2005, pp. 519-525).

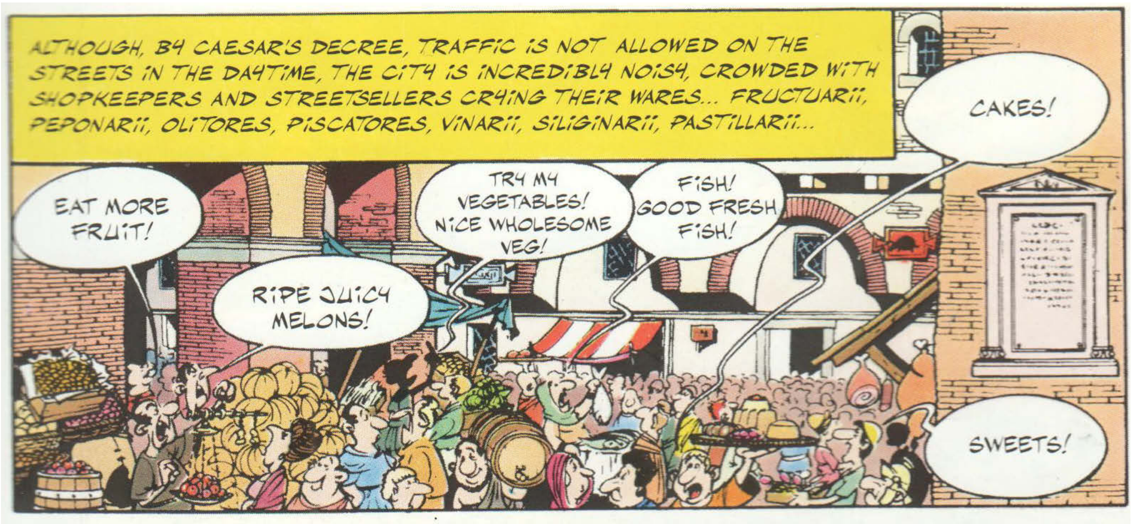

Figure 2.1 Goscinny and Uderzo's light hearted interpretation of Julius Caesar's ban on wheeled traffic in the centre of Rome
Source: Goscinny & Uderzo 1974

London – Paternoster Row

There is occasional, incidental evidence for other road closures being used for environmental purposes. For example, when Elizabeth Gaskell describes Charlotte Brontë's visit to her publisher in London in 1848, she mentions that Paternoster Row in London was closed to prevent the passage of carriages and ensure silence, by means of a post at each end:

> Paternoster Row was for many years sacred to publishers. It is a narrow flagged street, lying under the shadow of St. Paul's; at each end there are posts placed, so as to prevent the passage of carriages, and thus preserve a solemn silence for the deliberations of the 'Fathers of the Row' (Gaskell 1971, Chapter xvi, p. 292).

2.2.2 Road closures for environmental reasons – mid-twentieth century

United States of America (New York) – Washington Square Park

A modern example of a road closure comes from the United States of America. Fifth Avenue ran through Washington Square Park in New York City until 1959. The planning authorities wanted to enlarge the road. However, at the insistence of local people and as a result of a seven year campaign, led by Shirley Hayes, it was closed and incorporated in the park instead, thus protecting the historic nature of Greenwich Village and the only large green space in the neighbourhood (New York City Parks 2001). The predicted traffic chaos did not occur. Jane Jacobs (1962) is one person who is particularly associated with publicizing this example of RRC.

Germany – pedestrian malls

Also in modern times there has been a tradition in Germany of closing streets in order to pedestrianize them, which dates back to the city of Essen in 1926. By 1966, 63 West German cities had pedestrian malls (Hajdu 1988). Hass-Klau (1997) gives two reasons for the success of pedestrianization schemes in Europe:

- road traffic had already been diverted onto ring roads, so that it was already bypassing the centre before pedestrianization was implemented; and
- effective public transport systems.

Australia – pedestrian malls

Road closures for environmental reasons in Australia have been undertaken for several decades (Tinslay 1979). In particular, streets have been pedestrianized in Australia since the 1970s (e.g. Harris 1974). Duffy (1981), writing of a mall in Launceston, summarizes it well:

‘The whole objective can be succinctly put: ‘The creation of pleasant places where people can relax.’’

Examples in the Greater Sydney area include Martin Place and the Pitt Street Mall in Sydney city centre and Church Street in the centre of Parramatta. The latter, however, was not successful as a retail centre and was reopened to some traffic in 2007 (Parramatta City Council 2007).

2.2.3 Other ways in which road capacity is reduced

Bridge damage

Damage to bridges or bridges failing because they were not designed to withstand local environmental conditions are examples of road capacity being (unintentionally) reduced (e.g. Hayden 1976, pp. 122-124; Crosby in Crosby (Ed.) 1998, p. 78).

Facilities for particular modes

Other ways in which road capacity can be reduced or reallocated are listed in s.1.1.3. Although some of these are modern concepts, the sometimes deleterious effect on capacity caused by one form of transport facility for other traffic has been noticed for many years (e.g. problems for, and because of, trams/light rail: ‘STREET TRAMWAYS’ 1878; ‘That Horrible Tram’ 1882, cited by Burke 1997, p. 10; ‘Colonel Crompton on the motor car’ 1902; Report of the Royal Commission for the Improvement of the City of Sydney and its Suburbs 1909; ‘A new parking ban?’ 1955; Saulwick 2011).

2.3 Some studies of reductions in road capacity

2.3.1 Introduction

Although there is a long history of reducing road capacity (s.2.2), no documented technical studies on this topic, in English, before the 1970s have been found. Therefore, the literature review for this thesis considers case studies from the 1970s onwards.

It is necessary at this point to distinguish between the effect that reducing road capacity has on the ability of the road network to carry vehicles and the effect that reducing road capacity has on the traffic (i.e. the motorists) using the road network. This study is concerned with the latter phenomenon, that is, motorists' reactions to RRC. However, for completeness, reference will be made to two documents concerned with the effect on vehicle carrying capacity of a reduction in road capacity, and a study related to the inclusion of reduced road capacity in transport models. It should also be noted that other studies of the effect on vehicle carrying capacity of a reduction in road capacity have been undertaken (e.g. Wall *et al* (2003) considered the effect on other traffic of inserting advanced stop lines for cyclists).

2.3.2 Traffic engineering and reduced road capacity - the *Highway Capacity Manual*

The *Highway Capacity Manual* (HCM) is produced by the Transportation Research Board in the U.S.A. It was first published in 1950. New editions were published in 1965, 1985 (with updates in 1994 and 1997), 2000 and 2010. It is also used in other parts of the world (e.g. Austroads 2009, p. 26; Yang *et al* 2009) (TRB 2000, p. vii). It considers the capacity of roads to carry motor vehicles in both theoretical and empirical aspects, and discusses reduction in capacity in terms of its effect on the physical ability of the road to cope with traffic. It considers the reduction that would be caused by:

- lane closure;
- reduction in width;
- construction activities;
- weather;
- road traffic accidents; and
- (motor) vehicular breakdown.

It also gives equations with which to quantify the effects (*ibid.* pp. 22-26ff). It does not consider the effect on motorists of reducing road capacity. That is, it assumes that motorists will (wish to) continue driving, however the road environment has changed.

For example, in their description of reduced road capacity using HCM methods (pp. 619ff), McShane & Roess (1990) in the U.S.A. give an example of a network working close to capacity (ratio of volume to capacity, v/c=0.93). A 15% loss of network capacity would result in a new volume to capacity ration of 1.09; that is, the network would be 9% over capacity. There is no comment on how this may affect motorists' perceptions of the road network, and their actions, in a wider sense.

2.3.3 Reduction in road capacity at roadworks

In 2008, the Transport Research Laboratory in England published a report entitled *A Review of Literature on the Nature of the Impact of Roadworks on Traffic Movement and Delay* (Bourne *et al*).

After discussing the economic impacts and causes of delays due to roadworks, the report considers possible means of reducing the delays (that is, ways of increasing capacity). The topic is divided up as follows:

- understanding capacity and delays at work sites;
- optimizing capacity;
- managing incidents;
- completing works efficiently; and
- diversion and demand management.

Certain topics discussed are not relevant to this thesis. For example, the observation that the main cause of congestion is driver behaviour in the merge area will not necessarily be of any relevance to incidents of RRC in which there is no merge area.

However, the review touches upon topics which may be relevant to longer term cases of RRC; that is, it may be useful to incorporate the lessons when an incident of RRC is being undertaken. These include the observations that:

- capacity is of a stochastic nature; that is to say, it follows some random probability distribution or pattern, so that its behaviour may be analysed statistically but not predicted precisely. It is not a fixed quantity but varies according to driver behaviour, other traffic, and road and weather conditions;
- the percentage of heavy goods vehicles (HGV) has the greatest effect on capacity;
- capacity is higher when the nearside lane is closed than when the offside lane is closed; and
- capacity can be increased by modifying driver behaviour. Examples given include:
    - restricting HGVs to the nearside lane;
    - prohibiting lane changing;
    - having a police presence;

- reducing the variability of speeds and headways to create a smooth flow; and
- using demand management techniques to minimize the number of vehicles.

It is assumed, but there is little study to support the assumption, that three narrow lanes have more capacity than two wide ones (Austroads' levels of service assume a minimum width of 3.6m for each lane (Austroads 2009, p. 35)).

2.3.4 Early behavioural studies

As described in s.2.2, reducing road capacity for environmental reasons is not new. The observation that reducing road capacity may reduce travel is also not new:

> Very broadly speaking, the amount of traffic is governed by what is regarded as a tolerable level of congestion. .... If the capacity of the road network is not increased, the mileage performed will stabilise, and if the capacity is reduced, the mileage will be reduced correspondingly (Plowden 1972, p.15).

Nevertheless:

> It is not clear just how this process works, but its existence has long been recognised, especially in America ...[3] (*ibid*, p.16).

Grover & Richardson (1993) also assert that 'A condition for decreasing traffic generation is to decrease overall road capacity.' Goodwin (1997) discusses possible reasons for traffic disappearing after a road closure.

Individual case studies (e.g. Lock & Gelling 1976; Lee 1978; Lee & Wood 1978a; Lee & Wood 1978b; Scott 1978; Hendrickson *et al* 1982; Bullard 1987; Meyer 1988; Pratt 1991;

[3] Plowden does not give a reference for this statement, so it is not possible to determine its basis. One possibility is the case of Washington Square Park (s.2.2.2).

Devine *et al* 1992; Grover & Richardson 1993; Gordon *et al* 1998; Giuliano & Golob 1998) have found two general results arising from an incident of RRC. Firstly, most motorists' reaction to RRC is to either change their route or time of travel (that is, take the least (personally) disruptive course of action (Yun *et al* 2011)) and secondly, chaos does not result. Nevertheless, no overall study of the behavioural aspects of RRC (that is, the effects on motorists rather than the network), produced prior to 1998, has been found.

2.4 The highway capacity reduction report

2.4.1 Introduction

In the 1990s, London Transport, which operated buses in London, became frustrated at the difficulty they were having getting dedicated road space for buses in situations where this might impose delays on general traffic (If new roads generate traffic, what happens when capacity is reduced? 1997). In conjunction with the UK Department of Environment, Transport and the Regions, it sponsored a study of the evidence about the traffic impacts of the reduction or reallocation of road capacity. The study was undertaken by the Transport Studies Unit of the UK's Economic and Social Research Council (ESRC) at University College, London.

The terms of reference for the study included:

> ... establishing a practical and authoritative means of estimating the likely effect on traffic flows of selective reduction of highway capacity for certain classes of vehicles ...

It was intended that the work would:

> ... review existing knowledge including both practical experience and theoretical principles, and should provide a convincing and defensible means to estimate the effects of capacity withdrawal ... (Cairns *et al* 1998, p. 2)

The report of the study, entitled *Traffic Impact of Highway Capacity Reductions: Assessment of the Evidence* (the HCR report) (*ibid.*) was published early in 1998. It discusses the theoretical aspects of closing roads, and how and why people change their travel behaviour. The report then describes a selection of case studies of a reduction in road space in locations worldwide and concludes that, on the balance of probability, there is a real relationship between reduced road capacity[4] and reduced motor traffic.

2.4.2 Why traffic disappears

The authors noted that traffic in an area will only reduce under certain conditions. That is, the traffic will reduce if the reduction in road capacity is not offset by spare capacity elsewhere or at some other time, and other actions, such as changes in traffic management or motorists' driving style, do not permit the original number of vehicles to fit into the remaining space.

The changes whose effects make driving in an area unacceptable to motorists include:

- a significant reduction in capacity without adequate spare capacity on alternative routes or at acceptable other times due to the nature of the network;
- the prevailing level of congestion; or
- the comprehensiveness of the road closure scheme (*ibid.* p. 57).

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[4] The overall capacity of urban road networks is normally determined by the capacity of the major intersections, although the number or width of the lanes on the roads themselves have an effect as well (O'Flaherty 1986, p. 344; Austroads 2009, p. 26). See also Bourne *et al* (2008); HCR report (*op. cit.*); Smeed & Wardrup (1964).

The changes in traffic volume after an instance of RRC vary over a wide range. There are cases where the volume of traffic increased. Nevertheless, Cairns *et al* (1998) report that if the outlier results are omitted, 50% of the remaining locations show overall reductions in flow of more than 16% on the roads which have been affected (*ibid.* p. 14). This figure was later revised down (s.2.3.8).

2.4.3 Change of flow with the passage of time

Responses to road closures varied with the passage of time. The evidence from the case studies was not of such a nature as to allow systematic longitudinal examination of motorists' responses to RRC. However, it was possible to infer behaviour (*ibid.* p. 33) (also Meyer 1988).

In the very short term of the first few days, there is sometimes noticeable disruption (the 'traffic chaos' that is sometimes forecast) which resolves itself. However, this does not always occur, even on the first day. It is suggested that this is because motorists have heeded any advance publicity and altered their behaviour as necessary (Hendrickson *et al* (1982) suggest the process may start even before the closure).

In the short term (up to a year), there is a settling down period in which motorists take account of the new situation. This may be affected by the other events going on in their lives (e.g. moving jobs or home).

In the longer term (over a year), reductions in flow may be eroded or enhanced. Motorists may creep back onto the network (these may be the same motorists who initially disappeared, returning; new motorists joining; or general traffic growth due to increased car ownership. Economic conditions which affect the amount of travel done may also affect flows.) However, the HCR report (*op. cit.*) contains reports of an initial reduction in flow becoming larger with time, sometimes because of additional policies which reinforce the reduction.

2.4.4 Theoretical aspects

The evidence considered by the HCR report (*op. cit.*) was principally of an empirical nature and the authors found evidence of behavioural changes which explained the observed results. Nevertheless, assessment of theoretical evidence was part of the brief. The theoretical considerations for RRC are summarized below (*ibid.* pp. 7-13):

1. traffic flow and assignment theory

In 1964, Smeed and Wardrup demonstrated theoretically that journey times for both modes would decrease if enough people moved from cars into buses, because of the greater carrying capacity of the latter in comparison with the former. However, because of the (simplifying) assumption that motorists' only response to any congestion caused by allocating road space away from buses, to cars, would be to take an alternative route, it was feared that chaos would result.

2. theoretical justifications for a reduction in overall capacity

There are some situations in which theory suggests that an overall reduction in road capacity might be warranted. They include:

- the possibility of excess road provision, leading to induced traffic;
- Braess' paradox, an anomaly whereby the provision of extra road links increases journey time (and removing them would make all travellers on the network better off) (e.g. Youn *et al* 2008);

- positive feedback, assuming that reduced road capacity encourages the marginal traveller to use public transport, and an increase in public transport ridership improves the road environment for private motorists;
- market distortion, when the market price for urban land for roads does not represent the full economic cost and no charges are imposed for congestion and other environmental costs that motorists impose on society; and
- the consideration of non-transport functions of streets, including the use by utilities, and the social and commercial possibilities, which may outweigh the transport value of the street.

4. travel choice and behavioural response

Understanding of travel behaviour theory is important for understanding the effect of RRC. As noted below, the current state of behavioural theory:

- does not support the idea that change of route is the main response to RRC;
- does not support the standard models of trip generation, distribution, mode choice or assignment as the limit of choices made by travellers;
- does not support the view that choices are instantaneous, in equilibrium or based on decision rules that are defined by generalized cost of travel or utility maximization.

5. evaluation of schemes

An evaluation of schemes to increase road capacity is sometimes undertaken, either to justify the scheme or choose between alternatives. It is suggested that a similar evaluation should be undertaken for reductions in road capacity using similar criteria (environmental, social, equity, strategic policy objectives).

6. inference from the evidence on expanding road capacity

The SACTRA report (1994) concluded that expanding road capacity can induce traffic. It also concluded that: 'The mechanisms underlying suppression of traffic are the same as, but in the opposite direction to, those resulting in induced traffic ...'.

2.4.5 Overall findings

In summary, the report concluded that:

> *...traffic does 'disappear' in response to reductions in capacity, but only to the extent that it needs to do so.* This occurs due to responses by a proportion of drivers who take action to avoid what they consider, in relation to their prevailing experience, to be unacceptable conditions (Cairns *et al.*1998, p.57 (emphasis as in the original))

This phenomenon is sometimes referred to as traffic evaporation (European Commission 2004) or traffic degeneration (Rees & Williams 1998).

Two other important observations were also noted (Cairns *et al* 1998, p.58):

1. motorists' changes in behaviour include altering route, time of travel, mode of travel, origin/destinations, the frequency of trips and the person who makes the trip (these last four responses are all examples of the original trip disappearing) (Table 2.1, below).

   This is a wider range of responses than is normally allowed for in transport planning.

Table 2.1 Possible responses to reduced road capacity

Response to reduced road capacity	Examples
Changes in driving style	▪ Drive more smoothly ▪ Drive more slowly ▪ Drive closer together ▪ Refrain from overtaking
Changes in route	▪ Moderate and more extreme
Changes in journey start time	▪ Use flexitime ▪ Stagger school hours ▪ Offer free public transport fare periods ▪ Offer free congestion charging periods ▪ Reduce shift work ▪ Reduce overtime ▪ Do more trip planning
Change in destination	▪ Use different (closer) shops
Change in frequency of journeys	▪ Make occasional rather than regular trips
Change of mode	▪ Bus ▪ Rail (heavy and light) ▪ Motorcycle ▪ Cycle ▪ Different car (use a different vehicle/ carpool/ become a car passenger/keep a car on each side of the problem area) ▪ Park and ride/kiss and ride ▪ Ferry ▪ Walk
Differential response by journey purpose	▪ Non-work trips give way to work related trips
Consolidation of trips	▪ Undertake several errands in one round trip
Change in allocation of trips	▪ Between household members ▪ Outside household
Suppression of trip	▪ Use electronic communications instead of face to face meetings ▪ Work from home/teleworking, part or full-time ▪ Compress work week ▪ Retire from (full-time) paid employment ▪ Bankruptcy ▪ Use home delivery service ▪ Restrict vehicle use ▪ Take a holiday ▪ Cancel errand
Change in job location	▪ Different site ▪ Different employer
Change in housing location	▪ Move house ▪ Acquire additional accommodation for use during working week
Changes in developer choices for locating new developments	▪ New branch of existing operation ▪ Relocation of existing operation ▪ New business ▪ New housing

Source: Based on Figure 5A of the HCR report (*ibid.*, p. 58) with additional examples.
Note: Not all responses are applicable to all situations. An individual may make more than one alteration in their travel behaviour as a result of an incident of RRC.

2. analysis of a series of studies shows that a substantial proportion (usually 30-80%) of the traffic observed in an 'after' survey consists of different people from those observed in a 'before' survey, owing to day to day variability in traffic and longer term changes going on in motorists' lives.

Thus traffic consists of both a stable population of users and a changing population. Some will be able to respond to network changes more quickly than others, so the full effect of the network changes may take some time to emerge.

2.4.6 Modelling and reductions in road capacity

Although other forms of mathematical modelling have a place in the study of RRC (e.g. Clegg 2005; Youn *et al* 2008; Mokhtarian *et al* 2009; Carpenter 2010; Ye *et al* 2010; Yun *et al* 2011; Sohn 2011; González-Guzmán & Robusté 2011), the term 'transport modelling' usually refers to the software simulation of traffic that is used to help plan road schemes. Transport models are predicated on certain assumptions about motorists' behaviour (e.g. Ortúzar and Willumsen 1990, Chapter 1). These include the assumption that motorists will be making the same sort of trips and choosing the same sort of route as they do now, at a later date (e.g. 10 or 25 years into the future), based on, and primarily for, rational reasons. In fact, this cannot be assumed (Goodwin *et al* 2004).

Traffic Impact of Highway Capacity Reductions: Report on Modelling (MVA Ltd 1998), a companion volume to the HCR report (*op. cit.*), was also published in 1998. It was concerned with the general implications for transport modelling of a reduction in road capacity. It concluded that the initial modelling of a proposal for a road network should proceed as if no allowance needed to be made for traffic reduction. Only if the modelling suggested that this would cause significant traffic problems should any further adjustments to the models be considered. It also mentioned the difficulty of deciding the area which the model should cover so that all important effects are captured without being so large that spurious 'noise' effects become significant.

It is outside the scope of this study to consider further the application of transport models to the topic of reduced road capacity (or to the distribution of road space among competing modes).

2.4.7 Response to the highway capacity reduction report

A summary of the HCR report (*op. cit.*) was published in the June 1998 issue of *Traffic Engineering + Control*, a British magazine for transport practitioners and academics (Goodwin *et al* 1998). The report on modelling was summarized in the following issue (Coombe *et al* 1998). The study aroused some interest.

The work was further publicized to transport planners, academics, local authorities and the wider public, including transport campaigners, both in the UK and abroad (e.g. Hamer 1998; Kruse 1998; Rees & Williams 1998; Cairns 1999a; Cairns 1999b; Kane & Behrens 2000; Cairns 2002; Cervero 2006; Clegg 2007; Siegel 2007; Davis 2009). A copy of the first article was made available on the Internet (http://www.worldcarfree.net/resources/freesources/Evide.htm).

Kruse (1998), who was interested in planning for small and medium sized communities in the U.S.A., notes that: 'The key to accommodating a major change in traffic patterns like a road closure, appears to be flexibility of the transportation system'. That is, the alternatives that are available to people are instrumental in ensuring that a road closure does not cause chaos. These may be different transport modes but may also be the redundancy built into the road network, policy incentives, the ability to change the way people drive (e.g. make the trip at a different time) and different ways of fulfilling the errands which driving originally served.

She notes another lesson that can be drawn from the HCR report (*op. cit.*): the exaggeration of the importance of (in her examples) the freeways in the specific area's transportation system and the transformation possible to the urban area when a concrete barrier (such as a freeway) is removed.

Further work on RRC was carried out in the years following the release of the HCR report.

2.4.8 Further studies of reduced road capacity

In 2000 a follow-up conference, *Reallocating Roadspace: Putting Theory into Practice*, was held in London to discuss further experience with reallocating roadspace (Cairns *et al* 2002). Further case studies were discussed and transport professionals were surveyed as to their experience of RRC. The median proportion of traffic disappearing after an incident of RRC declined to 11%.

In a follow up article (*ibid.*) the authors point out that reducing the road capacity does not necessarily reduce accessibility. For example, the changes brought about as part of the Oxford Transport Strategy (that is, parking restrictions, bus priority, road closures and park-and-ride services (HCR *op. cit.*, p. 185)) caused a reduction in the number of vehicles entering the central area. However, monitoring showed that although the number of people arriving and parking declined by about 700-800 per day, the number of people arriving by bus increased by about 2000. That is, there were more people entering central Oxford by bus than used to enter by car.

In 1999-2000, drawing on the material in the HCR report and associated papers, researchers in Calgary, Canada investigated travellers' responses to the closure of the Centre Street Bridge. There were five alternative bridges to the Centre Street Bridge. The researchers found that many of the regularities noted in the HCR report (*op. cit.*) occurred (e.g. initial confusion, some modal transfer and few motorists making changes because of the bridge closure). However, they also note that 'there was significant crossover switching, as drivers sought the best route under the new traffic conditions' (Hunt *et al* 2002). This phenomenon is referred to in this thesis as a 'ripple effect'. Although in this case the ripple effect refers to route choice, it is also possible to have a ripple effect in time and choice of mode.

In 2004, the European Commission published a guide to successfully implementing road closures. The guide included a discussion of the issues surrounding the dominance of car traffic in urban areas, the concept of traffic evaporation, eight case studies from the European Community and guidelines on best practice in implementing schemes (European Commission 2004).

Also in 2004, Goodwin *et al* gave a presentation marking 10 years of the ESRC's Transport Studies Unit (TSU). Entitled 'Changing Travel Behaviour', the members of the unit described their work over the years. This included a description of the work on reducing road capacity, and its relation to components of behaviour change, including 'life shocks' (which are referred to later in this thesis as 'life events') (Goodwin *et al* 2004).

In 2012, the Institute for Transportation and Development Policy (ITDP), in conjunction with EMBARQ (a programme of the World Resources Institute), published a report entitled *The Life and Death of Urban Highways*, which, like Siegel (2007), was concerned with the removal (or non-construction) of freeways. It discusses five case studies: three in the USA, one in South Korea and one in Columbia. In two of the three cases from the USA, studies found that there was capacity for the freeway traffic on other roads. Therefore, strictly speaking, this was not a study of RRC. Rather, it is a study of a particular type of road infrastructure.

In the context of transport demand management, Fujii & Gärling (2003) note that it is possible to achieve long lasting (i.e. greater than one year) increase in the use of public transport (by people who were previously driving) from a temporary incident of RRC.

Reports of individual case studies continue to be produced (e.g. Rees & William 1998; Fujii *et al* 2001; Lee *et al* 2006; Cervero 2006; Clegg 2006; Shin & Lee 2006; Marinelli & Watson 2009; Mokhtarian *et al* 2009; Gilmore *et al* 2010; Carpenter 2010; Mobius Research and Strategy Ltd 2010; Ye *et al* 2010; Yun *et al* 2011). Some of these are discussed in s.2.6. The reports of other studies sometimes include descriptions of measures which were undertaken to facilitate traffic during any period of disruption (e.g. Ye *et al* 2010).

Other reports have been published on the reallocation of road space (e.g. bus lanes (Booz Allen Hamilton 2006; Currie *et al* 2007; Fleming *et al* 2013)). This may or may not involve a reduction in road capacity (s.2.6.4). However, the change in road capacity is given little, if any, attention.

2.4.9 Other evidence

Other situations of restrictions on car use may have lessons for situations of RRC. For example, Loukopoulos *et al* (2005) discuss the reactions of motorists in Trøndheim, Norway to the introduction of a toll ring. The survey also looked at the types of changes in travel behaviour which motorists had made in the categories of change in timing, mode and destination: fewer trips; more trips with others; and change of route. It should be noted that these are only a fraction of the changes that could be made (Table 2.1). The authors note that the majority of motorists did not change their travel as a result of the introduction of the toll ring, particularly those with a higher income.

2.5 Methodological issues

2.5.1 Limitations in possibilities for data collection

The HCR report considers theoretical aspects of the topic and the collected evidence from empirical studies. The authors did not undertake any new surveys for their study, although the report on the Hanshin-Awaji earthquake in Japan was produced for the HCR study (*op. cit.*, p.3).

The HCR report considers evidence from over 150 sources (including journal articles, reports, conference papers, newspaper articles, a PhD thesis and personal communications), relating to nearly 100 specific locations. Included in these is material relating to 44 case studies of road capacity reduction or reallocation. That material gives quantitative results and encompasses 55 individual locations from around the world. Material related to the effect on motorists of railway strikes in the Netherlands and a load spillage in England is also considered.

The authors note that:

> The further the analysis proceeded, the more it became clear that the results only make sense if it is accepted that behavioural responses must be more complex, and cover a wider geographical area, and take place over a longer time period, than *can* be revealed from simple before-and-after aggregate traffic counts, separated by a few months. The 'perfect study' (which would have to include traffic counts in a very large area,

> watertight screenlines, longitudinal monitoring of the changes in behaviour for specific individuals in a very large catchment area, all continued for five years or more) has never been carried out, (or, at least, was not revealed in the search for evidence). Collecting such data would cost more than many of the schemes for which the data would be used. Even specially designed research projects are unlikely to produce absolutely certain results, due to the complex range of other changes that are likely to be occurring at the time. (*ibid*, p. 4 (emphasis as in the original))

That is, it would be too expensive to collect all the data necessary for a perfect study and because of the complexity of the situation, it would probably not be possible to obtain definitive results.

2.5.2 Limitations of data actually collected

Monitoring in the HCR case studies was undertaken principally by means of one or more of the following types of surveys:

- personal vehicle traffic counts (motor vehicles (40); cycles (5));
- public transport passenger counts (bus (13); rail (3); ferry (2));
- pedestrian counts (5);
- journey time surveys (20); and
- attitudinal surveys (13).

Other surveys were undertaken in some instances, including measures of road traffic accidents and the effect of RRC on environmental markers. The results were not consistent between cases. The HCR report notes a number of problems (*ibid*, p. 55):

- unreliable screenlines for traffic counts;

- screenlines cover a small area;
- counting methods may be proportional to number of trips *or* mileage;
- surveys of behaviour do not cover adequate periods of time;
- surveys of behaviour were not always carried out at the most appropriate intervals;
- surveys of behaviour rarely use techniques which can identify underlying changes in individual behaviour behind the net changes in aggregate behaviour;
- reports sometimes omit information which would be relevant to the study;
- reports may require interpretation; and
- other transport changes may have occurred in the same period which make it difficult to isolate cause and effect.

In addition, the authors of the HCR report identify four main potential sources of systematic bias (*ibid*, pp. 55-56):

- day to day variability in traffic not allowed for in one-day traffic counts;
- journey detours may be longer distance than captured in cordon counts;
- traffic growth occurs due to factors such as increased income and car ownership; and
- partial sampling.

These problems do not, of course, apply only to the studies reviewed in the HCR report. For example, no individual study has been found which probed for the full range of possible responses, as set out in Table 2.1. The problems listed above have been reported by other authors (e.g. Hunt *et al* 2002). Mokhtarian *et al* (2009) (and Ye *et al* 2010) note that, due to time constraints, they were unable to generate a rigorous, geographically based random sample of travellers for their surveys.

2.5.3 Limitations in methodology

It should also be noted that all the surveys mentioned in s.2.5.2 were quantitative; there were no qualitative attitudinal studies, that is, studies which were primarily concerned with the quality of the whole driving experience expressed in motorists' own words. On a few occasions there was qualitative input to the HCR report (*op. cit.*), that is, input in which travellers described why they behaved as they did, rather than merely descriptions of the behaviour in numerical terms (for example, why a particular route was preferred rather than how often it was used). For example, in the featured case studies:

- the discussion of the closure of Partingdale Lane in London in 1997 mentions petitions and letters received by the London Borough of Barnet (*ibid*, p. 151); and
- the description of the damage to the Tasman Bridge in 1975 included comments from the author of this doctoral study regarding her experience and the reactions of some local businesses, as part of a submission suggesting that the TSU consider that incident (*ibid*, p. 119).

Restricting the methodology to quantitative only, means that the surveys indicate only what was done, rather explain with any certainty why the motorists took the courses of actions they did. It may be argued, of course, that it is outside the sphere of responsibility of traffic engineers recording the progress of an incident of RRC to investigate behavioural aspects of travel and transport.

2.5.4 Attitudinal data

In order to understand better a situation which involves people's behaviour, it is necessary to understand their attitudes to the topic in question. There are several approaches that can be taken to obtain attitudinal data. Respondents may be:

1. asked whether they agree or disagree with a given statement;
2. given the opportunity for open-ended comment as part of, or at the end of, a series of pre-determined questions; or
3. given the opportunity to make open-ended comments with only the general topic fixed by the researcher.

First approach

The first approach has the advantage that a simple yes/no answer or a choice from a range of alternatives is relatively easy to obtain and easy to process. Researchers using this method include Lee 1978; Lee & Wood 1978a; Marinelli & Watson 2009 and Gilmore *et al* 2010.

However, this method has the disadvantage that it restricts possible behaviour changes of interest to those conceived of by the researcher. That is, this approach assumes that the researcher is omniscient (or is trying, perhaps unconsciously, to make the situation fit some preconceived notion of how things are[5]). Put another way: 'The world of the survey, however, is bounded by the perspectives and goals of the survey writers. The survey restricts not only the question frame but the answer frame as well, anticipating the important issues and questions and the responses' (Poulenez-Donovan & Ulberg 1994).

5 For example, Bonsall *et al* (1984) noted that surveys tend to overestimate the degree of stability in traveller behaviour: 'Conventional surveys often see variability in day-to-day behaviour not as a legitimate item of data, but rather as a problem to be circumvented by skilful wording of questions.'

As the presence of an omniscient researcher seems unlikely, and as a failure to recognize reality is unhelpful in elucidating the facts, this method of ascertaining attitudes is not optimal in spite of the ease of processing. Other methods must be used to explore subjects where the issues have not been identified and researchers are seeking to answer 'why?' type questions. Therefore, to best answer these type of questions, it is necessary to allow motorists affected by the schemes some sort of open-ended input.

Second approach

When undertaking the literature review for this research, three examples of transport-related studies of an incident of reduction in road space, incorporating surveys of traffic flows, were found which included the second approach (Grover & Richardson 1993; Rees & Williams 1998; Mobius Research and Strategy Ltd 2010). They gave respondents the opportunity to add their own thoughts after, or as part of, a standard selection of questions. These will be described later in this section. Although Lee & Wood (1978a) asked some open ended attitudinal questions, the answers were assigned to standard groups.

Third approach

The third example of open-ended comments is the qualitative study, which draws on opinions expressed in participants' own words (Grosvenor 2000). In these cases, the researcher sets out to explore a topic in depth, with people who are affected by the phenomenon in question. They do this by providing only an outline of the areas of interest and allowing the respondents to comment freely. No examples of qualitative studies of RRC have been found, although:

- the HCR report (*op. cit.*) mentioned examples of RRC which had unsolicited input in the form of letters and petitions; and

- Grover & Richardson (1993) undertook a study with qualitative elements when they invited motorists to focus groups to discuss a case of pedestrianization which reduced road space while *increasing* capacity ('Most of the debate on the effects of the Walk on traffic was conducted by planners, politicians, journalists and traders. .... Nobody had sought the opinions of those people mostly affected by the closure, the drivers who used the street').

2.6 Illustrative examples and case studies

2.6.1 Introduction

The HCR report (*ibid.*) includes a selection of case studies which illustrate some of the particular points which could be made about this topic. The HCR report has become more accessible to researchers in Australia than was the case six years ago. To the author's knowledge, there are now three copies (at the date of writing: 6th December 2012) available to researchers in Australian university libraries. It is therefore thought unnecessary to repeat any of the descriptions of incidents of reallocation of road space which are contained therein.

Other authors have compiled literature reviews of examples of road space reallocation (e.g. Booz, Allen & Hamilton 2006). However, as new traffic schemes are implemented regularly, it is likely that keeping such a list up to date would require a commitment in time and effort that could not be justified.

2.6.2 Attitudinal data

In this thesis, the emphasis is on motorists' reactions, that is, the effect on motorists' behaviour of reducing road capacity. Therefore, although descriptions of particular episodes of reducing road capacity are useful in introducing the subject to the reader, it is necessary at some point to concentrate on episodes for which the studies have produced some insight into motorists' reactions to the changes, rather than studies which merely document, for example, numerical changes in traffic flows or the effects on environmental indicators. Hence this literature review will concentrate on studies which document reasons given for those changes in motorists' behaviour, that is, studies which produce attitudinal data.

2.6.3 Selection of illustrative examples

As discussed, the examples given in the rest of this section are studies which take the second approach to obtaining transport-related attitudinal data, that is, survey respondents were invited at some point to explain their new travel behaviour in the selected situation. The studies chosen are listed in Table 2.2.

It will be appreciated that these examples do not claim to be a comprehensive illustration of motorists' responses to a reduction in road capacity.

Table 2.2 Incidents of reallocation of road space which include a qualitative aspect to the study

Location	**City**	**Type**	**Precipitating factor**	**Year**	**Feature of interest to this study**
Swanston Street	Melbourne Australia	Road closure	Pedestrianization	1992	No reduction in capacity despite the road closure; motorists explained why they took the actions they did.
Lake Road	Auckland, New Zealand	Road works	Road maintenance	2010	No possibility of changing route to circumvent road works; motorists propose reactions and justify their choices.
Hammersmith Bridge	London, England	Road works	Remedial work	1998	Bridge closed to motorists but not buses or cyclists; motorists explained why they took the actions they did.

2.6.4 Swanston Street, Melbourne, Australia

The closure of Swanston Street in Melbourne to private motor vehicles is an example of closing a road to pedestrianize an area, without reducing the network capacity but nevertheless reducing the amount of road space. Hence any changes that motorists did make could not have been because of reduced road capacity.

Melbourne is a planned city whose centre was laid out as a rectangular grid, with five major streets running northeast to southwest (E-W) and nine major streets running northwest to southeast (N-S) (Tipping nd)). Laneways run between the major streets in both directions.

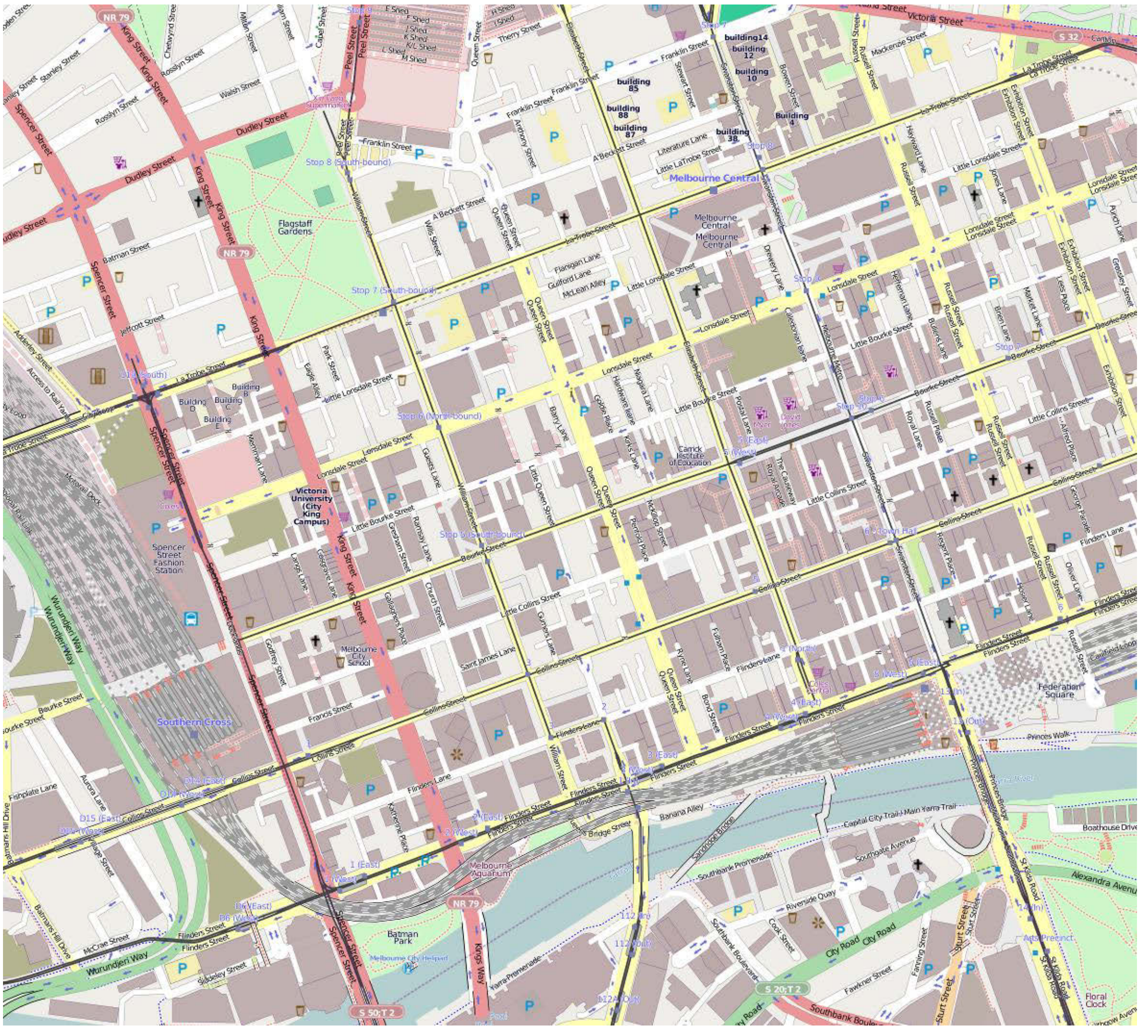

Figure 2.2 Central Melbourne

In 1992, Swanston Street was one of the major N-S routes in the Melbourne central business district (CBD), with flows of over 28,000 motor vehicles per day, of which about 20,000 were through traffic. On the 28th March the length of Swanston Street in the central area was closed to most motor vehicles. It remained open to trams, emergency vehicles, commercial vehicles (including taxis at specified times), cyclists and pedestrians. At the same time, in the rest of the central city area, 225 traffic management measures were installed in order to increase capacity elsewhere for the diverted cars, including:

- the introduction of, and extension to, clearways and no ‘standing’ restrictions;
- banning some turns;
- modifications to traffic signal phases and operation;
- minor road widenings and alterations to line markings;
- relocation of safety zones;
- changing ‘centre of the road’ turns into hook turns (i.e. turning right from the nearside lane rather than the offside lane, to allow a clear passage for trams proceeding straight through); and
- removal of on-street parking. (VicRoads nd).

‘Before’ and ‘after’ traffic counts indicated a general increase in traffic in the survey area of between two and four percent (2-4%). However, control sites, analysed as a group, showed no change in overall traffic volumes throughout the metropolitan area (Wells & Strickland 1993). Assuming that the city centre operated at capacity both before and after the closure of Swanston Street, the traffic management measures which were undertaken in preparation for the closure appear to have resulted in an increase, rather than a decrease, in capacity. In particular, traffic using E-W routes had increased by 10-15%. Traffic in the streets parallel to Swanston Street had increased by amounts ranging from 30% to 60%.

A study (Grover & Richardson 1993) was carried out around the time of closure. The study was in two parts. Surveys were conducted before and after the closure. The results indicate that respondents who had changed their trip behaviour had, in the main, continued to travel by car but used different routes from those they had used before the closure.

Before the closure, motorists who had been observed driving on Swanston Street were surveyed in order to select people for invitation to focus groups. The screening was done on the basis of:

- origins and destinations;
- reasons for making the trip;
- time of day that the trip was made; and
- motorist's attitude to the closure of Swanston Street.

A sample of 24 motorists was assigned to focus groups in such a way as to ensure that differing attitudes to the pedestrianization and differing trip patterns were represented at each session. The discussion at each focus group session was concerned with how the motorist would react to the closure, in particular, what alternatives they proposed for trips that could not be undertaken by driving along Swanston Street. Participants all predicted that they would be most likely to continue making their trips by car, albeit on parallel routes to Swanston Street.

After Swanston Street was closed, all the people who had responded to the first contact were sent a questionnaire which asked about their actual trip making behaviour since the closure of Swanston Street. A summary of the replies is given in Table 2.3.

It can be seen that motorists who no longer made the trip they described for the first questionnaire did so for reasons other than the closure of Swanston Street. Only one person had changed mode, for a reason unrelated to Swanston Street. Hence, it is clear that the closure of Swanston Street had not caused any trips (in this sample) to disappear, although for most of the motorists surveyed, it had caused some rerouting.

Table 2.3 Changes in trip making behaviour, Swanston Street motorists

Behaviour change	Number	%	Reasons for change
No longer made the same trip	16	15	Moved workplace (7) Moved house (2) Initial trip unique (7)
Now used public transport	1	1	No longer had access to free parking
Used the same route to access the CBD but a different route in the central area (delivery driver or sales representative)	5	5	
Still driving, by different route	84	79	Closure of Swanston Street (82) Passenger changed workplace (1) King or Spencer Streets were always alternative routes (1)
Total	**106**	**100**	

Source: Based on Table 1, Grover & Richardson (1993)
Note: Numbers in parentheses indicate the number of motorist who gave that reason for any change.

2.6.5 Auckland, New Zealand

It has been noted that route changes and time changes are the normal responses to a reduction in road capacity. A study from Auckland explored motorists' behaviour when route changes (on their own) were not possible.

Auckland is a port city in New Zealand and the urban area is spread over many islands and peninsulas. Road works were necessary on Lake Road, Devonport Peninsula, to improve safety on a 500 m stretch between Esmonde Road (to the north) and Jutland Road (to the south).

The work began in March 2010 and included:

- increasing capacity from one to two (wider) lanes plus a cycle lane, in each direction;
- new footpaths and a signalled pedestrian crossing;
- a continuous, flush median strip to ensure turning traffic does not hold up other traffic;
- indented bus bays;
- strategically placed right-turn bans; and
- power lines placed underground, improved stormwater infrastructure, new road surface and landscaping along the route. (North Shore City Council 2009)

For the first step in this upgrade it was possible to confine works to the areas adjacent to the road. However, for six to eight weeks, starting in October 2010, it was necessary to work within the carriageway of Lake Road itself.

At this point on the peninsula, Lake Road provides the only route in and out of a residential area for motorists (there is an alternative, albeit circuitous route available to cyclists). There are three ferries which travel (south) to Auckland CBD from the southern or western tips of the peninsula.

Figure 2.3 Lake Road, Auckland

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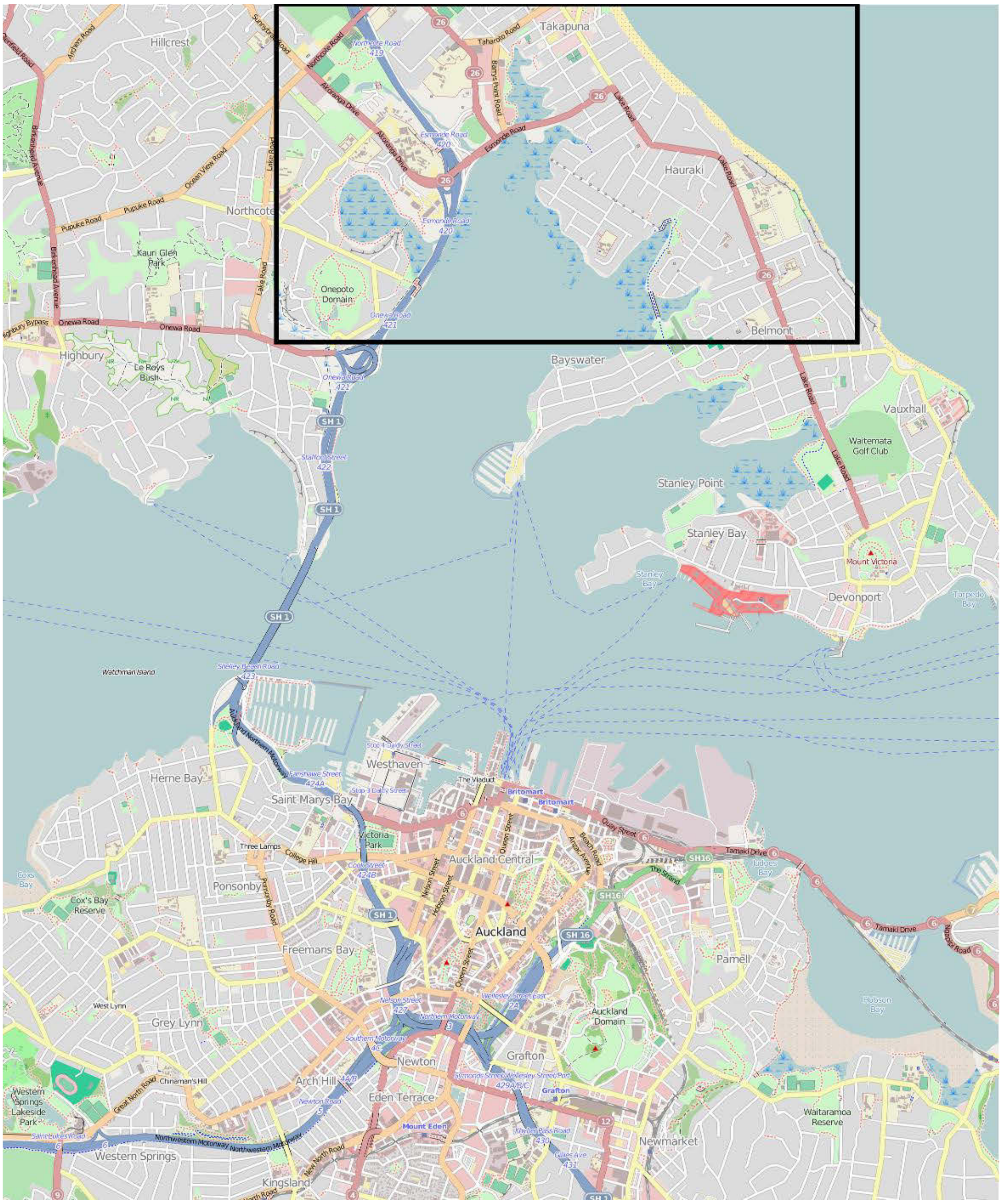

Figure 2.4 Relationship of Lake Road to central Auckland
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The Travel Behaviour Change Team of the North Shore City Council (whose area included the Devonport Peninsula) was established as a result of the council's Transport Strategy in 2006. They undertook work to reduce single occupancy car travel and increase the use of the other modes. A survey was undertaken in May and June 2010 (that is, after work on the upgrade had begun, but prior to the beginning of the works on the carriageway of Lake Road), to provide base-line data against which any changes in travel behaviour, as a result of the team's efforts, could be compared. The description in this section is based on the report of this study (Mobius Research and Strategy Ltd 2010).

Five hundred participants were randomly selected from residents of the Devonport Peninsula and surveyed, either by computer assisted telephone interviewing or on-line.

The survey contained questions on:

- the advantages and disadvantages of living on the Devonport peninsula;
- the respondents' length of time in the Devonport peninsula area and their attitudes towards traffic levels since moving;
- single occupancy and 'with passenger' travel;
- the respondents' attitudes towards congestion and travelling along Lake Road;
- the respondents' interest in possible ideas to help reduce congestion; and
- the vehicles in the household.

The survey was concerned with several aspects of travel behaviour. The data that dealt with repetitious behaviour was analysed further for this doctoral study. Respondents were asked about changes to their travel behaviour over the previous 12 months. A minority (15%) considered that they had made changes. This tallies with the 15% that is the average number of trips that the HCR report (*op. cit.*) expects to disappear in a situation of RRC.

Of that 15%, 41% (7% of the whole sample) had used another mode more often and 29% (5% of the whole sample) had made changes to their time of travel. Other changes mentioned included working from home and doing more activities locally. Of particular interest is the analysis of single occupant vehicle (SOV) motorists in comparison with motorists who were serving passengers. The report states that SOV drivers were more likely (19%) to have made changes to their travel behaviour than those serving passengers (9%), although it has not been possible to determine how these figures were derived from the analysis given in the report.

The survey asked for respondents' potential reactions to increasing congestion and likely behaviour changes if there were further delays during the Lake Road upgrade. The answers are compared in Table 2.4.

Table 2.4 Proposed responses to congestion or delays on Lake Road, Auckland, 2010

If congestion on Lake Road got worse	**%**	**Likely behaviour change if further delays during Lake Road upgrade**	**%**
Nothing/I have no choice/just put up with it	29	Nothing I can do/complain a lot, just put up with it	19
		Be patient/hope that things will improve eventually	14
Try and change the times I travel	18	Plan my trips better/allow more time	22
Only travel at peak times if necessary	2	Change the times I travel	18
Move from the area/think about moving	13	Avoid Lake Road	13
I already do what I can to avoid traffic (cycle, walk, take ferry) when possible	11	Consider an alternative mode (bus, ferry, walk, carpool)	11
Use the ferry	7		
Consider taking a bus/hope bus routes and times improve	7		
Might consider sharing rides	2		
Combine trips	2		
Retire	2		
Other	7		
		Will not affect me too much	3

Source: After Tables 17 and 18 of the Lake Road report (Mobius Research and Strategy Ltd 2010)
Note: N=500

It should firstly be noted that this is a stated preference survey. Respondents are not reporting actions that they have already undertaken. Rather, they are explaining what they think they would do. Circumstances may alter their actual responses.

It can be seen that there are differences in responses to the two situations. The potential responses to congestion, compared with the potential responses to delays:

- show a greater range of alternatives (11 compared with 7);
- include possibilities that involve a major change to the person's life (move, retire);
- suggest more motorists feel that there is something they can do to alleviate the problems arising because of congestion rather than due to road works (81% v. 67%);
- suggest one fifth (20%) of motorists view reorganization of their time of travel as a way to avoid congestion, whereas 40% (twice as many) see it as a way to deal with delays;
- show that equal numbers (13%) offer a change of (driving) route as a way to deal with congestion or delays, although the more drastic way to change route, by moving house, was only mentioned by people expecting to suffer more congestion. Those expecting (temporary) delays only suggested avoiding the road in question. It may be that the people expecting congestion also expect it to be a long term experience (however, this possibility was not investigated). It should be noted that changing from driving to catching a ferry is likely to involve a change of route, since the exit from the peninsula by ferry is to the south, whereas the exit for motorists is to the north;

- show more motorists (27%) proposed using public transport as a way of beating congestion than the 11% who saw it as a response which might alleviate delays; and
- show that combining trips was not offered as a response to delays.

That is, it can be seen that the expectations of the residents of Devonport Peninsula with regard to traffic congestion on Lake Road differ from their expectations with regard to the delays associated with traffic works on Lake Road. For example, moving house is suggested by some respondents as a possible response to increasing congestion, but not delays because of road works. Nevertheless, the researchers found that the public accepted that the reductions in capacity were necessary and inevitable.

In summary, few (15%) of the respondents had made changes because of the traffic on Lake Road in the previous 12 months, although many more (81%) considered that they might if the congestion got worse. However, only 67% expected that they would change their travel behaviour if there were further delays due to road works. This suggests that there is potential for congestion to be a greater spur to action that delays due to road works – perhaps because road works are not expected to last as long as congestion.

2.6.6 Hammersmith Bridge, London

Hammersmith Bridge is one of 13 road bridges[6] across the River Thames in southwest London. It connects Barnes, south of the river, to Hammersmith, north of the Thames. From Sunday 2nd February 1997 the bridge was closed to most traffic, following the discovery of structural defects. It remained open to scheduled buses, motorcycles, cycles, pedestrians and emergency vehicles.

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[6] Travelling (south)westwards from central London: Lambeth Bridge, Vauxhall Bridge, Chelsea Bridge, Albert Bridge, Battersea Bridge, Wandsworth Bridge, Putney Bridge, Hammersmith Bridge, Chiswick Bridge, Kew Bridge, Twickenham Bridge, Richmond Bridge, Kingston-upon-Thames Bridge. There are also rail bridges and foot bridges.

On the Friday before the bridge was closed (i.e. 31st January 1997), staff from Hammersmith and Fulham Borough Council distributed postcards, inviting motorists to participate in a survey. Telephone interviews were conducted with those who responded. Those who were willing to take part in a second phase were contacted by telephone again, eight months later.

The findings of the first phase of the survey are discussed in the HCR report (*op. cit.*, pp. 127-137). That discussion will not be repeated here. This description is based on Rees & Williams (1998).

The quantitative aspects of the use of the bridge from the second phase of the study (in relation to the first phase) can be summarized as follows:

- there was a decrease in the proportion of people using the car;
- there was an increase in the proportion of people using public transport;
- most people who still drove used either Putney Bridge or Chiswick Bridge (i.e. the closest alternatives);
- the average reported time spent travelling on drive trips was not as high as in Phase 1, but was still higher than pre-bridge closure;
- 63% of drivers had changed their time of travel;
- one quarter had changed their shopping location;
- one sixth of respondents walked or cycled more often; and
- there was more awareness of the public transport alternatives for crossing the river.

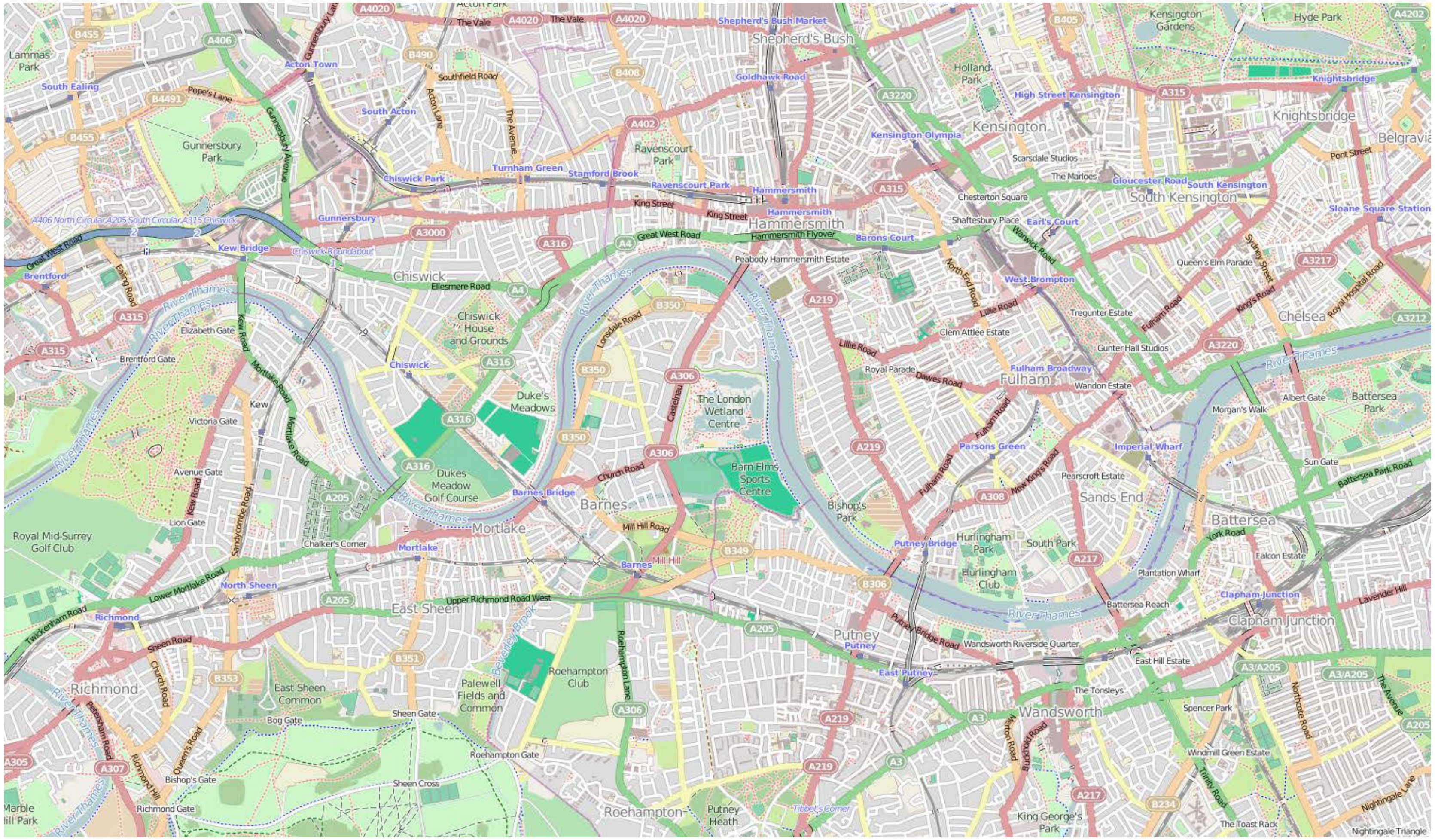

Figure 2.5 Hammersmith Bridge and surrounding area

Interviewees were also asked about their attitude to:

- groups allowed to use the bridge;
- safety for walkers and cyclists in surrounding area; and
- effect of closure for the environment.

Differences of opinion were noted depending on whether the respondent lived locally or not. This suggests that the two groups – locals and those merely passing through – may have different perspectives on the closure.

After Phase 2 it was decided to conduct extra in-depth interviews to find out why people had stopped making the trips they made before the bridge was closed. In particular, researchers were interested in the influence of closing the bridge on trip making.

Of the 37 respondents who completed an interview, only two said that they stopped making the work journeys they used to make because of the closure of the bridge. Other reasons for stopping included:

- change of work pattern or job (5);
- no longer in full time paid employment (5);
- set up own business (1); and
- moved house (4).

By contrast, only four of the 37 respondents had stopped making non-work related journeys for reasons other than the bridge closure. In particular, 13 respondents had changed their shopping location. Explanations included:

"Have changed shopping habits – now go to Putney or Chiswick shopping as Hammersmith is too inconvenient now that the bridge is closed"

*"Made it difficult to shop in Hammersmith, its [*sic*] much easier to shop elsewhere"*

"I shop in Barnes now"

There was greater awareness of, and likelihood of using, public transport among locals and less of a feeling of inconvenience at the closure of the bridge. One possible explanation may relate to local knowledge; local residents may have a greater knowledge of local transport alternatives than people only passing through and would therefore be in a better position to use them instead of driving if the latter became a problem. Non-locals may only know their usual route through the neighbourhood and have no alternative to fall back on if this is not available.

Rees and Williams conclude that:

> For the majority of respondents the closure of the bridge had *not* been a contributory factor in them no longer making work related journeys. However for some of the respondents the closure of the bridge had had an effect on their non work related journeys. Respondents tends to now shop in other locations, which are more accessible by car. (emphasis as in the original)

2.7 Current knowledge of reduced road capacity

2.7.1 Traffic flow

Although each incident is unique[7], some regularities are apparent in cases of RRC. Quantitative studies have found (ss.2.3.4 and 2.3.8):

- capacity is not necessarily reduced when road space is reduced;
- most people either change route or change time of travel to circumvent the problems caused by the RRC;
- the percentage of travellers changing mode is usually low;
- nevertheless, the figure of 15% overall reduction in the number of trips (due to a variety of responses), as determined in the HCR report (*q.v.*) appears reasonable.

The qualitative aspects of RRC which have been studied (that is, how motorists replace a trip which has been made inconvenient) reinforce the findings reported in the HCR report (*op. cit.*) and elsewhere, that:

- the most common changes are alterations to departure time and route;
- non-work trips are more likely to change than work trips; and
- a change in road space sometimes coincides with other changes in the motorists' life, so a given trip would have changed in spite of what was happening on the network.

2.7.2 Other aspects

It was noted in s.2.3.5 that the study by the TSU was commissioned only to investigate the effect of RRC on traffic flows. Indeed, the authors of the HCR report note that:

[7] E.g. cause of RRC, network layout, available alternate routes, available alternate modes

> This report does not address the wider political, cultural, social, economic and environmental issues of capacity reduction in any detail. These are obviously very important in the debate, and have been mentioned by many of those submitting evidence about local schemes. However, they fall outside the scope of the research commissioned. (*op. cit.*, p. 2)

However, individual papers have considered some other aspects. Some of the aspects of RRC which are also transport issues but which are outside the scope of the report commissioned by the HCR include:

- road safety and cycling - the data acquired for the HCR study was later analysed for evidence of the impact of RRC on cyclists and road traffic accidents (Cairns 1999a; Cairns 1999b);
- bus ridership during a period of disruption due to road works (Carpenter 2010);
- the minimization of disruption for motorists during road works (Meyer 1988; Devine *et al* 1992);
- how motorists coped with the disruption of road works (Ye *et al* 2010);
- economic arguments for using RRC to combat congestion (Bell 1995);
- business related transport, including commuting, customer access to businesses, shipping and supply disruptions (Gordon *et al* 1998);
- telecommuting (Pratt 1991);
- measuring post-disaster transportation systems performance (Chang & Nojima 2001);
- the need for freeways (Siegel 2007, ITDP 2012);
- gender related aspects of disruption due to road works (Mokhtarian *et al* 2009);

- non-work travel behaviour during road works (Yun *et al* 2011); and
- estimating the amount of road space which should be reallocated from private vehicles to public transport (González-Guzmán & Robusté 2011).

Papers considering non-transport issues in relation to particular incidents of RRC (although transport is sometimes discussed as well), include:

- criminological and sociological (Whelan *et al* 1976);
- civil and environmental engineering (Shin & Lee 2006);
- land use/urban regeneration (Weiss 2011; Cervero 2006; Cervero *et al* 2007); and
- environmental indicators/quality of life (Crabbe & Elsom 1998; Levy *et al* 2006; Gilmore *et al* 2010).

It has not been possible to find any study of planners' or politicians' attitudes, although there is anecdotal evidence of attitudes relating to particular incidents (e.g. HCR, *op. cit.*, pp. 142-147; Cairns *et al* 2002; Walsh 2006; Ye *et al* 2010) and advice available on implementing schemes which emphasizes the importance of political support (European Commission 2004).

2.7.3 Gaps in knowledge

Clearly the subject of reducing road capacity has many facets which could be explored, even if the study was restricted to transport considerations.

Most surveys undertaken in the case studies quoted in the HCR report (*op. cit.*) and other studies (s.2.3) were traffic (including passenger) counts. That is, they were observational, quantitative and aggregate in nature.

However, observation of a phenomenon is only the first step towards building a comprehensive knowledge of it. It is also necessary to determine why the phenomenon happens as it does. Only when there is understanding will it be possible to harness, with any confidence, the phenomenon in order to, for example, maximize or minimize its effect. In the case of transport, where an outcome is the result of many individuals with only limited knowledge of what other people using the same facility are doing, harnessing the phenomenon of RRC might be to affect modal choices or selection of route. That is, in order to understand why motorists make the choices they do, it is necessary to study the behaviour of individuals.

Sections 2.6.4, 2.6.5 and 2.6.6 describe what motorists did, or expected to do, in a situation of reduced road space. However, the motorists were not asked why they chose the option they did. This omission is noted explicitly in Hunt *et al* (2002). For example, in s.2.6.6, the motorists who previously travelled across the bridge to shop in Hammersmith were not asked why they had chosen to shop in Barnes, Putney or Chiswick rather than, for example, taking the bus across Hammersmith Bridge or asking another member of the household to take on that errand.

One of the motorists mentioned in s.2.6.6 explained that since the closure of Hammersmith Bridge, they had changed their shopping habits. The existence of 'habits' may have some effect on motorists' responses to RRC. It is proposed to explore in greater depth the question of the effect of existing habits on individual responses to RRC. Chapter 3 discusses habits, as related to transport.

2.8 Summary

Reducing road capacity is not a new phenomenon. Neither is an awareness of the effects that reduced capacity may have. However, although some work has been done concerning the effect on physical network capacity (including modelling), and reports on individual incidents of reduced road capacity have appeared before and since, no systematic study of the behavioural aspects of the subject has been found, prior to that produced by the Transport Studies Unit of the Economic and Social Research Council in the U.K. in 1998, entitled *Traffic Impact of Highway Capacity Reductions: Assessment of the Evidence* (Cairns *et al* 1998) (the HCR report). A companion report, *Traffic Impact of Highway Capacity Reductions: Report on Modelling* (MVA Ltd 1998) was also published in 1998. Both these reports were concerned with the flow of motor vehicles (in contrast to, for example, road traffic accidents).

The principal conclusion of the HCR report is that traffic will disappear when road capacity is reduced, owing to the variety of responses that individual motorists make. It is also clear from the range of behavioural responses documented by the report, and other studies, that it is important to have a variety of alternatives available, if disruption is to be minimized. This includes different routes, possibilities for variations in the time of travel and provision for motorists to move from their car to another mode. However, reduced road capacity on its own is not likely to cause a major shift in mode away from private motor vehicles to public transport since changing route and time of travel are the major responses in most situations.

The authors of the HCR report note some of the problems in interpreting the results of the case studies they reviewed (in particular, lack of consistency in methods of measurement between studies, leading to an inability to compare them) and deficiencies in the methods of assessment used. It states that much work remained to be done on the topic (and it is possible to find new studies since 1998 tackling both transport-centred aspects and other issues related to reduced road capacity).

In the main, the studies included in the HCR report, and other transport studies, have drawn upon quantitative surveys, particularly traffic counts, as a basis for their findings. This can inform the transport planner of what has happened as a result of reduced road capacity but not the reasons. The HCR report includes little qualitative input and no qualitative studies. The examples given in this chapter illustrate the type of qualitative input that has been gathered. They give some idea of why a course of action was taken but, except in the case of trips which changed for reasons unrelated to the reduction in road capacity, do not explain why a different course of action was *not* taken, that is, they do not explain the reasons why one option was taken rather than another.

In order to investigate the reasons for the choices that motorists make in a case of reduced road capacity in greater depth, it was decided to investigate the role of habit in their behaviour - that is, their previous routine behaviour that may or may not have influenced their reaction to the new situation. In order to provide some background for this, Chapter 3 includes a discussion of habits.

CHAPTER 3

The Need for Travel, Life Events and Travel Habits

This chapter integrates existing knowledge of the need for travel, life events and travel habits and expands certain aspects. These topics were briefly mentioned in Chapter 2.

Section 3.1 introduces the chapter. Section 3.2 considers the need to make trips using private motor vehicles. Section 3.3 introduces the concept of a life event. Section 3.4 introduces the concepts of planned and unplanned behaviour. Section 3.5 considers habit in greater depth. Section 3.6 explains the relevance of the need to travel, life events and habit to this study. Section 3.7 summarizes the chapter.

3.1 Introduction

In order to provide (sufficient) facilities (in the most appropriate places) for traffic, it is necessary to measure demand. If it becomes clear that it will be necessary to manage the traffic, perhaps because the demand is greater than the supply side can cater for (e.g. space for cars at peak hours or when road capacity has been reduced), it will be necessary to understand how and why traffic behaves as it does (Anable 2005).

Group behaviour is the combination of the behaviour of many individuals, who may or may not be influenced by the people around them. Traffic is one example of group behaviour. Some parameters of group behaviour are relatively easy to measure, particularly physical parameters such as volume of flow. However, to find out why traffic behaves as it does (in, for example, a situation of reduced road capacity), it is necessary to find out why individuals behave as they do and how they interact. In particular, since individuals can differ markedly in attitudes and motivation and therefore behaviour, it is necessary to understand how people make decisions about travel:

- why they do and do not travel;
- how and when they make decisions on trip parameters such as route and mode;
- when they decide whether to make trips; and
- other factors they take into account.

It has been observed that some trips are suppressed in a situation of reduced road capacity (Cairns *et al* 1998). Therefore, it seems reasonable to infer that not all trips motorists make are strictly necessary.

3.2 Need to make trips

3.2.1 Introduction

It is usually considered that travel is a derived demand (e.g. Chen *et al* 2004; Schönfelder & Axhausen 2009; Koetse & Rietveld 2009). That is, trips are undertaken in order to facilitate some other activity, rather than as activities in their own right. This implies that the activity is more important than the travel.

While it can be argued that this is not true in all cases (see, for example, Ory & Mokhtarian 2005; Choo & Mokhtarian 2008; Redshaw 2008; Parkin 2012, pp. 9, 12), there is nevertheless evidence to suggest that there are both theoretical and empirical reasons for thinking that, in an ideal world, people would not make as many trips as they currently do.

That is, some trips could be dispensed with, without adversely affecting the individual's activities or quality of life:

> ... the traffic flows which can be seen on the roads .... represent people's behaviour and choices after they have adapted themselves to the possibilities and limitations of the situation. They may be forced into a course of action which they thoroughly dislike. If a shopper buys a certain product only because the other ones he asked for are out of stock, the manufacturer would be unwise to interpret such a purchase as showing a desire for this product. But analogous situations occur constantly in urban transport. The man who waits at a bus stop for ten minutes and finally hails a taxi is only the most obvious example. (Plowden 1972, pp. 29-30)

Plowden's example of unwanted behaviour relates to choice of mode; another example might be a woman driving at night rather than catching a train because of concerns about security (Root *et al* 2000).

The principle also applies to trips which the traveller does not want to make. An instance of this might be parents driving their children to an activity and collecting them afterwards, perhaps because the parents did not feel that the children were mature enough to undertake the trip alone or that driving the children was expected of them as 'good' parents (what Dowling (2000) refers to as 'reluctant' drivers).

Due to the rising consciousness of the need to consider sustainability, people are also asking whether it is possible to have the benefits of cars, at the same time a cleaner, quieter and safer environment (Root *et al* 2000).

The success of TravelSmart (and similar) interventions, where people are encouraged to reduce their reliance on the car by learning how to use other modes of transport instead (thus giving them a wider choice of travel options), is empirical evidence that not all car trips are necessary (TravelSmart Australia 2009). It is also possible to find surveys, both qualitative and quantitative, which support this empirical finding. Some examples are discussed in ss.3.2.2 and 3.2.3.

3.2.2 Qualitative surveys of the necessity for driving

There have been many studies undertaken to ascertain the reasons people use cars, both in preference to other modes of transport and as an activity in its own right (e.g. Tertoolen *et al* 1998; Stradling 2002; Hiscock *et al* 2002; Gardner & Abraham 2007; Redshaw 2008; Hoye *et al* 2011, pp. 22, 28). Clearly, it is not 'rational' to make unnecessary trips. The situations cited in s.3.2.1 are examples of the use of private motor vehicles (PMVs) which people justify by reference to factors (feelings of security, society's expectations) other than a simple desire to minimize trip costs (time, distance, monetary cost). Security and expectations are not easily quantifiable objectively as time, distance and money. It is necessary to undertake qualitative work to understand the place of these less straightforward factors.

Attitudes to transport in urban Australia

In 2011 the National Transport Commission (NTC) commissioned GA Research to survey Australians on transport issues (Hoye *et al* 2011). The objective of the research was to gather insights into the Australian public's perception of transport, mobility and access, and opportunities for future reform. The surveys were in two parts: a nationwide online survey of 1005 people and eight forums covering 117 people around the mainland states and the ACT (that is, omitting Tasmania and the Northern Territory).

The survey produced a range of findings. They included the fact that most people felt that they drove too much:

> Around half of the respondents in the online survey agreed somewhat (29%) or strongly (22%) that they'd like to be able to drive less (net 51%). This was also the case in the fora, [*sic*] where respondents expressed an interest in driving less but felt that public transport was somewhat if not completely inadequate, or simply not convenient for them (*ibid.* p. 37).

Furthermore:

> Many participants, however, indicated that they were willing to change and would like to be able to drive less – especially if it meant getting around quicker, cheaper, with greater ease and comfort, and less stress or 'road rage'. (*ibid.* s.5.3, p. 56)

Car dependence in England

A qualitative study was undertaken in England (Lucas 2009), which sought to measure the degree of car dependence amongst respondents. It did this in the context of moving beyond voluntary interventions designed to encourage people to reduce the use of their car, towards more coercive measures such as road pricing or carbon taxes. The survey found that motorists felt that they did not need to make all the car trips they did.

The study used five exploratory focus groups to gain attitudinal information concerning the nature of car dependence in England. The groups were composed of:

- motorists voluntarily switching to other modes;
- motorists banned from driving;
- motorists over the age of 75;

- new drivers (young people between the ages of 18 and 25); and
- non-car owners (without regular access to a car).

The members of the focus groups came from Nottingham in the East Midlands of England and Banbury in south-east England.

The report quoted members of the groups admitting that their trips were not all necessary. The reasons people gave for making car trips, whether necessary or unnecessary, included:

- laziness/idleness;
- justifying the financial outlay on the purchase price and tax and insurance;
- not wishing to pay twice for transport (i.e. both fixed costs of a car and incidental costs of public transport); and
- emotional attachment to the car.

3.2.3 Quantitative surveys of the need for car trips

Quantitative attempts have been made to gauge the extent of essential (or, alternatively, discretionary) trips made by any traveller in several countries around the world.

British surveys

An attitudinal survey of 1100 British motorists was undertaken by MORI in 1990 for RAC Motoring Services. People were asked to rate their annual driving as:

- essential;
- important;
- not very important; or
- not at all important.

Less than 50% of driving was categorized as essential. Around 10% of annual driving was rated as 'not at all important' and another 18% as 'not very important' (MORI 1990; cited by Jones & Sloman 2003, p. 4).

That is, over a quarter of motorists' annual driving was deemed by the motorists themselves to be neither essential nor important. The implication is that, for a substantial proportion of trips, motorists are driving by choice rather than necessity.

Note that these findings do not give a measure of the importance of the errands for which the car is used. They do not indicate whether it is the errand or the mode employed to fulfil the errand which is important.

The importance of particular trips should not be confused with the importance of having access to a car. While the MORI survey quoted above found that less than half of all trips were essential, a Lex Services (1995) survey of motorists found that the percentage of motorists who agreed with the statement 'I would find it very difficult to adjust my lifestyle to being without a car' remained at about 80% between 1989 and 1995 (cited by Cullinane & Cullinane 2003). This suggests that people might be prepared to forgo certain trips, but not use of the car altogether.

The British studies suggest that people are aware that some of their errands, for which they use a car, could be done in other ways or suppressed altogether.

U.S. survey of excess driving

As part of a study into whether trips were being undertaken by necessity, Handy and her colleagues (2005) undertook an interview survey of motorists on the staff of the University of Texas in the U.S.A. The study found that over 44% of respondents felt that they were driving more than they needed to and almost 80% felt they were driving more than they wanted to.

Handy and her colleagues argue that the differences between driving by choice and driving by necessity are important for policy makers. If trips are done out of necessity, transport planners can search for ways to shorten them or allow them to be done by other modes, or suppressed altogether. If motorists choose to drive, however, there are different implications, which touch on concepts of freedom of choice.

Although explanations for why Americans drive as much as they do have been suggested, including the spread of the suburbs and the lack of public transport alternatives, Handy and her colleagues note that the trip purposes which have been increasing by the largest amount are those that tend to be flexible (in their specific destination) or optional, that is, trips for shopping and social or recreational purposes.

Handy and her colleagues use the term 'excess driving' to mean:

> ... driving beyond that required for household maintenance *given* choices about residential location, job location, and activity participation. The required level of driving can be defined more specifically as the minimum number of trips using the shortest routes to the closest destinations possible using modes other than the car as often as possible. Excess driving is then defined as driving above and beyond the required level and can be generated by the choice of longer routes, farther destinations, greater use of the car and more frequent trips than the minimum required. (emphasis as in the original)

It should be noted that there may be good reasons why, for example, a distant supermarket is preferable to a close one, such as the range of goods available.

The study considered the reasons offered for excess driving and found that they could be categorized as follows:

- the value of driving itself;
- the value of activities [carried out] while driving (such as watching the scenery);
- variety seeking;
- habit;
- poor planning;
- misperceptions; and
- lack of information.

3.3 Life Events

3.3.1 Introduction

It is clear from the examples given in s.3.2 that people do not always regard all their car trips as necessary. If some of the factors listed in ss.3.2.2 and 3.2.3 could be altered, the implication is that the amount of trip making could be reduced. In particular, excess trips made because of habit, poor planning, misperceptions and lack of information have the potential to be eliminated if the appropriate information can be supplied and travellers reconsider their behaviour. In relation to the first case, several authors, including Goodwin (1977); Bamberg *et al* (2003b); Fujii & Kitamura (2003); Gärling & Axhausen (2003); Harms (2003) and Handy *et al* (2005) have noted that the key to changing habitual behaviour is to require individuals to think about their choices. While habitual behaviour may change for a variety of reasons, including self-motivation and pressure from people who are significant to the individual concerned, this section considers one particular occasion on which individuals may be encouraged to think about their travel behaviour afresh; that is, when they undergo a life event.

3.3.2 Definition

A 'life event' (Ampt *et al* 2006) (also referred to as a 'life shock' (Goodwin *et al* 2004; Behrens & del Mistro 2006) or 'key event' (van der Waerden *et al* 2003) is defined here as 'an infrequent event that interferes with routine behaviour and can cause people to reconsider their current behaviour'.

Common life events include gaining access to a car, moving house, starting a new job and having a child (Table 3.1 provides a more comprehensive list of life events which may impact travel). In the Netherlands, van der Waerden and his colleagues (*ibid.*, Table 3) surveyed 500 people in order to gain an understanding of the distribution and frequency of life events. Acquiring a driver's licence, changing paid employment and obtaining a car were the three most frequent life events in their sample of 173 usable responses.

Life events can have the effect of altering the roles that people assume (Chatterjee *et al* 2013). Chatterjee and his colleagues also suggest that:

> Transport policy makers and practitioners could take advantage of life events as opportunities to promote travel alternatives but they need to be able to access groups/individuals at these points. They could benefit from collaborating with professionals from other sectors.

Ampt and her colleagues give an example of this being done in Australia. Their partner organizations included real estate agents and housing agencies (Ampt *et al* 2006).

Table 3.1 Examples of potential life events which may affect travel

Potential life event	Examples
Change in major activity outside the home	▪ education ▪ paid employment ▪ voluntary work ▪ recreational activity ▪ imprisonment
Relocation of major activity	▪ moving house ▪ moving office ▪ changing educational establishment ▪ entering/leaving jail
Change in close personal relationship	▪ starting/ending a relationship ▪ setting up/dismantling a household ▪ arrival/departure of a household member
Change in ability to perform activities	▪ change in income ▪ alteration in available time ▪ change in self-confidence (e.g. because of new skills) ▪ change in health ▪ gaining/losing licence to operate a motor vehicle
Changing transport skills	▪ learning to drive ▪ learning to cycle ▪ learning to ride a motorcycle ▪ learning to use public transport
Changing access to a vehicle or public transport pass	▪ buying/selling a vehicle (e.g. car, motorcycle, cycle) ▪ acquiring/losing a company car ▪ changing access to a carpool ▪ temporary alteration in access to mode of transport
Changing transport culture	▪ removal to a country or a town or a place of employment with a different range of 'normal' travel behaviours ▪ reception of significant information regarding existing or potential modes
Significant external event	▪ changes in road capacity ▪ changes in car parking availability or access ▪ imposition or removal of a road toll ▪ transport strike ▪ organized event (such as a TravelSmart episode or cycle to work day), designed to change attitudes towards transport ▪ property redevelopment involving residential or business relocation ▪ opening/closing substantial attractor (e.g. factory, business park, university) ▪ extreme weather ▪ war ▪ recession

Note: 'changing' is defined here as gaining or losing.

From the results of study into the effects of reduced road capacity (RRC) (Cairns *et al* 1998), as discussed in s.2.3.5, it is clear that an incident of RRC can cause motorists to reconsider their behaviour. Therefore, RRC has been included in the list of examples of potential life events in Table 3.1. It should be noted that although some of these events are more disruptive than others, they all have the potential to cause significant changes to travel behaviour.

3.3.3 Life events and travel behaviour

Some people recognize that a life event can change their travel behaviour:

> Participants were asked whether they had changed their transport behaviours in the past, and if so, in what way. Some had changed their behaviours, mainly due to a change in life circumstances – e.g. moving home, having children, changing jobs. (Hoye *et al* 2011, p.23)

Goodwin suggests two different reasons for this:

> ... changes in circumstances will directly create new travel patterns and needs, which will be easily evident. .... disruption of settled patterns of behavior will enable a person to respond to previously-ignored travel opportunities and costs. Changes in circumstances, whatever they are, provoke people to respond to policy. (Goodwin 1997, p. 90)

Studies specifically considering life events have looked at the way that they cause people to be open to changing their travel behaviour by changing modes. Examples include:

- general investigation of the concept of life events and mode choice (van der Waerden, Timmermans & Borgers 2003);

- changing car parking availability (Hanssen 1995; Brown, Werner, & Kim 2003);
- moving home (Stanbridge, Lyons & Farthing 2004; Ampt, Wundke, & Stopher, 2006);
- organized travel event (Rose & Marfurt 2007);
- car sharing (Harms 2003); and
- child birth (Lanzendorf 2010).

It was noted in Chapter 2 that, when an incident of RRC creates a life event, the most common response from motorists is to change routes or the time of travel, although sometimes other aspects of their behaviour related to travel alter (e.g. Lock & Gelling 1976; Lee 1978; Lee 1978; Scott 1978; Hendrickson *et al* 1982; Bullard 1987; Meyer 1988; Pratt 1991; Devine *et al* 1992; Grover & Richardson 1993; Gordon *et al* 1998; Giuliano & Golob 1998; Rees & William 1998; Fujii *et al* 2001; Hunt *et al* 2002; Lee *et al* 2006; Cervero 2006; Clegg 2006; Shin & Lee 2006; Marinelli & Watson 2009; Mokhtarian *et al* 2009; Gilmore *et al* 2010; Carpenter 2010; Mobius Research and Strategy Ltd 2010; Ye *et al* 2010; Yun *et al* 2011).

As indicated in Table 3.1, many events qualify as potential life events. In relation to reducing road capacity, Goodwin *et al* note:

> The evidence suggested that in general, people do not make such changes [see Table 2.1] 'just because' of a change in road capacity. But precisely because of the natural variability in travel choices for other reasons, a change in road conditions may help to tip the balance in which change is chosen.
>
> This also makes sense of earlier work in South Yorkshire. Habits and constraints, based on existing circumstances, may be so strong as to prevent changing behaviour in

response to some policy initiative, because the constraints of life simply do not allow it. Even so, after a while, there will certainly be a 'life shock' of some sort, and then some change in behaviour is unavoidable. This can be done in a way that enables a response to the new circumstances, higher costs, lower costs, more reliable buses, or less road space.

The interesting thing is that, as the diagram below [Figure 3.1] shows, year by year fewer and fewer people will be left who have not had some such upset in their routine. The time-scale – 1 to 5 years, for the majority of the population – is very close indeed to the sort of lags that the econometric results found for elasticities.[8] (Goodwin *et al* 2004)

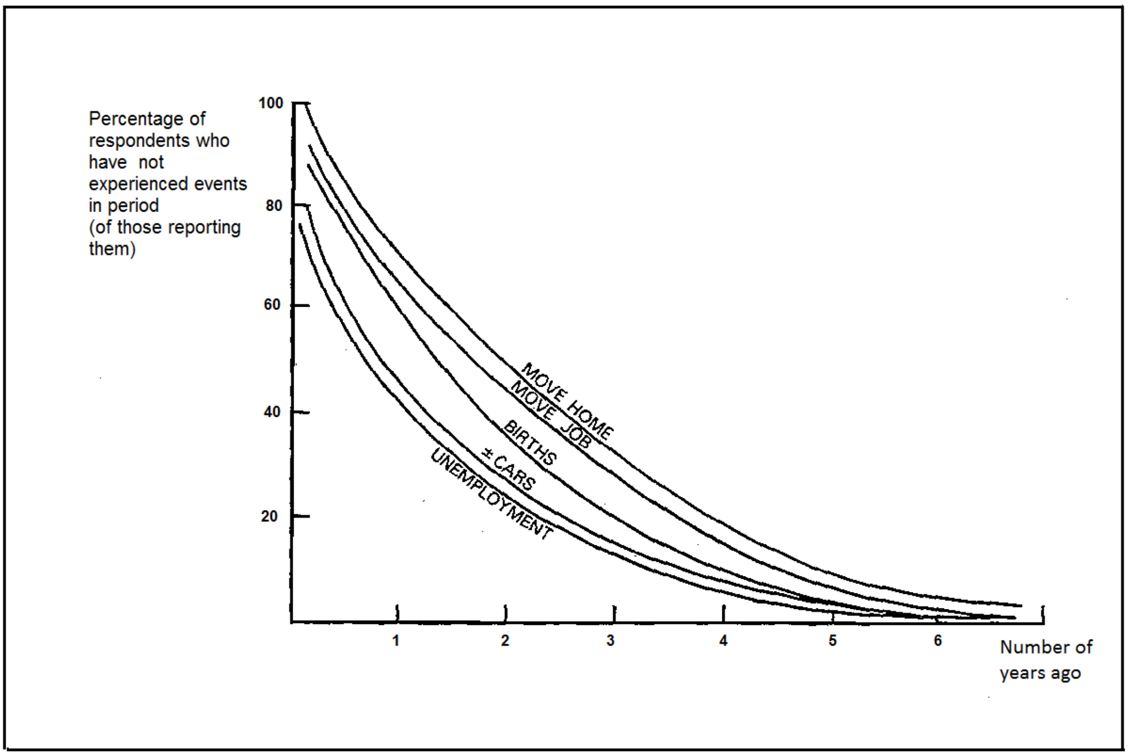

Figure 3.1 Frequency of life events from a panel study of South Yorkshire (England) households

Source: After Figure 4J of the HCR report (Cairns *et al* 1998, p. 50). Originally presented in Goodwin (1984).

[8] Elasticity: the percentage change in demand caused by a 1% change in price

The results shown in Figure 3.1 are drawn from a postal questionnaire answered by about 1500 people, as a part of a study of South Yorkshire (England) households (Goodwin 1984). The study was concerned with five types of life events:

- moving house;
- changed job;
- birth of a baby into the household;
- changes in the level of car ownership; and
- period of unemployment.

Each type of life event was considered independently of the others. Figure 3.1 illustrates the time profile of events. The proportion of respondents who had experienced each type of life event in the last ten years were as follows:

- 47% had moved home;
- 38% had changed job;
- 21% had had a child born into the household;
- 23% had experienced changes in the level of car ownership; and
- 22% had had an experience of unemployment.

(Cairns *et al* 1998, p. 50).

That is, the evidence suggests that, after five years, most individuals can be expected to have undergone at least one of the listed life events (alternatively, after five years there were few respondents who had not undergone one of these life events) (although as Table 3.1

shows, there are potentially many more life events which could be considered). This may lead to a change in travel behaviour.

These life events are not coordinated. It is worth noting that life events for one individual can affect the travel behaviour of other individuals. For example, when children become able to travel independently, their parents will no longer need to make 'serve passenger' trips for them (Chatterjee *et al* 2013).

3.3.4 Characteristics of reduced road capacity as a life event

Reducing road capacity has features which set it apart from some or all of the other life events listed in Table 3.1, but do not appear to have been considered elsewhere. It is:

1. a group event;
2. involuntary;
3. equitable; and
4. usually within human control.

1. Group event

One incident of a significant external event (e.g. RRC, change in car parking availability; extreme weather) affects many people simultaneously, whereas an incident of each of the other listed events involves only one or two people, although both types of events may affect a larger group indirectly.

The fact that many life events (such as changing job, moving house or starting a new job) are happening to many people at the same time is a coincidence; it does not imply a connection between those people.

Even with potential life events such as a bike-to-work day or TravelSmart programme, which are carried out in a coordinated fashion and involve many people who are interested in changing their travel behaviour, it cannot be guaranteed that there will actually be a change in travel behaviour. Nor can it be guaranteed how many people will be affected and whether the change will happen at any particular time.

When road capacity is reduced, however, there is no need to wait for many separate events to prompt changes in many individuals' travel behaviour. Instead, a single event is substituted which affects all the users of the capacity reduced link. The resulting behavioural changes (if any) may not all occur immediately. However, the road authority has the opportunity to set in motion a programme to modify travel behaviour, if it so wishes. For example, if it wishes to encourage bus travel it could install bus lanes to improve bus reliability.

2. Involuntary nature

'Group' life events can be divided into two types: voluntary and involuntary.

Events such as an episode of TravelSmart may lead to a change in intention and behaviour, but involvement in TravelSmart is voluntary. There is no guarantee that travel behaviour will change.

In contrast to most of the life events listed in Table 3.1, which are to some degree voluntary, involuntary life events, such as extreme weather or an episode of RRC, are imposed on people; they are not optional (although each individual's reaction to it may be unique). The fact that the life event is imposed may affect individuals' attitudes towards it and any changes in behaviour that are required. Nevertheless, it should be noted that some individual life events, such as unemployment, are likely to be neither voluntary nor wanted.

3. Equity

RRC affects all members of the affected group (using a similar mode) equally. Reduced road capacity is not affected by the motorist's status (e.g. car parking for certain people may be set aside or protected compared with car parking for the majority) or ability to pay (e.g. Singapore's electronic road pricing, which can be varied by time of day, has reduced traffic at certain times of day by charging extra at those times. Motorists must make a decision as to whether they can afford to, or justify, travelling during the expensive periods (Han 2010). This type of decision would not be required in a case of RRC as the reduction in road capacity is not optional for drivers).

4. Potential for human control

Although some episodes of RRC are outside human control (e.g. damage to infrastructure as a result of an earthquake), most types of RRC (s.1.1.3) are within the control of road authorities and therefore potentially under political influence (e.g. the decision to install street-running light rail). This means, for example, that they can be used as part of a programme to favour one mode over others.

Thus reducing road capacity:

- affects many people at one time;
- enhances the possibility that some travel behaviour will change; and
- gives authorities some control over the time at which the travel behaviour changes;
- allows traffic authorities to change the travel environment in such a way as to encourage a particular mode or modes.

3.4 Explanations of behaviour

3.4.1 Introduction

It was established in s.3.3 that RRC qualifies as a life event and therefore has the potential to cause a change in behaviour. The changed behaviour may be something completely new (including simple elimination of the previous behaviour without replacement by something new) or it may be a continuation of previous behaviour, modified to suit the new situation. The change may be consciously planned or a natural progression from previous behaviour.

Social psychologists (that is, researchers who study the behaviour of individuals in a social context) have proposed many models to explain aspects of human behaviour in a variety of different situations. Examples include:

- Theory [*sic*] of Planned Behaviour (TPB) (Ajzen 1991; Ajzen 2005);
- ASE model (de Vries & Mudde 1998);
- Theory [*sic*] of Interpersonal Behaviour (TIB) (Triandis 1977, pp. 1-38);
- Maslow's Hierarchy of Needs (Maslow 1987); and
- Group think (Janis 1982).

3.4.2 Planned behaviour

Ajzen's Theory of Planned Behaviour is one well-known approach to explaining behaviour relevant to travel (Conner & Armitage 1998; Gardner 2009).

The Theory of Planned Behaviour

Ajzen's Theory of Planned Behaviour (TPB) (Ajzen 1991; Ajzen 2005) describes how attitude (formed by perceived cost and benefits), subjective norms (that is, behaviour that is accepted in, or expected of, the individual's group, that is formed by social pressure and motivations) and a perception of behavioural control (formed by beliefs about difficulties and possibility of control) come together to produce a behavioural intention, which may be turned into behaviour. This is presented graphically in Figure 3.2.

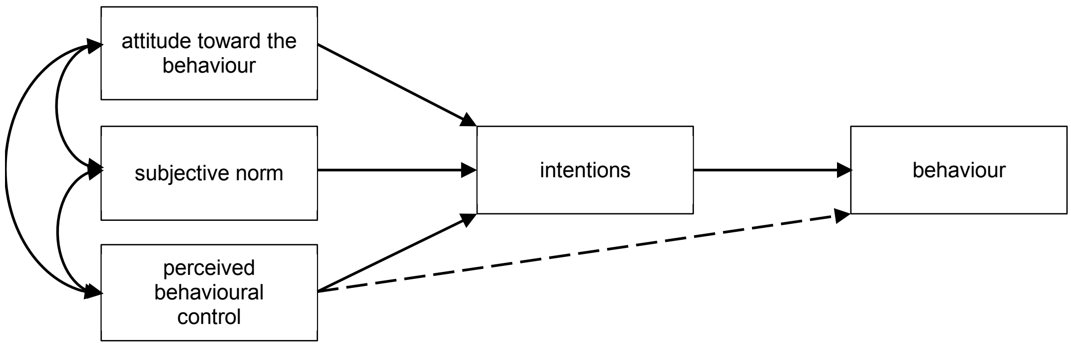

Figure 3.2 Ajzen's Theory of Planned Behaviour
Source: Ajzen (2005), p.118

This explanation of behaviour (and similar models of reasoned action) have found wide acceptance and has been used in fields as diverse as health (e.g. Towler & Shepherd 1991; Bolman *et al* 2011) and transport (Anable 2005; Bamberg *et al* 2003b; Kerr *et al* 2010).

A significant problem with the Theory of Planned Behaviour is that only a small element of everyday behaviour is the result of planning. It is widely agreed (James 1890; Mittal 1988; Dahlstrand & Biel 1997), not least by Ajzen himself, that most behaviour is not planned:

> ... as we perform our daily routines we are rarely aware of forming an intention to do so. It stands to reason that, for relatively novel behaviors, people engage in a certain amount of deliberation before they form an intention to engage or not engage in the behavior under consideration. After repeated opportunities for performance, however, deliberation is no longer required because the intention is activated spontaneously in the behavior-relevant situation (Ajzen & Fishbein 2000; Ajzen 2002) (Ajzen 2005, p. 113).

3.4.3 Unplanned behaviour

In contrast to planned behaviour there are behaviours behind which there is no conscious thought (Ajzen's (2005) 'spontaneous' behaviour). That is, they occur without awareness on the part of the individual (Mittal 1988). Examples include:

- instincts;
- actions limited by physical abilities (e.g. left/right handedness);
- automatic bodily functions (e.g. breathing, sleeping), which are regulated by the body's internal processes) although in some cases, the automaticity may be consciously overridden (e.g. slow, deep breathing).
- conditioned reflexes – automatic responses which occur as a result of a stimulus which is no longer the original precursor to that behaviour (e.g. Pavlov's dogs which salivated when a bell was rung (initially signalling the presence of food) (Pavlov 1960, pp. 16-34));
- panic behaviour (e.g. performance nerves);
- learnt behaviour (e.g. skills such as driving a car or playing a musical instrument);
- addictions (e.g. alcohol) or compulsive behaviours (e.g. nail biting);
- scripts. These are abstract knowledge constructs – that is, a predetermined series of events that are expected to occur in order to attain a certain goal or behave appropriately in a given situation. They must be customized to the particular situation in which they are carried out (that is, scripts only contain a subset of the information needed to perform the behaviour (Gärling *et al* 2001)). They may be cultural wide (e.g. going to a restaurant (enter, be shown to a table, peruse menu, place order)) or personal (Abelson 1981; Eagly & Chaiken 1993, p. 182); and

- habit. This is automatic behaviour carried out in response to cues from the environment (e.g. using a car for every trip). However, unlike conditioned reflexes, the behaviour carried out during repetition of a habit initially required some planning on the part of the individual.

3.4.4 Combining planned and unplanned behaviour

The Theory of Interpersonal Behaviour

Less well known than the Theory of Planned Behaviour (Domarchi *et al* 2008) is Triandis' Theory of Interpersonal Behaviour. Under this hypothesis, Triandis allowed for both planned and unplanned behaviour (Triandis 1977, pp. 1-38), by including habit as one factor in behaviour (Figure 3.3). Triandis' overall model has components similar to Ajzen's better known Theory of Planned Behaviour (Figure 3.2); that is:

- an element related to attitudes about the behaviour;
- a social element; and
- an element under the control of emotions.

Like Ajzen's Theory of Planned Behaviour, these elements come together to form an intention, which may then be turned into behaviour. However, Triandis shows habit present explicitly, with its own independent path, so that habit is present as an alternative to forming an intention before performing a behaviour. That is, Triandis recognized that behaviour could be either planned or unplanned and that the relative weights of habit and intention could vary from moment to moment (Triandis 1977, p. 13).

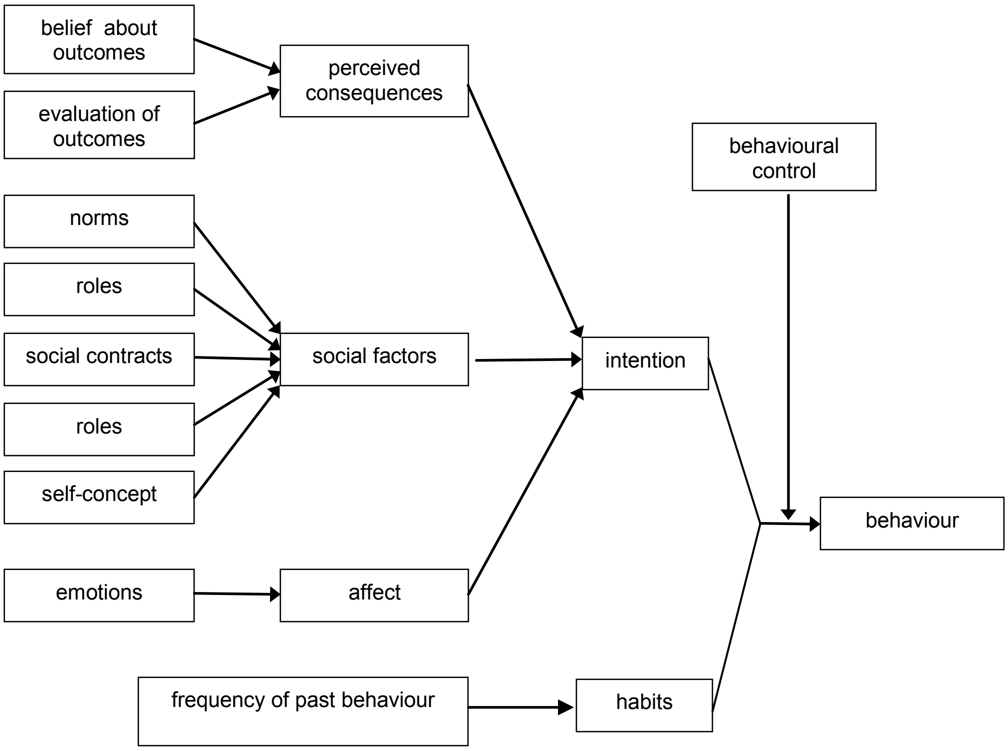

Figure 3.3 Triandis' Theory of Interpersonal Behaviour
Source: After Triandis (1977) p. 37

In particular, he derived an equation giving the probability of an act (P_a) as determined by three factors:

1. the strength of the habit of performing the behaviour;
2. the intention to perform the behaviour; and
3. the presence or absence of conditions that facilitate performance of the behaviour.

$$P_a = (w_h \,.\, H + w_i \,.\, I) \,.\, F \qquad (3.1)$$

where

- P_a is the probability of the behaviour; it varies from 0 (certainty that it will not take place) to 1 (certainty that it will take place);
- H is the habit to act;

- *I* is the intention to act;
- *F* refers to objective facilitating or inhibiting conditions; and
- w_h and w_i are weights of the habit and intention component, respectively. The weights vary between 0 and 1 and sum to 1. That is, a low weight of intention goes with a high weight of habit and vice versa.

(*ibid*, pp. 9-10; Verplanken, Aarts & van Knippenberg 1997).

3.5 Habit

3.5.1 Introduction

Handy and her colleagues (2005) note that habits are one of the factors leading to excess trip making which have potential to be altered if travellers reconsider their behaviour (s.3.2.2). They use the term loosely, without defining it. This section attempts to deal with the concept more rigorously. The majority of papers quoted are drawn from the transport literature although the subject of habit covers a much wider area than this.

3.5.2 Definition of habit

Synonyms for 'habit' in layperson's terms include 'second nature', 'custom', 'wont, pattern', 'regularity', 'inveteracy', 'compulsion', 'obsession, fixation', 'tendency', 'tradition', 'routine' and 'procedure' (Bloomsbury Thesaurus 1993, pp. 621-622). All these words relate to previous behaviour and are an indication that the behaviour has been repeated many times. However, the repetition of a given behaviour may be due to the enduring influence of the factors which determined the behaviour initially. That is, what is observed may merely be behavioural stability (Ouellette & Wood 1998; Ajzen 2005, p. 91; Verplanken *et al* 2005). Mittal (1988) points out that 'repeated occurrence is necessary for the formation of habit, but it is not habit itself'.

It is therefore necessary to define 'habit' more precisely if it is to be used as a technical term. The definition of habit has been refined over time, from an initial concern only with repetition (even using the word to refer to inanimate objects) to a more rigorous view which considers (learned) automatic behaviour, the cues which elicit it and, in order to differentiate it from merely spontaneous behaviour, the goals which the initial sequence of actions was designed to achieve. Examples of definitions of 'habit' in the psychology literature include:

- James (1890, p. 109) views habit as a physical state (e.g. a nerve current repeatedly taking the same path through the brain) '... the phenomena of habit in living beings are due to the plasticity of the organic materials of which their bodies are composed.';
- Hull (1943, p. 102) defines habit as 'a *persisting state of the organism* (resulting from the reinforcement) which is a necessary, but not a sufficient, condition for the evocation of the action in question.)' (emphasis as in the original);
- Triandis (1977, p. 12) views all repetitive behaviour as habit, whether learned or innate;
- by 1980 Triandis had revised this definition to 'situation-behaviour sequences that are or have become automatic, so that they occur without self-instruction. The individual is usually not 'conscious' of these sequences' ((Triandis 1980, p. 204) quoted in Mittal (1988));
- Maslow (1987) defines habit as 'an attempt to solve a present problem by using a previously successful solution';
- Mittal (1988) does not offer a precise definition of habit. Rather, he notes what habit was not. He notes that: 'If a behavior recurs *with* awareness, it must be

deemed as being driven by intentions or self-instruction, not habit' and 'In order for habit to play a theoretical role in bridging the intention – behaviour gap, habit *must* be distinguished from intentions. *Awareness* is *the* discriminating characteristic' (Mittal 1988, emphasis as in the original);

- Ronis *et al* (1989) consider that 'Habit may be considered as frequently repeated behaviour or alternatively as behaviour that is in some sense automatic or out of the awareness of the subject';
- Verplanken *et al* (1994) describe habits as 'relatively stable behavioural patterns, which have been reinforced in the past.' A fundamental feature of a habit is that it occurs without any awareness on the part of the person in question. Hence, 'Habits are executed without deliberate consideration, and result from automatic processes, as opposed to controlled processes like consciously made decisions.'
- Ouellette and Wood (1998) define habits as '... tendencies to repeat responses given a stable supporting context'; and
- Klöckner and Matthies (2004) understood habit as 'a behavioural script .... that mediates between situational cues and behavioural patterns.'

Verplanken and his colleagues note that behaviour must have rewarding consequences in order to develop into a habit. In particular: 'Goal-directed awareness distinguishes habits from other forms of repeated automatic behaviour, such as body reflexes.' (Verplanken *et al* 1997). That is, habit is not totally automatic – there is an element of consciousness involved. They have developed the following definition of habit:

> Habits are learned sequences of acts that have become automatic responses to specific cues, and are functional in obtaining certain goals or end-states (Aarts *et al* 1997; Verplanken & Aarts 1999).

That is, repetition of behaviour leads to learning those actions. When they are repeatedly enacted in a particular environment in order to achieve a particular goal, that particular environment becomes a cue to enact the behaviour and a habit is formed. When the goal is activated, the habits associated with the current environment are also activated. Thus, for example, commuting habits (e.g. catching the train to the city) will only be activated if the goal of travelling to work has already been activated. For an office worker, the habits related to work will not be practised at the weekend.

In this study, Verplanken & Aarts' rigorous definition of habit is used.

As the technical definitions of 'habits' grew more precise, it was still necessary to paraphrase them for use with the general public. Wood *et al* (2002) define habits as behaviours that are repeated in stable contexts – for the study in question, habits were defined (to respondents) as behaviours that were performed 'just about every day' and 'in the same location'. Stanbridge asked the participants in her study 'whether they felt their previous travel mode choice was habitual or not, the automatic nature of habits having been stressed to them' (Stanbridge *et al* 2004).

3.5.3 Further characteristics of habits

There are further specific aspects of habits which warrant discussion, including:

- specificity;
- ease of use;

- development of habits;
- potential complexity of habit;
- presence or otherwise of enduring factors;
- stable contexts;
- differing strengths of habits;
- relative influence of habits and intentions; and
- information seeking behaviour.

These points are discussed below, with the exception of habit strength, which is discussed in s.3.5.5.

Specificity

Verplanken and Aarts (1999) differentiated between habits of a general nature and those of a specific nature. General habits occur in a variety of settings and are therefore under the control of cues that appear in many different situations. Specific habits are confined to a particular situation. Verplanken and Aarts give an example of reading a particular magazine at the hairdresser. If the customer only reads the magazine when she visits the hairdresser, it can be described as a specific habit. However, if she reads the magazine when she has some spare time (e.g. in the dentist's waiting room or on a bus), reading the magazine at the hairdresser is one instance of a general habit.

Ease of use

Habits can be performed quickly, at the same time as other activities, with minimal attention. They can be both desired (e.g. using a standard greeting when answering the telephone) or undesired (e.g. compulsively eating unhealthy but nevertheless pleasurable food).

> In sum, in constant contexts, well-practiced behaviours are repeated because of the speed and ease with which such responses can be performed. Performance of habitual behaviors does not, however, require conscious intention. (Oullette & Wood 1998)

Development of habits

A definition of habit, outlining the features which mark a behaviour as habitual, was provided in s.3.5.2. By that definition, habits must have a learning phase (initiation) when the behaviour is planned or otherwise initiated. This is followed by a persistence phase when the person becomes 'frozen' into the behaviour (Ronis *et al* 1989; Dahlstrand & Biel 1997; Gärling *et al* 2001; Gardner 2009). It should be noted that there is no mention of choice in the definition. That is, it is not necessary to select from a range of options in order to generate habitual behaviour.

It should also be noted that Oullette & Wood (1998) find no socio-demographic factors that lead to the development of strong habits.

Potential complexity of habits

It should also be noted that any behaviour can have both planned (volitional) elements (e.g. a goal of deciding where to go) and habitual elements (e.g. using the car to get there) (*ibid.*). Several habits may be involved in one, more complex behaviour. Verplanken and Aarts' definition of habits (s.3.5.2) mentions that they are responses to specific cues. These may be general cues (e.g. using a car for any trip longer than walking distance) or specific (e.g. going grocery shopping). The cues and behaviours may be more elaborate than this. For example, the individual may walk to the train station in the morning if there is enough time and it is not raining. However, if it is raining, and/or they are in a hurry, they may drive to the station. In such a case there are more than one cue (weather and time) and more than one behaviour (walking and driving) associated with the habit of catching the train in the morning (Chen *et al* 2004).

Enduring factors

It was noted in s.3.5.2 that the repetition of a behaviour may be due to the enduring influence of the factors which determined the behaviour initially (that is, the stability of causal antecedents). However, Verplanken and Aarts' (1999) definition of 'habit' also requires an element of automaticity and goal-directed behaviour. Hence, it can be seen that repetition of a particular behaviour is necessary, but not sufficient, to permit it to be described as habitual.

Stable contexts

Work by Wood and colleagues (2005) suggests that when the usual contexts for habits change, the habitual behaviour does not occur. This is consistent with the definition of habit from Verplanken & Aarts (1999) cited in s.3.5.2 and the discussion of life events in s.3.3. Verplanken & Wood (2006) suggest that such disruption enhances the chance of behaviour being (re)considered. Verplanken *et al* (2008) refer to this as the habit discontinuity hypothesis.

In the context of mode choice and an unstable environment, it has been demonstrated that habits are disrupted which can then result in an altered pattern of mode choice (Brown *et al* 2003; Harms 2003).

Variations in strength of habit

It has been observed that there is a gradation in the strength of habits; that is, in the likelihood that the habitual behaviour is the only behaviour that will be expressed in the situation in question. Generally speaking, a strong habit is one in which the given behaviour is performed to the exclusion of all other possibilities. Weak habits reduce the likelihood that the person will consider alternatives to whatever they normally do (Thøgersen 2006). The measurement of habit is discussed in s.3.5.6.

Relative influence of habits and intentions

It has been observed empirically that there is a relationship between the strength of habit and the influence of intentions over actual behaviour. Where habit is weak, intention will predict behaviour but, where habit is strong, intention has a negligible effect on behaviour, as predicted by Triandis:

> ... when a behavior is new, untried, and unlearned, the behavioral-intention component will be solely responsible for the behavior, while, when the behavior is old, well learned, or overlearned and has occurred many times before in the organism's life span, it is very likely to be under the control of the habit component ... (Triandis 1977, p. 205)

For example, Thøgersen (2006) found that, with respect to mode choice, past behaviour was a stronger predictor of current behaviour than attitude, perceived ability of public transport to cover transport needs or car ownership. In the Netherlands, de Bruijn *et al* (2009) find that, after controlling for the variables in TPB, habit was the best predictor of bicycle use. Intention was a significant predictor of bicycle use for weak bicycle habits but a non-significant predictor for strong bicycle habits.

Other studies where this relationship between intention and habits has been observed include: Wittenbraker *et al* (1983); Mittal (1988); Verplanken *et al* (1994); Ouellette & Wood (1998); Verplanken *et al* (1998); Klöckner & Matthies (2004); Gardner (2009); and Chen & Lai (2011).

Variations in information seeking behaviour

Researchers have found that the amount of information processing done before performing a behaviour depends on the strength of the associated habit (if any).

When they tested a group of students with regard to use of information in a travel mode choice task, Aarts and his colleagues found that:

> In comparison to weak habit students, strong habit students used fewer attributes about the circumstances under which the trip had to be made. In addition, strong habit individuals were more selective in using the information of the attributes of choice options than weak habit individuals. These results suggest that habitual travel mode choices are based on a small subset of trip-related cues necessary to make these choices. .... when confronted with the goal to travel, strong habit persons tend to use heuristic and low effort strategies to arrive at decisions about using that mode, whereas weak habit persons, seem to apply more complex and cognitively demanding strategies. More generally, habitual choices tend to follow cognitive short-cuts. (Aarts *et al* (1997))

In another study, the same researchers (Verplanken *et al* 1997) considered the role of habit in the acquisition of information while choosing a travel mode. They found that those with a strong habit towards a particular mode inspected less of the information they were offered, particularly about alternatives to their habitual mode, and when they were asked to account for their modal choice, had less elaborate choice strategies.

The researchers note that:

> ... a less elaborate choice process may be expected when a habit is based on a high level of knowledge and experience concerning the domain of interest. .... In that case a

limited choice process is functional. Experts, for instance, may acquire little information and yet make an accurate decision. .... On the other hand, the automaticity of experts' decisions differs from the type of automaticity that characterizes most mundane behaviours, in that experts are generally aware of all relevant choice alternatives, whereas habit in daily behaviours may lead to a narrow focus on the habitually chosen option, i.e. habit may limit the decision-maker's consideration set ... (*ibid.*)

That is, as a strong habit is (almost) always performed in the situation in question, there is no need to find further information concerning different options for that situation, or to consider whether a different (already known) option might be better (and in what way) under the circumstances. Hence, in the case of a strong habit there is neither searching out of new information nor reflection on existing knowledge and practice. This lack of interest in new information and shallow information processing leads to 'tunnel vision' (Verplanken *et al* 2008).

In the extreme, ... strongly habitual choices are relatively simple stimulus-response relations. In this case, the individual may not perceive such a situation as a choice at all, which thus precludes the consideration of situational cues and alternative options (Verplanken *et al* 1997).

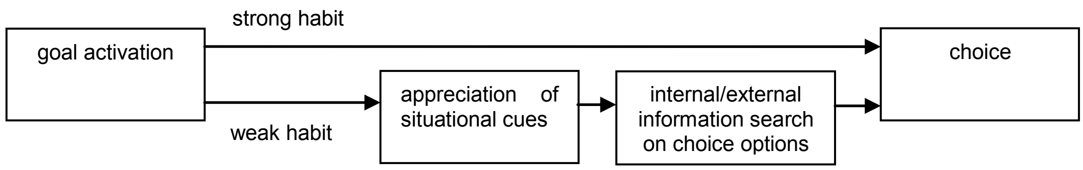

Figure 3.4 Process model of making choices by weak and strong habit individuals
Source: After Verplanken *et al* 1997

3.5.4 Validity of habit hypothesis

The concept of habit is accepted in other fields such as transport (e.g. Goodwin 1977; Hanson & Huff 1988; Papinski *et al* 2009), environmental behaviour (Dahlstrand & Biel 1997; Stern 2000), health (Wind *et al* 2005) and by the community at large (s.3.5.2):

> There is no more miserable human being than one in whom nothing is habitual but indecision, and for whom the lighting of every cigar, the drinking of every cup, the time of rising and going to bed every day, and the beginning of every bit of work are subjects of express volitional deliberation. (James 1890, p. 122).

However, there is disagreement amongst theorists about the validity of the concept of habit as an explanation for behaviour.

Ouellete and Wood undertook a meta-study to test their ideas about the effect of past behaviour on future responses. They concluded that:

> In general, intention and past behavior appeared to alternate as predictors of future acts. In domains that facilitated development and execution of habits, past behavior was a strong predictor and intention relatively weak. In domains that did not facilitate habits, past behavior was a relatively weak direct predictor and intention was quite strong. One interpretation of this pattern is that intention effects emerge primarily in the absence of habit. (Ouellette & Wood 1998)

Ajzen disagreed:

> Some theorists (e.g. Ouellette & Wood 1998; Gollwitzer 1999; Aarts and Dijksterhuis 2000) go one step further in their analysis of habitual behavior. They argue that habits are established when people have frequent opportunities to perform a behavior under identical or very similar circumstances. Once a habit has been established under these

conditions, initiation of the behavior is said to come under the control of external or internal stimulus cues. In the presence of these cues, the behavior is automatically activated without cognitive intervention. Consider, for example, people's early morning routines to brush their teeth in their bathroom. The situational cues present in the bathroom (sink, faucet, mirror, etc) are assumed to automatically elicit the tooth-brushing practice without the intervention of a behavioral intention, even a spontaneously activated one. This analysis implies that intention become increasingly irrelevant as a behavior habituates. In other words, a measure of intention should be a good predictor of relatively novel or unpracticed behaviors, but it should lose its predictive validity when it comes to routine or habitual responses in familiar situations.

Empirical findings lend little support to this hypothesis. (Ajzen 2005, p. 113)

Wood and colleagues, however, noted that Ajzen's analysis:

... was based on the bivariate correlations between past behavior, intention, and future behavior. Specifically, he noted that Ouellette and Wood (1998) found that past behavior and intention were both correlated with future behavior, and that these correlations emerged in domains and contexts in which habits were likely to develop as well as ones in which they were not. Yet, these bivariate correlations are not an appropriate test of the habituation perspective. Past behavior is often highly correlated with intention, presumably because people reason from their typical behavior and report intentions that correspond to what they usually do. A more informative test is provided by analyses that have examined the independent predictive power of intention and past behavior. Although Ajzen (2002) neglected to mention these findings, they reveal the expected pattern – past behaviour tends to emerge as the primary predictor when habits have developed, whereas intention is the primary predictor when habits are unlikely to have developed (Ferguson & Bibby, 2002;

> Ouellette & Wood, 1998; Verplanken *et al* 1998). Thus models that examined the unique impact of past behavior and intention provided evidence of the relatively automatic processes guiding habits (Wood *et al* 2002).

Gardner noted that:

> Consideration of situations in which motivation and habit correspond reveals the limitations of testing theory using correlational data, because strong intention–behaviour correlations conceal habit effects. Our findings highlight the potential for mistakenly accepting models as valid depictions of real-world behaviour where statistical significance of the multiple correlation coefficient (R^2) is the main criterion by which theory is evaluated. (Gardner 2009)

For the purposes of this study, habit is taken to be a valid concept and an important determinant of behaviour.

3.5.5 The importance of habit

Habits are important for three reasons. The **first** reason is their significance in explaining behaviours (e.g. Mittal 1988; Stern 2000; Klöckner & Matthies 2004). It has been observed that:

> the greater part of psychological research pursues to explain and understand behaviors that people do not perform frequently. As a consequence, decisions to perform a given behavior are often considered as being based on reasoned considerations of the good and bad consequences of that behavior. (Aarts *et al* 1997)

That is, common behaviours are under-researched and understanding of them is not as well developed as that of less common behaviours. Some researchers, however, do not consider habitual behaviour to be important because they feel that most behaviour 'of social relevance' is under volitional control (Ajzen & Fishbein 1980, p. 5).

The **second** reason is the frequency with which they are performed (Aarts *et al* 1997; Gärling *et al* 2001; Wood & Neal 2007). One study found that about 45% of daily behaviour could be described as habitual (or repetitious) (Wood *et al* 2002); James went further:

> Ninety-nine hundredths or, possibly, nine hundred and ninety-nine thousandths of our activity is purely automatic and habitual, from our rising in the morning to our lying down each night. Our dressing and undressing, our eating and drinking, our greetings and partings, our hat-raisings and giving way for ladies to precede, nay, even most of the forms of our common speech, are things of a type so fixed by repetition as almost to be classed as reflex actions. To each sort of impression we have an automatic, ready-made response. (James 1925, Chapter 8)

The **third** reason is their automatic nature (Aarts *et al* 1997); that is, they are performed without thought. Such automaticity can be helpful if it is in line with a person's intentions, speeds up the performance of the action and ensures that it is not omitted. However, if the behaviour is not in line with conscious intentions, habits may become an impediment to attaining goals.

Thus, the strength of habits can be a weakness in some circumstances (Harms 2003). Because thought is no longer put into the choice, no information is sought out that might affect the behaviour and no rationalization of the behaviour is attempted. Hence, if circumstances change, the behaviour will not necessarily still be optimal (it may, in fact, be counter to the person's desired goal (Møller & Thøgersen 2008)). For the same reasons, the behaviour will be difficult to change by persuasion:

> A choice that is non-deliberate may in fact be difficult to influence with rational arguments (e.g. increased costs), since the person making the choice tends to discount relevant information. (Gärling & Axhausen 2003)

> ... car use becomes a vicious circle, which is nearly impossible to break using persuasion techniques, because habit is not based upon a rationalization of the problem, and does not always involve informed choices. (Domarchi *et al* 2008)

Some researchers (e.g. Garvill *et al* 2003; Gardner 2009) have suggested ways to overcome the impasse, using their understanding of habits. For example, Ouellette and Wood (1998) suggest changing the supporting environment to provide opportunities for repetition of the new behaviour, and ensuring that the new behaviour has some immediate positive consequences.

3.5.6 Measurement of habit

Value scales

It is difficult to give an absolute numerical value to strength of habit which would allow habit strengths to be compared across studies (Eagly & Chaiken 1993, p. 181; Klöckner & Matthies 2004). Strength is usually defined relative to other results of the particular study. This means that it would be theoretically possible to differentiate habit strengths in one study, which could all be defined the same way (e.g. weak) in another study.

For example, in the case of de Bruijn *et al* (2009), habit strength is defined relative to the statistical average found in the study:

- a 'strong' habit was greater than one standard deviation above average habit strength; and
- a 'weak' habit was less than one standard deviation below average habit strength.

Garvill and colleagues assessed habits using two different methods and hence use two different definitions for strong and weak:

- for the response frequency method (see below) a strong car habit equated to >60% by car and a weak car habit <60% of trips by car; and
- for the self-reported car use measure, a strong car habit equated to greater than median use and a weak car habit equated to less than median use. (Garvill *et al* 2003)

Methods of measurement

Five methods of measuring habit have been found in the literature:

- reinforcement frequency (Hull 1943);
- self-reported frequency of behaviour (Triandis 1977, p. 10);
- response frequency (RF) (Verplanken *et al* 1994);
- self report habit index (SRHI)(Verplanken & Orbell 2003); and
- Wood's frequency/stability measure (Wood *et al* 2005).

All these measures of habit include an element of a statistical relationship between past and future behaviour. They are discussed below.

Reinforcement frequency

Reinforcement frequency was an early measure of habit. Strength of habit depended on, amongst other things, the number of times that a behaviour had been reinforced up to some physiological limit, the amount of reinforcement and the length of time between the act and reinforcement. However, it could be argued that what was being measured was learning, rather than habit (Hull 1943, pp. 102ff).

Self-reported frequency

Self-reported frequency of (past) behaviour is a simple (linear) measure of the number of times a behaviour has been performed in the past (e.g. Verplanken *et al* 1997). This measure can be criticized on several grounds (Verplanken *et al* 2005):

- the behaviour may merely represent a stable situation because the factors which determined the reported reaction initially are still in place;
- if a behaviour is automatic, it is unlikely that individuals will be able to recollect it correctly, after it has been performed (Mittal 1988; Ouellette & Wood 1998; Verplanken & Aarts 1999). Therefore, it is unlikely that they will be able to report the frequency correctly;
- a linear relationship between the number of times a behaviour is performed and strength of habit implies a minimum number of repetitions is need to establish the relationship. There is no empirical evidence for this; and
- in particular, a linear relationship implies that repetition could strengthen a behaviour to an infinite degree (implying that ultimately, a habit that a person employed frequently could not be broken). This has not been observed.

A variation of the self-reported frequency measure was used by some interviewers (e.g. Wittenbraker *et al* 1983; Mittal 1998; Aarts & Dijksterhuis 2000). They asked respondents how often a behaviour was performed 'without awareness' or 'by force of habit'. However, this approach merely makes the situation more complicated by posing two questions at once (Verplanken *et al* 2005):

- asking for a frequency estimate; and
- asking the respondent to decide whether their behaviour is a habit.

This method was used by Verplanken *et al* (1998) and Garvill *et al* (2003).

Response frequency

The response frequency measure was constructed to address some of these objections in situations of transport mode choice. It is a measure of general habit, rather than habit with respect to a specific incident. It measures the connection between cues and responses in terms of behavioural options. It requires respondents to state as quickly as possible the mode option that comes to mind when a journey goal is mentioned (e.g. shopping →car). The number of times that a mode is given is taken as an index of mode habit strength (Verplanken *et al* 1994). Response frequency:

- does not enquire into the past frequency of behaviour;
- is general, rather than being restricted to one particular journey;
- does not rely on the respondent remembering anything; and
- is easy to administer, in a structured setting.

The proponents report some problems with this method:

- it is a cross sectional study and therefore it is not possible to come to conclusions on causality;
- because of the speed of decision making required, it is not suitable for self administered questionnaires;
- it is only useful for behaviour that is expressed in a variety of contexts (e.g. using the car to go to work, go shopping or visit friends); and
- a new version of the test is needed for each particular context.

In addition, the method presents difficulties because of its nature as a stated preference technique (that is, respondents state what they consider likely that they would do in the future, instead of revealing what they have done in a similar situation in the past). It gives a potentially idealized picture of what the respondent would do in the situation described. Apart from changes in the respondent's situation which might alter their actual (rather than proposed) reaction (e.g. when used in the context of mode choice, the loss of driving licence), there are a number of potential biases, over and above the biases inherent in any survey (such as sampling error) which could result in misleading responses (Bradley & Kroes 1992; Ampt *et al* 1995; Hunt & Abraham 2007):

- *affirmation bias*: respondents may, consciously or unconsciously, be tempted to express the sorts of preferences or choices that they think the interviewer expects to hear, rather than what they really believe or could realistically be expected to prefer;
- *rationalization bias*: respondents may provide somewhat artificial responses in an attempt to rationalize their current behaviour. This may be related to the subconscious phenomenon known as cognitive dissonance (whereby people are

able to reconcile themselves to attitudes which conflict with their actual behaviour or other attitudes);

- *policy response bias*: respondents may deliberately respond in a biased way in an attempt to influence decisions or policies which they believe will be based on the results of the survey;
- *unconstrained response bias*: respondents may respond in an unrealistic way because they neglect to take actual constraints on their behaviour into account or do not truly understand what is involved in their choice (that is, they answer optimistically); and
- *status quo bias and other principles from behavioural economics*: such as risk aversion, loss aversion and heuristics (mental short cuts used to make decisions) whereby decisions are not made in a strictly rational manner (Reeson & Dunstall 2009).

Finally, in the context of mode choice, the method only allows for simple trips. It does not allow for multi-modal trips (even park and ride) nor does it cater for trip chaining, where the mode required for one errand in the trip chain might dictate the choice of mode for the whole trip.

Studies using this measure include Aarts *et al* (1997); Verplanken *et al* (1997); Verplanken *et al* (1998); Matthies *et al* (2002); Garvill *et al* (2003); Harms (2003); Klöckner & Matthies (2004); Møller & Thøgersen (2008) and Domarchi *et al* (2008). A variation of this method which included self-administered questionnaires was used by Gärling *et al* (2001); Fujii & Gärling (2003); Fujii & Kitamura (2003); Bamberg *et al* (2003a); Kerr *et al* (2010); and Chen & Lai (2011). As the method is explicitly stated to be unsuitable for self-administered questionnaires, some doubt must be cast on the validity of those results.

Self report habit index

The self report habit index (Verplanken & Orbell 2003) is an attempt to overcome problems in previous methods. It uses a 12 item index of habit strength based on the history of repetition of the behaviour, its automaticity and expression of personal identity, as it was felt that these qualities of habitual behaviour would be easier for respondents to conceptualize than 'habit strength' as such.

Respondents are asked whether they agree or disagree with statements such as 'I do without thinking' on a five (or preferably more) point scale, with values 1 = 'totally disagree' to n= 'totally agree'. The index value is the average of the scores for each item.

The additional problems described for the response frequency measure of habit strength also apply to the self report habit index.

Studies using this measure include Wind *et al* (2005), Møller & Thøgersen (2008) and de Bruijn *et al* (2009).

Møller & Thøgerson (2008) find that both the response frequency and the self-report habit index measures of habits give similar results.

Wood's frequency/stability measure

Wood and her colleagues estimated habit strength from the frequency of past behaviour (measured on a scale of 0 to 3), combined with the stability of the performance context (also measured on a scale of 0 to 3). When these numbers were multiplied together, they gave a value in the range 0 to 9. The higher scores represented frequent performance in stable circumstances (strong habits). The lower scores reflected either infrequent performance or variable circumstances (weak or no habits) (Wood *et al* 2005).

This measure of habit strength is a measure of revealed preference and, as such, not subject to many of the problems of stated preference surveys (see discussion of response frequency). However, it contains no measure of automaticity (or lack of awareness), which some researchers see as an integral aspect of habits.

3.5.7 Habits with respect to travel behaviour

Travellers themselves recognize the importance of habit in transport; habit was reported as one of the main reasons for current transport behaviour, particularly among drivers in the National Transport Commission's surveys (Hoye *et al* 2011, p. 21). Researchers have also considered the place of habit in travel behaviour: Verplanken *et al* (1994) note that: 'Like seat belt use, the repetitive nature of travel mode choice makes a role of habit in this behaviour very likely'.

Choice of mode (revealed or stated preference) is usually the focus of interest when travel habits or routine travel behaviour are discussed (e.g. Goodwin 1977; Verplanken *et al* 1994; Aarts *et al* 1997; Khattak & de Palma 1997; Verplanken & Aarts 1999; Aarts & Dijksterhuis 2000; Matthies *et al* 2002; Garvill *et al* 2003; Bamberg *et al* 2003b; Harms 2003; Klöckner & Matthies 2004; Thøgerson 2006; Domarchi *et al* 2008; Møller & Thøgerson 2008; Verplanken *et al* 2008; de Bruijn *et al* 2009; Gardner 2009; Guillen *et al* 2010). Nevertheless, other travel behaviour can be routine and performed in a stable context and therefore potentially habitual (Ouellette & Wood 1998). Examples include:

- travel patterns (Hanson & Huff 1988);
- trip making as a solution to a problem;

- behaviour towards other road users; e.g. providing sufficient overtaking space when passing motorcyclists or cyclists, giving way to pedestrians at zebra crossings, tailgating other motorists;
- style of driving – e.g. propensity to change lanes or overtake or make right turns; gap acceptance, desire to keep moving;
- use of seatbelts (Wittenbraker *et al* 1983; Mittal 1988);
- speed;
- route choice (Polydoropoulou & Ben-Akiva 1994; Papinski *et al* 2009);
- propensity to pay for the use of the road;
- destination for errand;
- time of travel;
- scheduling of activities requiring travel (Chen *et al* 2004);
- choice of mode for journey purpose; and
- use of technology.

3.6 The place of habits in the life event of reduced road capacity

From the foregoing discussion, it can be seen that studies have considered travel habits primarily in the context of mode choice; in particular, the choice of one mode in preference to another. However, there are potentially many aspects of travel behaviour which could be influenced by habit. This study aims to gain a better understanding of other potentially habitual aspects of travel behaviour and the effect that they have on a motorist's behaviour in the case of RRC.

Similarly, there are many situations that could be classified as life events (as listed in Table 3.1), yet most attention has been directed towards changing residence or employment, starting university, or childbearing, in the context of travel demand management and mode change. There are many more life events which could be studied, in particular life events which affect a group of people rather than individuals. For example, Fujii & Kitamura (2003) considered habitual travel mode changes after the temporary life event of a monthly free bus pass. The present study is concerned with the (group) life event of a reduction in road capacity.

Finally, although there is some awareness of the fact that some people are open to driving less than they do at present, there appears to be little work aimed at this aspect of trip making directly (in contrast to the desire to help people to continue to make their existing trips by a non-car mode). Empirical evidence suggests that this is a possible effect of reducing road capacity and therefore it deserves greater consideration, particularly in the context of sustainability.

3.7 Summary

If it is desired to manage traffic, it would be useful to know the reason individuals make trips and the reason they make them as they do: that is, how individuals choose the parameters for their trips. They may feel they need to make trips in order to carry out their desired activities, such as going to work or school. However, they may also be making the trip out of habit, or because they feel that they are expected to, or because they have not thought about whether they actually need to (i.e. whether the outcome can be achieved another way). As an extension of this, it would also be useful to understand why they sometimes change their travel behaviour. This will entail finding out what prompted them to choose a different behaviour and why they changed when they did.

Individuals change their behaviour as circumstances and attitudes change. Evidence suggests that within any five-year period, most individuals will have undergone at least one 'life event'. This is an event which causes people to reconsider their current behaviour. A life event may cause a review of trip making behaviour, considering factors such as the need for the trip and the parameters of the trip (e.g. mode, route, time of travel). There may be a change in trip making behaviour as a result.

Reducing road capacity creates an unstable situation and fulfils the criteria for a potential life event. Unlike many life events, which happen to people in an uncoordinated fashion, a single incident of reduced road capacity affects many people simultaneously. As a result, many people may have to think about how they are going to cope with the new situation. They may continue as before in one or more aspects of their trip making or they may change some aspects.

Clearly there can be many factors involved in changing behaviour. Ajzen's Theory of Planned Behaviour is sufficient to explain some behaviour. However, this model is predicated on intentions, that is, planned behaviour. Unplanned behaviour such as habit – that is, behaviour which takes place in a stable context – is the result of automatically carrying out learned actions which are cued by the environment and which is functional in achieving some goal – is an alternative explanation. Furthermore, some authors have found that changed behaviour is better explained by a combination of habits and intentions than intentions alone.

This study is particularly interested in habit. No work on habits with respect to reductions in road capacity has been found. Therefore, this study aims to find out whether habits play some part in motorists' reactions to the potential life event that is a reduction in road capacity and, if so, how.

CHAPTER 4

Traffic on Epping Road

This chapter presents relevant background to the field study. Of necessity, it presents a very abbreviated description of the events that culminated in the addition of the Lane Cove Tunnel ('the tunnel') to the Sydney Orbital [motorway] Network, and the associated works.

The chapter begins by explaining why Epping Road was chosen as the site for the field study for this doctorate. Section 4.2 describes the orbital motorway[9] network within Greater Sydney. Section 4.3 describes the events that took place leading up to the narrowing of Epping Road after the Lane Cove Tunnel was opened. Section 4.4 describes the changes to Epping Road that were part of the Lane Cove Tunnel scheme. Section 4.5 presents a brief summary of the controversial aspects of the scheme that are related to this study. Section 4.6 gives a summary of the traffic data relating to flows as presented in the Environmental Impact Statement. Section 4.7 contains extracts of the traffic data that was collected a year after the opening of the Lane Cove Tunnel. Section 4.8 gives figures for the amount of traffic on the Epping Road corridor in 2011, when most interviews took place. They include figures for heavy rail and the results of the cycle and pedestrian count that was conducted in 2011 on the Epping Road shared use path. Section 4.9 describes briefly the type of development taking place along Epping Road that may affect the amount of

[9] The words 'motorway' and 'freeway' are used interchangeably here. 'Freeway' refers to freedom to travel without interference from traffic wishing to join or leave the flow, rather than free of charge at point of use. A freeway/motorway is defined as a divided road with two or more lanes for use by traffic travelling in each direction, with no at-grade intersections and with full control of access from abutting property (Austroads 2009, p. 42)

traffic on Epping Road. Section 4.10 compares the figures for traffic volumes that have been collected and suggests trends. Section 4.11 summarizes the chapter.

4.1 Introduction

This study is concerned with the effect on motorists of a reduction in road capacity. In order to undertake a field study, it was necessary to find a situation where road capacity was sufficiently restricted that motorists would be inconvenienced enough to reconsider their behaviour. It was decided not to use road works for the field study, as it was considered that their temporary nature might mean that motorists would not display the same reactions as with a permanent change.

The researcher is based in Sydney and therefore a Sydney-based field study was desirable. The reductions in capacity made to Epping Road in Lane Cove after the Lane Cove Tunnel was built were deemed appropriate for a field study. Therefore it was not necessary to go outside Sydney for this study.

In order to provide sufficient information to enable a reader to understand both how Epping Road changed as well as the comments of the respondents to this study, it is necessary to describe the Lane Cove Tunnel scheme and the reasons for its being built. In this description, 'Epping Road corridor' refers to the combination of the Lane Cove Tunnel and the stretch of Epping Road to which it runs parallel.

It was also thought relevant to describe the traffic environment within which the subjects of this study were making their travel decisions. In particular, it would be desirable to know how the traffic had changed between 1999/2000 (when traffic surveys were undertaken, as part of the preparation of the Environmental Impact Statement (EIS) for the Lane Cove

Tunnel scheme) and the date of the study in 2011/2012 (when the tunnel had been operating for several years).

4.2 The Epping Road corridor and the Lane Cove Tunnel scheme

4.2.1 Epping Road

Epping Road is of arterial standard but heavily congested. It runs from Epping in the west to Longueville Road in Lane Cove in the east. It passes through mainly residential areas and also stretches of commercial, industrial and national park land. The Lane Cove River bisects the road and forms the western boundary of Lane Cove (Figure 4.1 at the rear of this volume). Major traffic attractors along Epping Road include Macquarie University and several business parks.

4.2.2 Greater Sydney Orbital Network

Greater Sydney has a 110 km ring of motorway standard roads within the urban area, with additional motorway standard roads adjacent to or intersecting this network (Figure 4.2). The Roads and Traffic Authority (RTA) (now Roads and Maritime Services (RMS)) is responsible for managing this network and the other major roads and the traffic system in NSW.

The Sydney Orbital Network itself consists of (see Figure 4.2, clockwise from the northeast corner) the Gore Hill Freeway, Warringah Freeway, Sydney Harbour Tunnel, M1 (Eastern Distributor), M5 East, M5 (South Western Motorway), M7 (Westlink), M2 (Hills Motorway) and the Lane Cove Tunnel. Six of these (the M1, M2, Lane Cove Tunnel, Sydney Harbour Tunnel, M5 and M7) are toll roads. At the time of writing, only the M5 East, Gore Hill Freeway and Warringah Freeway are toll-free, although NSW residents may

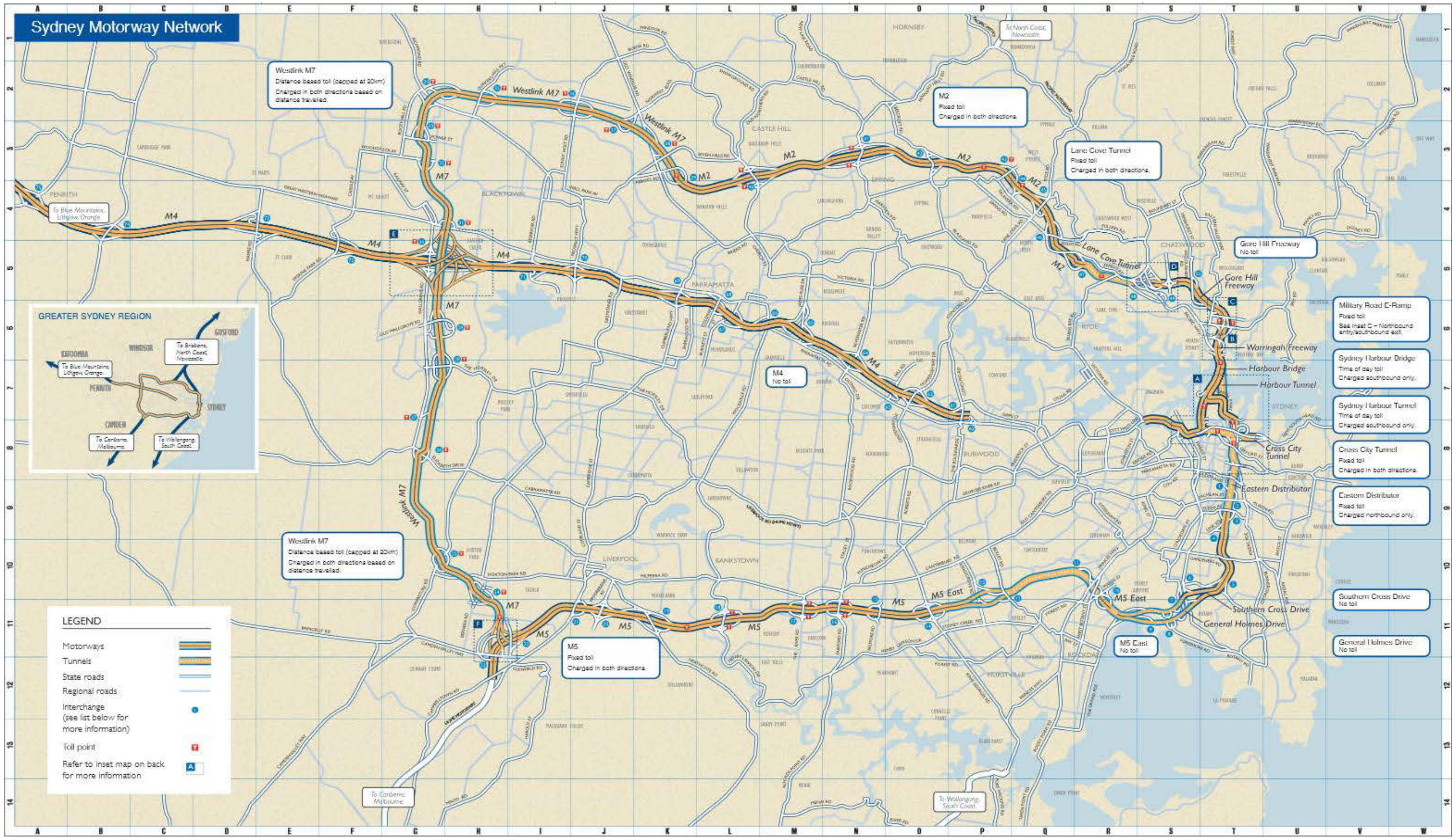

Figure 4.2 Sydney motorway network, including Sydney Orbital Network (SON)

Source: Roads and Maritime Services, http://sydneymotorways.com/assets/sydney_motorways_map.pdf claim a refund for private use of the M5 (RMS 2013a). Some roads were renumbered in 2013 (RMS 2013b).

All these roads are subject to further development, including widening and extensions (RTA 2010a). For example, the proposed Westconnex development will include more tunnels for the M5 East (Saulwick 2013).

The Lane Cove Tunnel was the last element of the orbital motorway to be constructed (SKM 2001, s.1.1, p. 1-1).

4.2.3 Lane Cove Tunnel and associated works

A motorway tunnel was proposed for the Lane Cove area in the 1990s. It was one of several options considered in order to connect the M2 to the Gore Hill Freeway, thereby relieving Epping Road in Lane Cove, which was acting as the link between the two motorways. Other options included the provision of grade separated interchanges and crossings, or widening, of Epping Road. Several different designs of tunnel were proposed, with varying lengths, alignments and lane configurations (*ibid.*, s.1.3, pp. 1-3ff and Chapter 5). In 1999, after community consultation, a tunnel with portals at the western end near the Epping Road crossing of the Lane Cove River (near the junction with Mowbray Road West) and at the eastern end, the Pacific Highway/Gore Hill Freeway interchange, was accepted as the option of choice (*ibid.*, p. 5 and Chapter 7).

The proposal that was presented to the community in the EIS (*ibid.*, s.7.1, p. 7-1) included improvements to Epping Road and the Warringah and Gore Hill Freeways, as well as the tunnel (Figure 4.1). As a result of further community consultation and ministerial requirements, the major elements of the final scheme in Lane Cove consisted of:

- a 3.6 km tunnel to join the M2 motorway and the Gore Hill Freeway at the Pacific Highway, associated connections and traffic works;
- a new bridge to cross the Lane Cove River, immediately south of the existing bridge;
- two 24 hour T2 transit lanes on the Gore Hill Freeway;
- reconfiguration of Epping and Longueville Roads, at mid block, between Mowbray Road West and the Pacific Highway, to provide one bus lane and one general traffic lane in each direction. In key locations westbound (between Longueville Road and Centennial Avenue and west of Sam Johnson Way), two through general traffic lanes were to be provided;
- provision of footpaths/cycle lanes/shared use path (SUP) for cyclists and pedestrians on the southern side of Epping Road, from Wicks Road, North Ryde, to Longueville Road, to join the SUP beside the Gore Hill Freeway to Park Road, Naremburn;
- provision of a bus interchange and pedestrian overpass immediately to the east of the junction of Epping Road, Parklands Avenue and Longueville Road and removal of existing overbridge near Kimberley Avenue; and
- reinstatement of two right turns from Epping Road into Parklands Avenue and Centennial Avenue.

Outside Lane Cove the scheme consisted of:

- two north facing ramps on the Warringah Freeway connecting to Falcon Street and Military Road in North Sydney; and

- provision of an a.m. T3 transit lane on Epping Road eastbound, between Pittwater Road and Mowbray Road West in North Ryde.

There were other, more minor works (RTA 2006, pp. ii, iii, 1; Catalyst Communications 2007, p. 3). Selected changes are described in more detail in s.4.4.

4.3 Principal events

The contract to build the Lane Cove Tunnel and associated works, and operate the tunnel was won by Connector Motorways Pty Ltd (formerly the Lane Cove Tunnel Company consortium (RTA 2006, p. 2)).

Construction commenced on the tunnel and associated work in April 2004 (*ibid.*, p. 2) and the first stage of the scheme (i.e. the tunnel) opened in March 2007 (RTA 2008, p. 21). When landscaping on Epping Road was finished in September 2008, the construction of the scheme was complete (RTA 2009b, p. 19) (see Table 4.1).

In 2005 a joint select committee of the Parliament of New South Wales (that is, composed of both members of the lower house (the Legislative Assembly) and members of the upper house (the Legislative Council)) (JSCCCT) commenced an inquiry into matters relating to the contracts, and consultation and communication associated with the Cross-City Tunnel (JSCCCT 2006, p. iv). This tunnel connects the eastern suburbs of Sydney to the western side of the central business district (CBD), thereby removing traffic from the CBD streets. It had not been successful in attracting the traffic that its promoters expected (JSCCCT 2006, pp. 47-48; Phibbs 2008; Phillips 2007; Goldberg 2006).

The committee's brief was widened in 2006 to include the Lane Cove Tunnel (JSCCCT 2006, p. 1).

One of the outcomes of the inquiry was that the timetable for construction of the bus lanes, SUP, bus interchange and reinstatement of right hand turns for the Lane Cove Tunnel scheme was altered during the course of building. The existing traffic arrangements on Epping Road were retained temporarily after the opening of the tunnel so that for five months there was greater capacity than that intended for the final road corridor (RTA 2006, pp. 17-18). The final sequence of events is outlined in Table 4.1.

It may be seen that it took approximately 15 years from tunnel proposal to scheme completion.

4.4 Changes to Epping Road

4.4.1 Introduction

The Lane Cove Tunnel scheme included proposals for changes to surface roads associated with the stretch of Epping Road between Wicks Road (west of the Lane Cove River) and Longueville Road. Some of the changes were necessary to integrate the tunnel (and 'new' Gore Hill and Warringah Freeways) into the wider road network; others were designed to improve the urban amenity of the corridor. Only some of the changes had the effect of reducing the surface capacity of Epping Road (SKM 2001, s.7.3, pp. 7-13ff). Major changes related to this study, which is predominantly concerned with the stretch of Epping Road in Lane Cove between Longueville Road and the Lane Cove River, are described below.

Table 4.1 Summary of events culminating in the modification of surface roads in the Lane Cove Tunnel (Epping Road) corridor

Event	Date
Motorway tunnel through Lane Cove proposed as one of several options to link M2 and Gore Hill Freeway.	early 1990s[1]
Tunnel accepted as preferred option to link M2 and Gore Hill Freeway.	December 1999[1]
EIS for the Lane Cove Tunnel published for public comment.	November 2001[1]
Construction work started on tunnel scheme.	April 2004[2]
Lane Cove Tunnel opened.	25th March 2007[3]
Construction of the bus interchange and pedestrian overbridge at Longueville Road began.	opening of tunnel[2]
Three lanes each way on Epping Road east of the Lane Cove River became two. Construction of the SUP, bus lanes and reinstated right turns began.	27th August 2007[4]
Two lanes each way on Epping Road east of the Lane Cove River became one general, and one bus, lane. Westbound right hand turns into Centennial Avenue and Parklands Ave opened.	9th March 2008[5]
Bus interchange at Longueville Road opened.	10th March 2008[5]
Final landscaping of 'new' Epping Road(/SUP) was completed	September 2008[3]

Sources: [1] Catalyst Communications (RTA) 2007, p. 6;
[2] RTA 2006, p. 2;
[3] RTA 2009b, p. 19;
[4] 'Delays for drivers on Epping Road' 2007
[5] Besser 2008b

4.4.2 Reduction in width of Epping Road

As part of the Lane Cove Tunnel scheme, the 2.8 km length of Epping Road in Lane Cove was made narrower than it had been prior to the tunnel's construction. Except in specific locations, where it was felt that greater capacity was needed, one lane was provided for buses and one lane for general traffic in each direction. This is in contrast to the period before the Lane Cove Tunnel was opened. At that time there were five through lanes between Tantallon Road and the Pacific Highway. During the a.m. and p.m. peak periods, tidal flow was in operation with three lanes in the dominant direction and two in the opposite direction (RTA 2006, p. 9).

West of Tantallon Road there were three lanes in each direction (SKM 2001, s.9.3.5, p. 9-8). During the a.m. peak, one of these lanes operated as a transit lane (RTA 2006, p. 9).

A detailed review was undertaken of:

- the traffic movements;
- the intersection at Centennial Avenue; and
- urban design considerations (e.g. community dislike of tidal flows).

As a result, 'it was concluded that the same performance [as tidal flow] could be achieved by providing two permanent westbound traffic lanes, and one eastbound.' (Figure 4.3) (SKM 2001, s.6.2.2, p. 6-10).

It should be noted that if the multiple lanes at intersections and the westbound midblock double lane sections between Mowbray Road West and Sam Johnson Way (which were designed to cater for heavy evening flows from Lane Cove West westwards), and between Centennial Avenue and Longueville Road (designed to cater for outbound flows on Epping Road west of the Pacific Highway to the south via Centennial Avenue) (*ibid.*, s.7.3.1, p. 7-17) are taken into account, measurement shows that in the **westbound direction**, over 50% of Epping Road in Lane Cove has more than one lane for general traffic.

Except in the vicinity of major junctions, there is only one lane for general traffic:

- on the westbound stretch of Epping Road between Sam Johnson Way and Elizabeth Parade (Figure 4.4); and
- the entire eastbound section of Epping Road in Lane Cove between the Lane Cove River and Longueville Road (except the stretch between Munro Street and Elizabeth Parade).

Figure 4.3 Epping Road at Tantallon Road intersection
(L-R) one bus lane and one general traffic lane (eastbound); two lanes for general traffic, one bus lane, two-way cycle lane and footpath (westbound) (northern footpath not shown) (looking east; 26/4/2011)

Figure 4.4 Epping Road at Stringybark Creek
Both westbound and eastbound sections of the road have one bus lane, one lane for general traffic and a turning lane. The SUP is on the left (looking west; 21/12/2013).

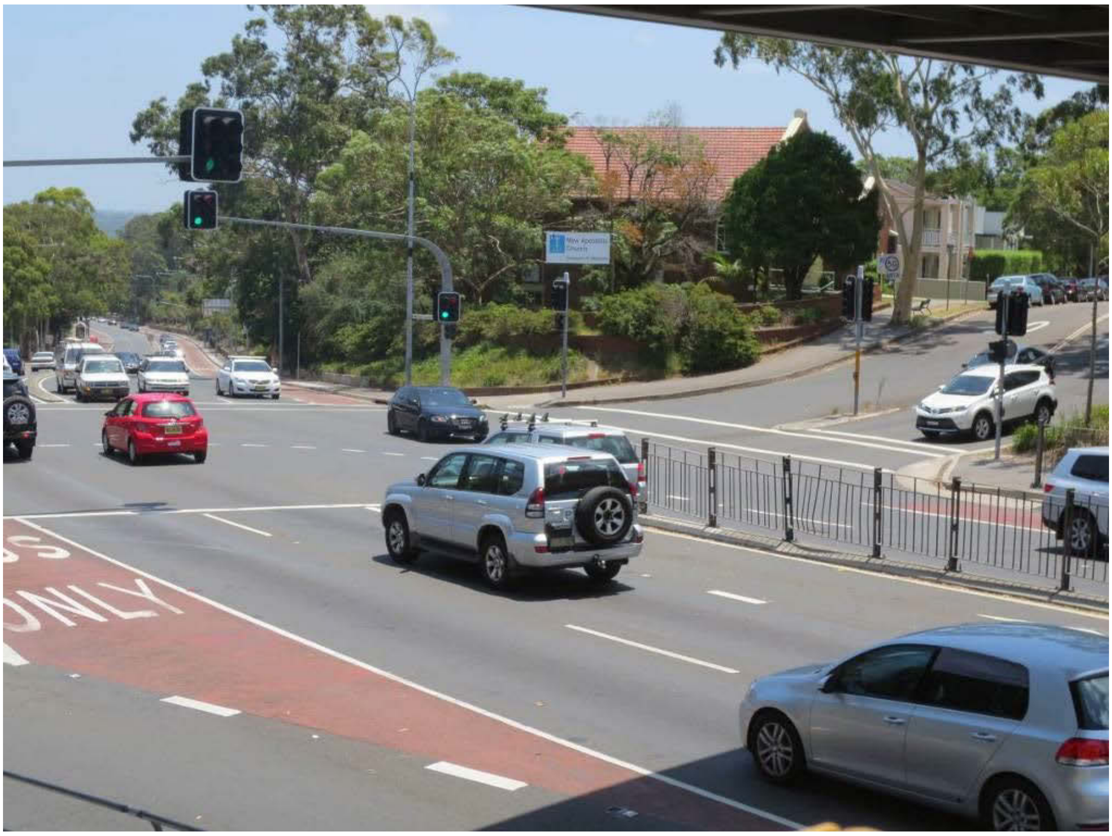

Figure 4.5 Reinstated right turn from Epping Road into Parklands Avenue
from Longueville Road/Epping Road (looking west; 21/12/2013)

Figure 4.6 Reinstated right turn from Epping Road into Centennial Avenue (north)
(looking south at Centennial Avenue; 21/12/2013)

4.4.3 Intersection layout

As part of the Lane Cove Tunnel scheme, two right turns from Epping Road (travelling in the westbound direction) were reinstated:

1. Longueville Road/Epping Road to Parklands Avenue (Figure 4.5); and
2. Epping Road to the northern arm of Centennial Avenue (Figure 4.6) (RTA 2006, p. 3).

Changes were made to the layout of Epping Road at Mowbray Road West, to cater for the tunnel's western portal and the at-grade pedestrian crossing (*op. cit.*, p. 10).

Some of the intersections along Epping Road are splayed. This provides enough storage capacity on the approach to ensure acceptable levels of service for both through traffic and side streets. On the departure side it provides sufficient lane length for traffic to merge without causing queuing through the intersection (SKM 2001, s.7.3.5, p. 7-40).

4.4.4 Signals and signal timings

There were five sets of traffic signals on the Lane Cove length of Epping Road prior to the construction of the Lane Cove Tunnel, at:

1. Longueville Road/Epping Road/Parklands Avenue;
2. Centennial Avenue;
3. Tantallon Road;
4. Sam Johnson Way; and
5. Mowbray Road West (*ibid.*, s.8.4.2, p. 8-14).

Modifications were proposed at some intersections to provide for cyclists; to allow for the reinstated right turns (s.4.4.3) and to reduce delays for motor traffic and pedestrians crossing Epping Road and Longueville Road (*ibid.*, s.7.3.5, p. 7-40). A signalled pedestrian crossing has been installed near Cox's Lane.

4.4.5 Provision for buses

Bus lanes

Prior to the construction of the Lane Cove Tunnel, buses had used an eastbound a.m. peak T2 transit lane on Epping Road in Lane Cove. This was part of a longer transit lane which extended from Pittwater Road in North Ryde, to the west, as far as the Gore Hill Freeway in the east.

After the tunnel opened, 24 hour bus lanes were constructed on each side of Epping Road between the Lane Cove River and Longueville Road, except westbound between Centennial Avenue and Elizabeth Parade (RTA 2006, p. 9). (The proximity of Centennial Avenue and Tantallon Road and the need to splay those intersections (see s.4.4.3) meant that any bus lane constructed between these two junctions would be so short (<100m) that it was felt that it might confuse motorists and lead to road traffic accidents (SKM 2001, s.6.2.2, p. 6-11) (Figure A.3).)

There are gaps in the bus lanes at certain intersections for turning traffic (*ibid.*, s.7.4, Table 7.1, p. 7-41).

The bus lanes on the north side of Epping Road continue eastward onto the Gore Hill Freeway. West of the Lane Cove River, there are other bus lanes and transit lanes along Epping Road.

The bus lanes are in operation for 24 hours and are also open to taxis, hire cars, motorcycles, cycles, emergency vehicles and special purpose vehicles operated by or under the direction of Roads and Maritime Services (RMS 2013c). Bus lanes were preferred to transit lanes because of the high level of misuse of the T2 transit lane observed in 2000 (17% single occupant vehicles) (SKM 2001, s.4.2.5, p. 4-8).

Bus interchange

A new bus interchange was built on the northern (eastbound) side of Longueville Road, east of the junction of Epping Road, Longueville Road and Parklands Avenue (Figure 4.9).

4.4.6 Provision for cyclists and pedestrians

Routes

There was no special provision of any type for cyclists on Epping Road in Lane Cove prior to the construction of the Lane Cove Tunnel. However, cyclists were permitted to use the (eastbound) transit lanes. The only provision for pedestrians at this time was intermittent footpaths on both the north and south sides of Epping Road, principally provided in association with bus stops and residential developments, or for recreational walkers.

A route for cyclists and pedestrians was constructed along the southern side of Epping Road. This extended the existing continuous footpaths between Moore Street (on the southern side) and the western end of Johnston Crescent (on the northern side) and Longueville Road. The route extends beyond Epping Road in Lane Cove, as far as Wicks Road in North Ryde to the west. It has since been extended (Macquarie University 2014). To the east, it connects with the shared use path (SUP) beside the Gore Hill Freeway to Naremburn (Catalyst Communications, p. 5; SKM 2001, s.7.5, p. 7-42; s.8.4.2, pp. 8-12 – 8-13).

Figure 4.7 Separate provision for pedestrians and cyclists on Epping Road
(L-R) footway and two-way cycle lane (approaching Centennial Avenue from the east; 10/8/2013)

Figure 4.8 Shared use path on Epping Road in Lane Cove
Separated provision for cyclists (two one-way paths) and pedestrians (one two-way path) (background); and two shared (one-way) paths (foreground) (looking east toward Moore St; 10/8/2013)

There are three types of provision for cyclists and pedestrians in Lane Cove:

1. existing footways plus separate two-way on-road cycle lanes (Figure 4.7);
2. a single path marked with a lane in each direction for cyclists and one lane for two-way pedestrian movement (Figure 4.8); and
3. a single path with one lane in each direction: each lane is shared by pedestrians and cyclists (Figure 4.8).

The type of provision made at any point depends principally on the expected flow of pedestrians and availability of land (*ibid*., s.6.2.2, p. 6-12).

Pedestrian crossings

Prior to the Lane Cove Tunnel scheme, crossings of Epping Road for pedestrians were provided by three overpasses, an underpass and at-grade crossings at some signalled intersections.

The overpasses at Sam Johnson Way and Moore Street were retained. The overpass at Kimberley Avenue was replaced by a pedestrian bridge (the Cameraygul Bridge) immediately east of the Epping Road/Longueville Road/Parklands Avenue intersection (Figure 4.9). The underpass at the junction of Epping Road and Mowbray Road West was replaced by an at-grade crossing which also incorporates provision for cyclists. This crossing has two stages in order to provide an acceptable level of service for motor traffic on Epping Road. The signals at Longueville Road, Centennial Avenue and Tantallon continue to make provision for pedestrians to cross. A signalled pedestrian crossing has also been installed at Cox's Lane.

4.4.7 Provision for goods vehicles banned from the Lane Cove Tunnel

Placarded dangerous goods vehicles and vehicles over 4.4 m high are not permitted in the Lane Cove Tunnel (RMS 2011b). These vehicles must continue to use Epping Road. However, it should be noted that the three overpasses for pedestrians along Epping Road in Lane Cove also have height restrictions. No special provision has been made for such vehicles on Epping Road.

Figure 4.9 Cameraygul Bridge and bus interchange, Lane Cove
Bus interchange (left background). Roads: (L-R) Parklands Avenue, Longueville Road (east), Longueville Road (south) and foreground, Epping Road (looking east; 21/12/2013)

4.4.8 Capacity in Epping Road corridor

In general, the reduction in capacity for motorists on the stretch of Epping Road in Lane Cove was actually a redistribution of capacity amongst all the modes using Epping Road. This is summarized in Table 4.2 in terms of available lanes. Clearly, however, capacity is dependent on more than just the number of lanes available. Some of the factors that affect the capacity of a link include:

- weather conditions;
- quality of road pavement;

- familiarity of motorists with the facility and their manner of driving;
- impediments on the link, including intersections;
- geometry of the link;
- design speed;
- nature and settings of traffic controls (including signs and signals);
- mixture of vehicles and their performance; and
- stopping, starting and turning nature of traffic. (TRB 2000, p. 2-3 -2-6).

As a result of the narrowing of Epping Road, buses, pedestrians and cyclists gained specific provision, while the provision for general motor traffic was ultimately reduced. However, for a five month period after the opening of the tunnel (see Table 4.1), the existing capacity on Epping Road itself was augmented by the tunnel. Hence for a short period there was more capacity than Table 4.2 suggests (RTA 2006, p. 23).

It should be noted that overall, after the change in road layout was complete, the capacity for motor vehicles travelling **through** the Epping Road **corridor** increased (see Table 4.2), although the capacity for motorists requiring **access** to **Epping Road itself** decreased. Thus the corridor capacity for all road users - motorists, bus users, cyclists and pedestrians - increased as a result of construction of the Lane Cove Tunnel - with caveats.

It is also worth noting that with the opening of three stations on the Epping to Chatswood railway line in 2009 (Cityrail 2009), the capacity for rail users in the general area of the western section of Epping Road has also increased (s.4.8.6). This may have reduced the need for some people to drive along this stretch of road.

Table 4.2 Capacity for motor traffic in the Epping Road corridor (measured in lanes)

Road	lanes pre-Lane Cove Tunnel	lanes post-Lane Cove Tunnel		
		all motor traffic	bus/transit lanes	general motor traffic
Epping Road	5[1]	4 [in places 5]	2	2 [in places 3]
Gore Hill Freeway	4	6	2	4
Lane Cove Tunnel	-	2 eastbound; 3 westbound	-	2 eastbound; 3 westbound
Epping Road + Lane Cove Tunnel	5	4 eastbound; 5 [in places 6] westbound	2	3 eastbound; 4 [in places 5] westbound

Note: [1] This included one a.m. peak eastbound T2 transit lane
Source: EIS (SKM 2001)

4.5 Reactions to the proposed changes on Epping Road

4.5.1 Introduction

The Lane Cove Tunnel EIS was the result of community consultation (including input from focus groups and organizations concerned with the operation of Epping Road (e.g. government departments and utilities) on an overview report from the RTA (SKM 2001, s.1.3ff, pp. 1-5 - 1-9; s.3.4.4, pp. 3-6 - 3-9; s.3.4.5, pp. 3-10ff). It was produced after the decision had been made to proceed with a tunnel. The overview report noted (*ibid.*, s. 3.1.2, Table 3-2, p. 3-3) that the community was concerned by:

- ventilation of the tunnel;
- air quality inside and outside the tunnel;
- road infrastructure provision;
- long and short term travel demand;
- tolls; and
- access to the freeway.

There was further community reaction after the publication of the EIS. Those reactions are the subject of this section. However, the aspects relating to ventilation and air quality, changes to the Gore Hill and Warringah Freeways and the arrangements for works associated with construction of the tunnel are outside the scope of this study.

The following comments on community reaction to the tunnel draw on the EIS, the reports of the JSCCCT, comment in the media and published responses of community action groups.

The traffic aspects of the Lane Cove Tunnel scheme related to Epping Road which attracted community attention included:

- the narrowing of Epping Road;
- changes to particular junction layouts;
- the provision for cycling, walking and public transport;
- the use of a private company to build the tunnel; and
- the requirement to pay a toll to use the tunnel.

Each of these points is discussed in greater detail below.

4.5.2 Narrowing of Epping Road

The stated aim of the reduction in capacity of Epping Road was to provide for public transport, cycling and pedestrians and landscaping (*ibid.*, p. 6). It was also considered likely to aid in minimizing the amount of induced traffic (*ibid.*, s.8.5, p. 8-17).

The reduction in number of lanes on Epping Road in Lane Cove had both objectors and supporters (RTA 2006, p. 21; SKM 2001, s.5.4.7, p. 5-13). The JSCCCT found that there was a lack of awareness in some parts of the community of the proposal to reduce the number of general traffic lanes on Epping Road (JSCCCT 2006, pp. x, 46, 48-49) even though it was explicitly mentioned in the EIS in several places (e.g. *op. cit.*, p. 6; s.1.7, p. 1-9; s.5.4.7, p. 5-13; s.7.1, p. 7-1).

There were two principal objections to the narrowing of Epping Road:

1. that it would be too narrow for the amount of traffic that wanted to use it (e.g. JSCCCT 2006, p. 45); and
2. that it was being done to force motorists into the tunnel (JSCCCT, p. x; Besser 2007; 'First peak hour test for 'new' Epping Road' 2008; 'More lanes to close for Lane Cove Tunnel' 2007)

By contrast, the Lane Cove Tunnel Action Group (LCTAG) described the narrowing as a 'fundamental outcome for LCTAG and the local community', although they accepted the need for an additional lane in places (LCTAG 2002, p. 5).

4.5.3 Changes to junction layouts

While some members of the community were pleased (albeit in a qualified sense) with the reinstatement of the right hand turns at Parklands Avenue and Centennial Avenue, there was also disappointment that other turns were not reinstated (*ibid.*, pp. 5-6).

4.5.4 Provision for non-car modes

Bus lanes

After community consultation the decision was taken that bus lanes would be more satisfactory than transit lanes (RTA 2006, p. 21), since the existing transit lanes had a high rate of abuse and presented difficulties in enforcement (SKM 2001, s.8.3.6, p. 8-11). Some people considered that they should be transit lane or ordinary lanes out of the peak ('First peak hour test for 'new' Epping Road' 2008) and this change has been requested again (Howlett 2010). One of the recommendations of the JSCCCT was that the government review the proposal to have one general traffic lane and one 24 hour bus lane in each direction (JSCCCT 2006, p. 50). It was explained that this was done to prepare for the future (AAP 2008).

Cyclists and pedestrians

Cyclists and pedestrians were pleased at the provision of a shared use path (e.g. JSCCCT 2006, pp. 46-47, 76-77). However, quoting the EIS (*op. cit.*, s.8.2.4, Table 8.7, p. 8-7), (see s.4.6.4) the Lane Cove Tunnel Action Group (LCTAG 2002, p. 8-9)) was of the opinion that since few commuter cyclists used Epping Road, there was no need for on-road cycle lanes at any point (s.4.4.5). They felt that the SUP could be extended (except through Turrumbarra Park) instead of providing on-road cycle lanes. Their submission made no reference to recreational cyclists. Other submissions called for Epping Road to be left unchanged. This would mean that neither cyclists nor pedestrians would have a continuous route (JSCCT3 2006, p. 47). Other organizations have called for the cycle provision to be scrapped (Smith 2008).

4.5.5 Involvement of private enterprise

Construction

The Lane Cove Tunnel was designed, funded and built by a private sector group known as Connector Motorways. Under their contract, the tunnel was to be maintained and operated by the consortium and transferred to the NSW government in 2037 (Catalyst Communications 2007, pp. 2-4). The tunnel has since been sold to Transurban Ltd, which also owns the adjacent M2 (Tatnell 2010).

The objection to the involvement of the private sector was connected to the objection to the narrowing of Epping Road, in that there was a feeling among some members of the community that the road was narrowed in order to force motorists to use the tunnel and thereby make money for the operators (Zapata 2008, Smith 2008).

Opening date

Speculation about deliberate delays was generated by the fact that the opening date of the tunnel was the day after a NSW state government election (e.g. Besser 2007; Baker 2007b).

Requirement to pay a toll

Because the tunnel was financed, designed, constructed, owned and operated by the private sector, there was a need to recoup the money spent on its construction and operation, while still making a profit for shareholders. This is in contrast to most public roads (although it should be noted that the Sydney Harbour Bridge, a public road, is tolled).

Table 4.3 Tolls on the Sydney Orbital Network (passenger vehicles)

Section	Distance (km)	Toll ($)	Effective charge/ km ($)
M1 (Eastern Distributor)	6	5.50 (northbound only)[f]	from 0.9167
M2 (Hills Motorway)	21	2.75 or 4.95 [f]	from 0.1310 or 0.2357
M5 (South Western Motorway)	22	4.40 [f]	from 0.2000
M5 East	10	n/a	n/a
M7 (Westlink)	40	35.82 cents/km, maximum 7.16[d]	maximum 0.3582
Lane Cove Tunnel	3.6	2.93 [f]	0.8139
Sydney Harbour Tunnel	2.3	4.00/3.00/2.50 [t]	1.7391/1.3043/1.0870
Gore Hill Freeway	3	n/a (but see Military Road ramp)	n/a
Warringah Freeway	3	n/a (but see Military Road ramp)	n/a
Military Road ramp	0.19	1.47 [f]	7.7368

Note: prices quoted are at 14/2/2012;
certain motorists are eligible for a refund of charges paid for travel on the M5;
[f] - flat rate related to the sections of motorway traversed;
[t] - time of day tolling;
[d] - distance based fee.

Sources: Transurban Ltd 2012; RMS 2013a

The charges made for the use of each section of the Sydney Orbital Network are not consistent on a per km basis (see Table 4.3). This has aroused some discontent (Baker 2007a; Baker 2007c; SKM 2001, s.33.1.2, p. 3-3, Table 3-2).

4.6 Traffic data pre-Lane Cove Tunnel

4.6.1 Introduction

As mentioned in s.4.1, an EIS was prepared for the Lane Cove Tunnel scheme (*op. cit.*). The RTA contracted consultants Sinclair Knight Merz (SKM) to undertake this task. The traffic and transport studies which formed one part of the EIS were undertaken by a different firm of consultants (Masson Wilson Twiney) (MWT 2001). For a detailed description of Epping Road and the network of which it formed a part, see the EIS (*op. cit.*) and Working Paper 4 (MWT 2001).

Traffic counts presented here are a mixture of 1999 standard RTA counts from counting stations on Epping Road and specially commissioned classified traffic counts from 2000.

4.6.2 All motor vehicles

Table 4.4 gives a classified count of weekday traffic volumes at a point on Epping Road east of Mowbray Road West in 2000.

Table 4.4 Weekday traffic volumes by selected vehicle classification on Epping Road, east of Mowbray Road West, 2000

Vehicle type	Eastbound	Westbound	Two way flow	% of total
Cars	37,689	41,957	79,646	89.2
Taxis	1,565	1,872	3,437	3.8
Light commercial vehicles	1,134	2,032	3,166	3.5
Trucks and semi-trailers	1,176	1,174	2,350	2.6
Buses	369	345	714	0.8
Total	**41,933**	**47,380**	**89,313**	**100.0**

Source: SKM 2001, s.8.2.2, p. 8-5, Table 8.2

Further counts were undertaken in 2004 by SKM. These have been incorporated in the post-tunnel study by Arup (2009a).

4.6.3 Cyclists

A count of cyclists was commissioned for the EIS. It found an average of six in the a.m. peak, heading east in the transit lane on Epping Road near Elizabeth Parade in March and April 2000 (*op. cit.*, p. 8-7: Table 8.7). No figures were given for cyclists heading west. Anecdotal evidence suggests that cyclists used Mowbray Road West in preference to Epping Road, when travelling west through Lane Cove.

4.6.4 Pedestrians

No count of pedestrians along Epping Road prior to the opening of the Lane Cove Tunnel has been found.

4.7 Traffic data post-Lane Cove Tunnel

4.7.1 Introduction

The opening of the Lane Cove Tunnel caused some motor traffic to divert from Epping Road. Some traffic, including vehicles carrying dangerous goods, cyclists, pedestrians and animals, is barred by law from using the Lane Cove Tunnel (NSW Government 2008) so it continued to use Epping Road.

As the layout of Epping Road in Lane Cove was changed as part of the Lane Cove Tunnel scheme, the flow before and after the construction of the tunnel is not strictly comparable. Nevertheless, in 2008, the RTA commissioned consultants Arup to undertake a post-opening traffic evaluation of the Lane Cove Tunnel project. This included a comparison of pre-tunnel flows with predicted and actual post-tunnel flows and a study of local street improvements (Arup 2009a; Arup 2009b). The study area included roads in the suburbs surrounding Epping Road and the Lane Cove Tunnel. Data was sourced from vehicle classification surveys, manual intersection counts, traffic signal data, permanent vehicle counts and a study conducted in 2004, before the opening of the tunnel, by SKM. Only the data relevant to Epping Road is discussed here.

4.7.2 All motor vehicles

It can be seen from Table 4.5 that traffic on the stretch of Epping Road in North Ryde increased between 2004 and 2008 and decreased on Epping Road as it passes through Lane Cove.

Table 4.5 Two-way a.m. peak hour average hourly flows at selected points

Location	2004	2008	04-08 % change
Epping Road east of Pittwater Road	2,962	4,593	55
Longueville Road east of Parklands Avenue	4,759	2,836	-40
Epping Road at Stringy Bark Creek	4,202	2,327	-45
Epping Road west of Sam Johnson Way	4,179	2,643	-37

Source: Arup 2009a, s.3.1, p. 9, Table 1

4.7.3 Buses

In 2008, the Epping Road corridor in Lane Cove was serviced by two bus operators: the State Transit Authority of NSW (STA) trading as Sydney Buses and ComfortDelgroCabcharge (CDC), trading as Hillsbus (Transport NSW 2008). Each operator ran public buses along Epping Road in Lane Cove. Hillsbus also ran express services through the Lane Cove Tunnel. Most of these services terminated in Sydney CBD.

It was not possible to obtain a complete set of timetables for the buses using Epping Road in 2008 although a flyer indicating the services which used the bus interchange in Lane Cove was available ('Your guide to bus services at Lane Cove Bus Interchange' 2008). Hillsbus did not respond to a request for old timetables. However, timetables for the services operated by Hillsbus in 2008, obtained with the aid of the Wayback Machine in

Internet Archive, indicate that 234 individual runs, distributed among 11 individual routes, used Epping Road on weekdays in 2008. The Wayback Machine had not saved STA timetables for this period. Therefore, it was necessary to use old Sydney Buses timetables from other sources. An incomplete set of timetables for Sydney Buses services using Epping Road on a weekday indicated that there were over 103 individual runs distributed among 11 individual routes. This gives a total of over 337 runs per day by the two bus companies along Epping Road in Lane Cove. In the absence of complete Sydney Buses figures, it was not felt appropriate to compare this with the number of buses counted on Epping Road in 2000.

In terms of headway, calculations suggest that a Hillsbus bus could be expected to travel along Epping Road every two to three minutes in the a.m. peak. There was insufficient data to produce a similar calculation for Sydney Buses. However, even in the absence of complete information about Sydney Buses, it is clear that during the a.m. peak there was a frequent bus service operating on Epping Road.

Bus travel times along Epping Road were reported to have reduced by up to 10 minutes on opening of the bus lane (RTA 2010b).

4.7.4 Cyclists

No count of cyclists' use of the Epping Road corridor was attempted after the Lane Cove Tunnel was opened.

4.7.5 Pedestrians

No count of pedestrians' use of Epping Road was attempted after the Lane Cove Tunnel was opened.

4.8 Traffic data as at 2011/2012

4.8.1 All motor vehicles

Epping Road

The interviews for this study were undertaken in 2011 or 2012 and it was considered desirable to obtain information about contemporaneous traffic conditions on Epping Road. However, it was not possible to obtain traffic counts for this period from RMS which corresponded with the counts in the Arup report. However, in 2011 consultants Parsons Brinckerhoff undertook a traffic study relating to the North Ryde Station Precinct for Transport NSW (Parsons Brinckerhoff 2012). As part of that study, traffic counts were undertaken in the North Ryde area. Of relevance to this study is the count of a.m. peak traffic just east of Pittwater Road on Epping Road, where 5,617 motor vehicles were tallied.

Also in 2011, consultants Colston Budd & Kafes Pty Ltd undertook a transport and accessibility impact assessment on behalf of the body promoting a development on the site of the Shell service station at 150 Epping Road (DoP 2014). As part of the assessment they undertook traffic counts on Epping Road in the vicinity of 150 Epping Road. The counts are not dated, but it is assumed that they were undertaken in the months before the report on the development was produced in March 2011. The most relevant counts for this thesis were those collected during the a.m. peak east of the (Shell service station) site access (2,880) and service road (2,915). These figures can be compared with the 2008 figures collected for the Arup report (2009a) at Epping Road west of Sam Johnson Way (2,643). The 2011 figures show an increase of 8-10% over the figures from 2008.

4.8.2 Buses

In 2011, the Epping Road corridor in Lane Cove was serviced by Sydney Buses and Hillsbus. Both operators ran public buses along Epping Road in Lane Cove, but Sydney Buses had begun running two services through the Lane Cove Tunnel since 2008. Hillsbus had increased the number of services using the Lane Cove Tunnel from eight to 11. As a result, in 2011 there were 435 individual runs by buses through the Lane Cove Tunnel in each Monday to Friday period, an increase from 114 over the same period in 2008. The number of buses using Epping Road had also increased, but not by the same amount. Hillsbus had one extra run along Epping Road in 2011, compared with 2008, bringing its total to 235. Sydney Buses operated 332 runs along Epping Road. Therefore, there was a total of 1002 runs by scheduled public buses between Monday and Friday in the Epping Road corridor in 2011.

In addition, some organizations in the Macquarie Park area supplied extra buses for employees only (e.g. Optus at Macquarie Park). Some operators offered services to the Macquarie Park area from suburbs of Sydney which do not require use of the Epping Road corridor. As in 2008, these figures did not include vehicles transporting school students, either to and from home or for school excursions.

4.8.3 Cyclists

Three sets of automatic counters were embedded in the SUP between the Lane Cove River and Gore Hill Freeway when it was constructed. However, problems with the counters mean that it has not been possible to use them to collect flow data (Steve Soelistio, pers. comm. 2011). In the absence of any other information, it was necessary to undertake a special count of cyclists in order to obtain representative figures for cycle flows at the time of the interviews with motorists (see Appendix A).

The results of the count that was undertaken in November 2011 suggest that about 140 cyclists used the SUP in the two-hour period 7 a.m. to 9 a.m. This included cyclists travelling in both directions. During the 12-hour period 7 a.m. to 7 p.m., a total of 271 cyclists were counted on either the SUP or the westbound bus lanes.

It should be noted that the count would be substantially increased by starting at 6 a.m. and extending the count until 9.14 a.m. (see Appendix A).

4.8.4 Pedestrians

A count of pedestrians was undertaken at the same time as the count of cyclists was undertaken near the junction of Epping Road and Mowbray Road West (see Appendix A). A total of 164 pedestrians were counted on the SUP here. It should be noted that if the count was performed at bus stops further east (e.g. Sam Johnson Way), the result is likely to be different. The pedestrians using the bus stop on the northern side of Epping Road near Mowbray Road West were not counted. The count should be regarded as indicative of one specific location only.

4.8.5 Rail

Infrastructure

There are no railway stations in Lane Cove. There are, however, three stations (Macquarie University, Macquarie Park and Delhi Road) on the Epping to Chatswood rail link. They service part of the area to the west of Lane Cove through which Epping Road runs. The stations are on the Northern line and were opened in February 2009 (Cityrail 2009). Therefore they provide an alternative way of reaching areas for which Epping Road is an important approach route, but have only done so since the Lane Cove Tunnel was opened. This situation differs from the expectations set out in the EIS (*op. cit.* s.8.5.1, p. 8-16).

Flow

The 2011 Cityrail timetables listed 68 services a day eastwards through these stations and 70 westwards. There were four services an hour in each direction during the peak periods with a 15 minute headway (www.131500.com.au).

4.8.6 Indicative flows

Table 4.6 presents counts of the traffic flow in the Epping Road corridor in 2011. As the basis for the count is not the same in each case, these flows are only indicative.

Table 4.6 Indicative traffic flows in the Epping Road corridor, 2011

Mode	Epping Road	Lane Cove Tunnel
Total motor vehicles	~45,000[AR]	~60,000[AT]
Public buses	568[24B]	449[24B]
Cyclists	271[12P]	-
Pedestrians	164[12P]	-

Notes
[12] - 12 hour (7 a.m. – 7 p.m.) counts at a location on the shared use path, on the southern side of Epping Road, east of the junction with Mowbray Road West
[24] – 24 hours
[A] – AADT: average annual daily total
Sources
R - Roads and Maritime Services (ex-RTA) (Mark Andrew, pers. comm. 2011)
T - Transurban Ltd (Peter Colacino, pers. comm.. 2011)
P – counts undertaken as part of a PhD study
B – bus timetables, as at December 2011 (public services only)

4.9 Further developments along the Epping Road corridor

Further changes continue to be made along the Epping Road corridor, including transport related and residential and commercial developments.

For example, RMS continues to monitor traffic along Epping Road and adjust signal timings and speed limits as necessary. Such adjustment may or may not be related to the Lane Cove Tunnel scheme (Mark Andrew, pers. comm. 2013).

Changes which occur once only include, in 2009 (after the Lane Cove Tunnel had come into use), the opening of a rail link between Chatswood, to the north-east and Epping, to the south-west (s.4.8.6). Also between 2011 and 2013, traffic was disrupted as the M2 motorway was widened (Transurban 2014). Spill-over effects may have caused some of the disruption on Epping Road of which interviewees complained.

Developments continue to be proposed which will affect the traffic using Epping Road. For example, at the time of writing, there is a proposal to use the old Shell service station site at 150 Epping Road for residential and commercial development (DoP 2014). If this proposal is successful, the development will generate new traffic movements on Epping Road in Lane Cove.

4.10 Trends in traffic

4.10.1 All motor vehicles

It was not possible to obtain figures for the flow of traffic on Epping Road in Lane Cove after 2008 to match the figures used in the before and after study conducted by consultants Arup (2009a). However, the two figures that were obtained give an indication of the changes in traffic volume on Epping Road that have occurred. The figure obtained for Epping Road near Pittwater Road in North Ryde in 2011 showed a 22% increase in volume compared with 2008. This suggests that traffic has been increasing on Epping Road west of Lane Cove. It is not possible to suggest a cause for this increase from the data available. However, the increase is of sufficient magnitude for a motorist travelling on Epping Road to notice the change. The figure obtained for the flow of traffic on Epping Road in Lane Cove near the site of the Shell service station show an increase over the 2008 figures of 8-10%. This suggests that while the traffic on Epping Road in Lane Cove has not increased as much as the traffic on Epping Road in Lane Cove, the change is nevertheless non-negligible.

Thus, while it is not possible to give a definitive statement of the change in flow on Epping Road, the data that is available suggests that there has been a non-negligible increase in motor traffic at both ends of the road since 2008.

4.10.2 Buses

A summary of the weekday public scheduled bus services on the Epping Road corridor, using available data, is presented in Table 4.7.

The number of weekday public scheduled buses and the number of bus services using the Epping Road corridor increased between 2000 and 2011. The buses on Epping Road were augmented by (express) buses using the Lane Cove Tunnel. The change is set out in Table 4.7 below.

Table 4.7 Weekday scheduled public buses in the Epping Road corridor (daily, two-way flow)

	Number of services*	**Number of trips on Epping Road**	**Number of trips through the Lane Cove Tunnel**	**Total trips**
2000	26	714	-	714
2008**	30	>337	114	>451
2011	38	567	435	1,002
change 2000-2011 (%)	12 (46)	-47 (-21)	435 (n/a)	288 (40)

Notes: * services running over the length of Epping Road east of Mowbray Road West in Lane Cove;
** data for Sydney Buses in 2008 is incomplete
2000 count was undertaken east of Mowbray Road West;

Sources: 2000 – SKM 2001, s.8.3, pp. 8-9 to 8-10 (does not distinguish between scheduled and private buses)
2008 – 'Your guide to bus services at Lane Cove Bus Interchange' 2008 and paper timetables ;
2011 – www.131500.com.au

From this table it can be seen that between 2000 and 2011 the number of scheduled public buses using Epping Road decreased, although the weekday number of runs in the Epping Road corridor increased by 40% to 1002. The use of the Lane Cove Tunnel accounted for the discrepancy. Fewer services used Epping Road and many more from the Hills District travelled express for the last stretch of their journey, using the Lane Cove Tunnel.

However, the presence of the bus lanes on Epping Road meant that the buses using Epping Road were able to traverse Lane Cove more quickly than they had previously.

Motorists travelling along Epping Road in Lane Cove may have observed a decrease in the number of buses on Epping Road over the period 2004-2011.

4.10.3 Cyclists

The volume of cycling during the peak period has increased substantially, from an average of six cyclists per day in 2000 to around 150 trips in 2011. There is insufficient data to give a statistically valid idea of how it has changed, although anecdotal evidence suggests an increase of about six or seven fold (IN7, pers. comm. 2011). The results of the NRMA count from 2008 (Smith 2008) and the cycle count undertaken for this study (see Appendix A) suggest that growth has been concentrated in the period since 2008.

Motorists travelling along Epping Road in Lane Cove may have observed an increase in the number of cyclists on Epping Road over the period 2004-2011.

4.10.4 Pedestrians

There is no information with which to compared pedestrian flows in 2000 with pedestrian flows after the tunnel was opened.

4.10.5 Overall trend

It can be seen from these comparative figures that the flow of motor vehicles on Epping Road in North Ryde increased between 1999 and 2004, increased again between 2004 and 2008 and again between 2008 and 2011. However, the figures show that for Epping Road in Lane Cove, the volume of motor vehicles reduced substantially between 2004 and 2008 before increasing to 2011.

It can also be seen that motorists travelling along Epping Road in Lane Cove would have experienced an increase in the number of cyclists in the corridor after the Lane Cove Tunnel was opened. However, the count undertaken for this study suggests that these cyclists are on the cycle lane/SUP or bus lane and therefore do not interact directly with motorists, except at intersections. The number of buses with which motorists might be expected to interact has decreased, not only because buses no longer have to share lanes with general traffic, but also because the number of buses on Epping Road itself has decreased. However, when the buses using the Lane Cove Tunnel are taken into consideration, there has been an overall increase in the number of buses on the corridor.

The capacity of the corridor for motorists, measured by the number of lanes available, increased after the tunnel opened but decreased when some lanes were resumed in order to construct the bus lanes, cycle and pedestrian facilities.

The capacity for buses, cyclists and pedestrians has increased since the Lane Cove Tunnel was opened.

However it is misleading to say that there is one bus and one general lane in each direction. While this is mostly true for the eastbound direction, over 50% of the westbound carriageway (including intersection approaches) has more than one lane.

4.11 Summary

Construction of the Lane Cove Tunnel and its incorporation into the Greater Sydney motorway network produced a fully connected orbital motorway and provided two possible routes for motorists to use when traversing the Epping Road corridor. Additional facilities were constructed for the use of buses, cyclists and pedestrians.

The figures that are publicly available suggest that traffic in the form of private motor vehicles, buses and cycles using the Epping Road corridor increased over the period between the opening of the Lane Cove Tunnel and the time at which the interviews for this study took place. However, the number of buses on Epping Road at the time of the interviews had decreased. Some of the buses formerly on Epping Road had begun to use the Lane Cove Tunnel, but some new bus services using the tunnel had also been instigated.

CHAPTER 5

Methodology and Data Collection

Gaps in the literature relating to this study were identified in Chapters 2 and 3. The sequence of events which led to Epping Road being a suitable site for this field study was described in Chapter 4. Chapter 4 also describes the data that was collected in order to provide a background to the changes in traffic flows which occurred on Epping Road as a result of the construction of the bus lanes and shared use path there, with the consequent reduction in capacity, in conjunction with the opening of the Lane Cove Tunnel. This chapter describes the methodology used to gather the attitudinal data required for the study and briefly summarizes the data that was gathered. The data itself is analysed in Chapters 6 and 7.

This chapter begins (s.5.1) with an introduction to the aims of the practical part of this study and outlines the methodology that was selected. It then (s.5.2) explains the methods which were proposed to elicit attitudes from the group of motorists of interest to this study and analyse them. The ethics procedures needed for this study are also discussed. Sections 5.3 and 5.4 detail the proposals for selecting and recruiting respondents, respectively. Section 5.5 summarizes the data that was acquired through directly soliciting opinions. Section 5.6 summarizes the data that was acquired through using opinions expressed in the public domain that were pertinent to this study. Section 5.7 provides a summary of the attitudinal data used in this study.

5.1 Introduction

5.1.1 Choice of methodology

As described in Chapter 2, the study of the topic of reduction in road capacity (RRC) has been principally quantitative: (aggregate) traffic analyses of particular case studies and the implications of RRC for transport modelling (that is, traffic forecasting). Outside the field of purely traffic studies, the effects of RRC on factors such as crime, property prices and the (air and noise) pollution (and hence the quality of life for stakeholders) of closing a road have been considered (see s.2.6.2).

Sufficient quantitative studies have been undertaken to provide convincing evidence that the phenomenon of disappearing traffic is real (Cairns *et al* 1998) (the HCR) report). However, some of the questions that Cairns *et al* note that remain to be considered (that is, 'wider political, cultural, social, economic and environmental issues of capacity reduction' (*ibid.* p. 2)) appear less amenable to a purely quantitative approach. For example, the political acceptability of reducing road capacity may depend on whether, where and how alternatives are provided (see Chapter 4).

An alternative to studying traffic in aggregate is to study disaggregate behaviour; that is, the actions of individual motorists. While this can be done in a purely quantitative fashion (e.g. how many people agree with a particular statement), qualitative methods offer the possibility of filling some of the gaps left by quantitative studies because they allow exploratory research. Qualitative research allows researchers to ask 'why' questions, not just 'how many' questions. That is, it is possible to explore the complexities of a subject; in particular, aspects which may be unexpected to the researcher (Clifton & Handy 2001). Furthermore, certain behaviours, such as habit, are not easy to quantify satisfactorily (e.g. see s.3.5.6).

5.1.2 Field study site

The road scheme chosen for the field study for this thesis was the reduction in capacity of Epping Road as it passes through Lane Cove, Sydney, associated with the construction of the Lane Cove Tunnel. Therefore, motorists who were affected by the narrowing of Epping Road in Lane Cove were the target interviewees. This covered both Lane Cove residents and those who were only passing through en-route elsewhere (see also Chapter 4).

This scheme was chosen for its proximity to the research base (i.e. the University of Technology, Sydney) and for its size. The changes experienced were substantial enough to leave a lasting impression on motorists, in a way that, for example, reducing road capacity by installing cycle lanes, might not. Roadworks, even of a long term nature, were not considered suitable because evidence gleaned in the literature review suggests that motorists' attitudes to temporary disruption differs from their attitudes to permanent changes (e.g. Mobius Research and Strategy Ltd 2010).

5.1.3 Research limitations

As noted in s.1.1.3, there are many different types of situation which qualify as a reduction in road capacity. It is possible that each different type of situation would produce a different reaction in the same motorist. Similarly, cases of reduced road capacity may occur in several different locations and elicit a different response from the same motorist, depending on the precise situation. It was not possible, within the time limitations of this study, to consider more than one case of reduced road capacity.

Furthermore, the resources available for this study did not allow for interviewing a large number of motorists (see s.5.2.2). However, as a qualitative study, it does not follow that a large number of subjects is necessarily better than a smaller number, since the study is exploring the range of reactions rather than undertaking a statistical analysis (Silverman 2006).

5.2 Methods

5.2.1 Qualitative methods

Many methods are available to qualitative researchers (Clifton & Handy 2001; Silverman 2006). Those used in this study were:

- interviews; and
- textual analysis.

5.2.2 Interviews

Semi-structured interviews (that is, interviews with a flexible agenda, rather than a rigid set of points to be covered) were chosen as a means to elicit information, so that interviewees could explain, at length if necessary, the reasons that led them to make the changes that they did, if any. Although there were certain topics that required responses, it was felt that there were likely to be issues that could explain motorists' behaviour but which had not yet been identified by researchers. Therefore it was felt necessary to allow the conversation to proceed in unanticipated directions.

Interviews require commitment in terms of cost of travel for the interviewer and a substantial commitment of time on the part of both the interviewer and interviewee. The interviewee's attitude toward the interviewer may affect what they are prepared to say. Nevertheless, interviews have the potential to produce more detailed information than could be obtained from, for example, a questionnaire survey of attitudes, which is likely to be limited by the researcher's expectations and assumptions.

In this study, it was necessary to consider the ethics associated with researching human behaviour. Obtaining ethics approval from the university is considered further in s.5.2.5.

It was proposed that, with the interviewee's agreement, the interviews would be recorded for later transcription. Notes would also be taken, if relevant, about the interview or interviewee (e.g. to explain gaps in the information). The interviewees would be presented with a transcription of the interviews, to allow them to clarify what they said in the interview, expand upon it or even retract their comments.

In this study, motorists were asked to explain retrospectively why they took certain courses of action. There was a possibility that respondents would either have no recollection of why they made changes, or would attempt to justify their actions retrospectively. However, Verhoeven *et al* (2008), Behrens & del Mistro (2010) and Lanzendorf (2010) found that travel behaviour associated with life events (that is, events which cause people to reconsider their current behaviour (van der Waerden *et al* 2003)) was recalled with some certainty, because the nature of the life events themselves was so memorable.

5.2.3 Other sources of attitudinal data

Although publicity had originally been generated in order to find interviewees (see Figure 5-1), some e-mails and telephone calls were received which described individuals' personal situation (see s.5.4.3). Although it was not considered appropriate to interview the individuals in question (for a variety of reasons), it was decided that there was value in including the communications in the analysis.

Given the controversial nature of the Lane Cove Tunnel scheme (see Chapter 4), it is not surprising that it became a topic of interest in social media. Therefore, it was decided to examine social media for opinions of the narrowing of Epping Road in Lane Cove.

Letters to the editors in local newspapers were perused but (surprisingly) did not prove to be a fruitful source of opinions on the narrowing of Epping Road.

5.2.4 Analysis

It was proposed to analyse the attitudinal data by examining the text and noting attitudes and behaviour that were common to more than one respondent. The information would then be categorized. It would be an iterative process, with transcripts and texts already examined subsequently re-examined for the presence of concepts brought to the researcher's attention in later transcripts and texts.

5.2.5 Ethics

Introduction

When undertaking experimental work involving human (or animal) subjects is subject it is necessary to consider the ethical nature of the process; that is, whether the proposed procedures are 'fair' to all parties concerned. As a doctoral researcher working with identifiable human subjects at the University of Technology, Sydney (UTS), it is necessary to specify the procedures that are to be carried out and obtain ethics approval for them from the university's Human Research Ethics Committee (HREC) before experimental work can proceed (UTS 2012).

The HREC Ethics Policy is designed to protect the interests of the participants in any experiment, the interests of the experimenter and the interests of the UTS. Under these policies, participants have a right to protection of their privacy, a right to protection from embarrassment or intrusion and a right to protection from harm (*ibid.*).

Ethical considerations for this study

The interviews carried out for this study were considered to fall into the category of information sources for which privacy considerations were essential, However, it was assumed that opinions expressed in the public domain (in this study, on Internet forums or web sites) were, *ipso facto*, available for perusal and use by members of the public, including researchers. No attempt was made to disguise the names or aliases by which contributors has identified themselves in these cases. The material provided via e-mail or telephone call was treated as confidential in the same way that interview conversations were.

As an aid to the literature review, two reports on particular case studies, not in the public domain (Brisbane Riverside Expressway and Auckland Lake Road closures), were provided by the authorities concerned (Queensland Main Roads and North Shore City Council, Auckland, New Zealand, respectively).

Those reports were provided on the condition that the source was acknowledged; and in the case of the Brisbane Riverside Expressway, that the information was only used for the purposes of this doctoral study. These conditions can be considered part of the ethical responsibilities of the study.

New traffic data (counts of cyclists and pedestrians) was also collected and added to that available from the Roads and Traffic Authority (RTA) (subsequently Roads and Maritime Services (RMS)) in order to enhance understanding of the situation in which motorists were making decisions as a result of the narrowing of Epping Road in Lane Cove, as described in Chapter 4. However, the data was anonymous; it was not linked to any individual and therefore did not require ethical approval (UTS 2012).

Ethics procedure for interviews

In order to comply with the HREC Policy on Ethics for postgraduate research (*ibid.*), it was necessary to obtain ethics approval for the proposed interviews. Obtaining ethics approval entailed satisfying HREC of the need for the information and of the manner in which it was proposed to obtain the information (*ibid.*).

In order to satisfy ethics requirements, four documents were prepared for the semi-structured interviews:

1. a letter of introduction;
2. a consent form;
3. a description of the research;
4. a form to record the interviewee's demographic information.

The *letter of introduction* was worded on the assumption that interviewees would be recruited via the snowball method (Denscombe 1998); that is, each interviewee would suggest further potential interviewees. This did not happen. In fact, only one interviewee was recruited using this method (see s.5.4). However, the letter contained a description of the procedure that was expected to take place in order to undertake and process the interview, so it was handed to interviewees at the beginning of the interview.

A personalized version of the letter introduced the researcher and the research and gave a brief explanation of why that person in particular had been asked to take part. It briefly described what was expected to happen during the interview and what would be done with results of the interview. It asked the respondent to return the attached consent form if they were interested in taking part in the study. However, as noted, the first contact with interviewees was not via mail, so the introductory letter was not used as initially intended.

A template letter of introduction is included in Appendix B.

The *formal consent form* set out the particulars of the study that were relevant to the interviewees:

- the name of the study (with the HREC number);
- the name of the researcher and affiliation details;
- brief description of the purpose of the study;
- brief description of the interviewee's role;
- retention policy for the data;
- a statement of anonymity for the interviewee;
- contact details for the researcher, the academic supervisor and the UTS Ethics Committee.

It noted that participation was voluntary and could be withdrawn at any time, without question. It asked for the interviewee's consent to participation in the study and consent for the interview to be recorded. It also explained who to contact if the interviewee had any concerns about the interview or associated activities.

A copy of the consent form was produced for both interviewer and interviewee and signed by both parties before the interview began. A template consent form is included in Appendix B.

A copy of a *description of the research*, in question and answer form, was given to each interviewee before the interview took place. Much of the information on this form repeated information given in the letter of introduction or consent form.

A copy of the description of the research is included in Appendix B.

The final form handed to interviewees before the interview began asked for *demographic information*; that is:

- name;
- home address;
- telephone contact number(s);
- e-mail address, if any;
- age group;
- employment situation;
- length of commute;
- income band;
- household occupancy;
- car ownership;
- household structure.

A copy of the form asking for demographic details is included in Appendix B.

A *letter of thanks* was also drafted, to be sent to interviewees at the end of the study. The template for this letter can be found in Appendix B. As a small 'thank you' to interviewees for giving up their time to take part in the interviews, copies of the papers relating to the findings of this study were offered to interviewees. All the interviewees were interested in receiving such papers. The first, a conference paper, was distributed in 2013.

Ethics approval was obtained in December 2010, HREC number 2010-463A.

Data retention

The Australian Vice-Chancellors Committee guidelines on data storage and retention, to which UTS adheres, require that data be retained for a minimum of five (5) years after the results of the research have been published. Accordingly, the data collected for this study will be managed by University Records at UTS (UTS 2012).

5.3 Selection of respondents

5.3.1 Sampling frame

The sampling frame for the study of motorists consisted of motorists whose habitual travel involved the use of Epping Road; in particular, motorists who had experience of Epping Road both before and after the Lane Cove Tunnel was opened and the number of lanes on Epping Road reduced. It is not practical to determine where all the users of a busy stretch of road originate or what their destinations are. However, the 2008/9 Greater Sydney Household Travel Survey found that the average trip length for a motorist was 9.6 km (Transport Data Centre 2010). Therefore it is assumed that a large proportion of motorists who use Epping Road under normal circumstances are reasonably local. It should be noted that in another study, it was found that motorists living locally to the area of the RRC had different views on the effect of the episode of RRC to those passing through from more distant areas (Rees & Williams 1998).

5.3.2 Criteria for selection

The HCR report noted that:

> *...traffic does 'disappear' in response to reductions in capacity, but only to the extent that it needs to do so.* This occurs due to responses by a proportion of drivers who take action to avoid

> what they consider, in relation to their prevailing experience, to be unacceptable conditions. (*op. cit.* p.57 (emphasis as in the original)).

Hence, the motorists considered of prime interest to this study were those who had noted the conditions on the 'new' Epping Road, found them unacceptable and had taken some action to mitigate the problems they perceived.

In the case of Epping Road, the situation was complicated by the strong feelings many motorists had about the Lane Cove Tunnel. Many people felt that Epping Road had been narrowed in order to force motorists to use the Lane Cove Tunnel (and hence pay a toll to the operator) (e.g. Findlay 2007). Motorists who used Epping Road in Lane Cove purely because they did not want to pay the tunnel toll were not asked to an interview. However, there were some people for whom it was not sensible to use the Lane Cove Tunnel, because to do so would require them to go out of their way, for no added benefit and thus add unnecessarily to the length of their trip.

It should be noted that no restriction was placed on the type of trips undertaken. Although peak hour and therefore mostly non-discretionary trips (Corpuz 2006) are of great concern to road authorities because of the congestion they cause, it was felt that it should not be assumed that motorists are only concerned about peak hour trips. Hence, no restrictions on the type of trips undertaken on Epping Road were specified.

5.3.3 Sample size

When selecting respondents to a survey it is usual to try to obtain a representative sample (Denscombe 1998). Thus, it is necessary to attempt to select a balance of gender, age, income, employment status and other factors which researchers have found to be relevant.

However, within the constraints of this doctoral study, it was not possible to interview a large number of motorists. Owing to time constraints associated with finding respondents, interviewing them and transcribing the interviews, ten people were interviewed. Nevertheless, the use of e-mails, social media and telephone calls has ensured that a wide variety of opinions are included in the analysis.

However, it is necessary to bear in mind that evidence from elsewhere suggests that change of route and change of time will form a large percentage of the responses (e.g. Hendrickson *et al* 1982; Bullard 1987; Meyer 1988; Khattak & de Palma 1997; Cairns *et al* 1998; Rees & Williams 1998; Hunt *et al* 2002; Ye *et al* 2010).

5.3.4 Amendments to methods and procedures

Section 5.4 describes the methods and procedure proposed to recruit motorists for interviews. However, experience demonstrated that there were a variety of problems with the proposals in their original form.

The adaptations and modifications to the proposed methods that were found necessary are described in s.5.5 and s.5.6. It was not considered necessary to obtain ethics approval for these changes.

5.4 Recruitment of motorists

5.4.1 Introduction

It was originally envisaged that interviewees would be recruited in the first place by means of publicity and subsequently using the snowball technique (i.e. by being recommended by previous interviewees (Denscombe 1998)). This latter technique has three advantages:

1. the recommendation from personal acquaintances gives the study and researcher credibility in the eyes of the potential interviewee which cold-callers do not necessarily have;
2. the technique permits the researcher to ask for potential interviewees with particular attributes (e.g. retirees);
3. it is not necessary to arrange interviews that might later be cancelled because it is felt that new information is not forthcoming.

However, with one exception, all the people suggested by initial interviewees proved to be unsuitable for interviews, either because of a lack of interest, misunderstanding of the aim of the study, or departure from Sydney. Therefore, most attitudinal data used in this study comes from motorists who were recruited directly; opinions offered as a result of publicity about the study (mainly in local (free) newspapers); and social media. That is, the data comes mostly from a convenience sample (*ibid.*).

5.4.2 Timing of approach - general

Mention of the Lane Cove Tunnel can arouse strong emotions in people who drive in the Lane Cove area (see Chapter 6). In order to minimize the emotional response from interviewees and maximize the rational response, it was decided to attempt to avoid situations in which people might be aroused to strong feelings about the tunnel and Epping Road. Hence no publicity was published around the time of the state election on 26th March 2011, in which transport was a topic of great interest. Nevertheless, at a public meeting on transport in Ryde on the 10th March 2011, organized by the *Sydney Morning Herald* (a local broadsheet newspaper, which had been running a long running campaign about transport for Sydney ('Along the right lines' 2010)), one member of the audience who had asked a question was approached and consented to take part in an interview.

5.4.3 Publicity

Introduction

In order to attract interviewees, it was necessary to generate publicity. Previous personal experience (pre-Internet) suggests that publicity via television has the widest reach. However, no opportunity for publicity via television presented itself. Therefore, the attempts to gain publicity were restricted to personal approaches, the print media and the Internet, using the following eight methods:

- personal contacts: personal acquaintances were asked either to nominate potential interviewees or instigate more general publicity;
- members of parliament: all the MPs, both state and federal, whose electorates covered any part of the area of interest were sent a letter, informing them of the study and asking for nominations of potential interviewees. There were no responses;
- large destinations in the area: contact an appropriate person to arrange internal publicity;
- business groups: publicity in electronic newsletters sent to local businesses (Ryde Business Forum);
- *ad hoc* opportunities, including a public meeting about transport in the Epping/Ryde area and chance conversations;
- distribution of printed material: posters on the noticeboards in the libraries at Lane Cove and North Ryde and mail drops;
- press release;
- web sites (UTS study specific and Macquarie University sustainable transport).

In order to prepare for the attempts to gain publicity, summaries of the study were written (in seven words, 25 words, 75 words and 348 words). This was sent to the contacts in electronic format where possible. This material was used as a basis for one of the web site pages and the posters which were distributed to libraries and updated as appropriate.

The press release brought in the greatest number of responses of any method of publicity. However, the study web site was useful for providing information about the study accessible to anyone, anywhere in the world. It also served as an outlet for results generated by the study.

Specific publicity: press release

A press release describing the study and the help that was needed was organized by UTS's Media Unit (see Figure 5.1). As a consequence of this press release, three local newspapers (the *North Shore Times, Northern District Times* and *Shire Hills Times*) took up the story.

The newspaper articles resulted in three interviews, 16 e-mails and two telephone conversations. There were five responses to the press release itself, including responses from the RTA and Lane Cove Council.

The people who responded to the publicity did not necessarily fulfil the criteria for interviews. It was clear that most respondents had seen the word 'complain' in the headline but not thought about the text of the press release. Consequently, most responses were from people who wished to complain about the changes that had been made to Epping Road (often locations that presented particular difficulties to the person in question). However most of these people did not fall into the category of people who had made changes to their travel because of the effects of the new bus lanes (although their comments have been included in the analysis where appropriate). Resenting the tunnel toll and refusing to pay were common themes of the complaints.

Specific publicity: web site

As a result of an offer from the (then) Sustainable Transport Officer at Macquarie University (a major destination in the area) to post a link from his area on the university web site to another web site, it was decided to build a web site for the study. A basic site, describing the study and what was wanted, was developed. It was augmented sporadically with outcomes from the study and relevant books and papers (both technical and popular works). The web site can be found at www.reductioninroadcapacity.info (see Figure 5.2).

The web site initially included a summary of the background of the study and details of what was wanted from the public, some information on the researcher and contact information. Further information (including references for persons interested in finding out more about the study and the subject) was added as it became available and knowledge of building web sites developed. Nevertheless, it was felt appropriate that substantial new information and concepts were released initially through the normal channels (that is, conference papers and academic or industry publications).

This web site became an outlet for publicity about the study which could be referred to when corresponding with potential interviewees, academics and other persons who had an interest in the work. It allowed introductory e-mails to be briefer than they might otherwise have had to be (in order to keep the correspondence brief and minimize the work required of the reader).

5.5 Attitudinal data - solicited opinions

5.5.1 Amendments to proposed selection procedure for interviewees

Sampling method

Although other possible interviewees were suggested by some of the people who were interviewed, for a variety of reasons it was only possible to speak to one of them. Therefore the sampling for this study was, in the main, convenience rather than snowball (Denscombe 1998).

Field study location

Epping Road runs from Lane Cove in the east to Epping in the west (see Figure 4.1). Only the eastern end of Epping Road has been narrowed. Therefore, it might be thought that only the eastern end of the road would be a problem for motorists. However, several people who put themselves forward for inclusion in the study drove principally on the western end of Epping Road. They felt that problems on the eastern end had spilled over on to the western end.

5.5.2 Interviewees

Ten motorists were recruited for interviews. They responded to requests for volunteers as follows:

- through personal contacts – 2;
- through the public meeting – 1;
- through electronic newsletters – 2;
- through local newspapers – 3;
- through web sites/forwarded e-mail press releases – 1;
- unknown – 1

Owing to equipment malfunction, the recordings of two interviews were lost and there was no response to a request to repeat the first of these interviews in which the data recording had failed. However, in the first case the essence of the interview was in the initial e-mail, and in the other, the interviewee revised and added to the written summary of the interview. Therefore, these two interviews have been included in the analysis.

Not all motorists who came forward with comments in response to the initial request for help were actually suitable as interviewees. Some, although inconvenienced by the changes, had not changed their routines. Some felt they had no choice about using Epping Road at the time they did; some refused to use the tunnel on principle.

Table 5.1 gives a demographic breakdown of the interviewees. Half were men and half were women. They were mostly older (over 55 years of age) people, in paid employment, with an income over $52,000. Six of the interviewees live in Lane Cove and four were motorists passing through en route to paid employment.

The interviews took place between February 2011 and September 2012.

Table 5.1 Demographic details of interviewees at the time of their interview

Interviewee	Gender	Age range	Employment status	Income range ($)	Connection to Lane Cove area
IN1	F	56-65	part time	>104,000	resident
IN2	F	>65	retired	20,800-52,000	resident
IN3	M	56-65	full time	52,000-104,000	passing through
IN4	F	46-55	full time	>104,000	passing through
IN5	M	56-65	part time	<20,800	resident
IN6	M	26-35	full time	52,000-104,000	passing through
IN7	M	36-45	full time	>104,000	resident
IN8	F	56-65	full time	>104,000	resident
IN9	M	56-65	part time	52,000-104,000	resident
IN10	F	46-65	full time	52,000-104,000	passing through

5.5.3 Other sources of opinions

The ten interviews were supplemented by a total of 18 e-mails, two telephone conversations and several casual conversations. That is, there were more than 30 solicited responses, of varying degrees of depth. The amount of demographic detail that it was possible to infer from the e-mails and telephone calls varied. Some respondents described themselves. Details for some respondents were also available in other places on the Internet.

When quoted, extracts from e-mails and notes added to the transcripts are not enclosed in quotation marks since they are extracts from written material.

Although relative few interviews were achieved as a result of the publicity, there was wider interest in the study, principally as a result of the article in the *North Shore Times* (which is the local newspaper for an area which includes the length of Epping Road which lies within Lane Cove). For further publicity, see s.5.4.3.

5.5.4 Interview results

A series of questions was developed, designed to explore the interviewees' past and present travel behaviour. A pilot interview was undertaken with the help of a fellow doctoral student who was experiencing long term disruptive roadworks near his home. As a result of this, the list of questions was revised (see Appendix B-6). Ultimately, however, the questions proved to be unrealistic, as they did not allow for the complexities of people's lives.

Problems included interviewees having their own agenda (principally unhappiness with the changes that had been made to Epping Road) and the changes people made to their activities, origins and destinations as time progressed, independently of the changes on Epping Road. The interviewees did not always confine themselves to one route or mode of transport for their journeys, even when the trip purpose for multiple journeys was identical.

Nevertheless, some unexpected points did arise from the interviews (see Chapters 6 and 7).

The interviews (the length of which varied between about 20 and 90 minutes) were recorded and additional notes made at the time as appropriate. The recordings were transcribed and transcription sent to interviewees for approval. In no case were alterations to the existing transcript requested, although in two cases notes written at the interview were edited by the interviewee concerned and additional material was appended. This additional material is reported in the third person and is not enclosed in quotation marks, as it exists only in written form. Nevertheless, there was e-mail correspondence with each interviewee before and after the formal interview. The information from those e-mails was incorporated in the analysis when it was relevant.

Interviewees appeared to have little difficulty remembering the changes they had made after Epping Road was narrowed.

Common and individual themes were extracted from the transcriptions. It was found necessary to make this an iterative process. As a theme emerged from the transcript of one interviewee or a respondent's e-mail, it was necessary to go back over the transcripts of previous interviewees or respondents, to check whether that issue had been at all salient for them as well. The findings are discussed in Chapters 6 and 7.

5.6 Attitudinal data - unsolicited sources of opinions

5.6.1 Introduction

With the advent of the Internet, e-mail and social media, it has become easier for individuals to offer opinions to a wide audience. Although the audience for social media is likely to be people with a specific interest or experience in the topic, because of the public nature of the Internet, the conversations are open to researchers as well.

Given the contentious nature of the project (e.g. SMH 2006; Findlay 2007; NRMA 2008; Zapata 2008; Besser 2008a) it is not surprising that the Lane Cove Tunnel scheme became a topic of conversation in social media. Topics discussed included many aspects of the design and construction of the tunnel itself (especially ventilation) and the cyclepath [*sic*] on the south side of Epping Road (the shared aspect of this path was rarely considered). There was little discussion of the narrowing of Epping Road or the extra bus lanes that related specifically to the interests of bus users, motorists, motorcyclists and pedestrians (although bus users and motorcyclists did discuss particular operational aspects of the altered road); that is, cyclists appeared to be the most prolific users of social media with respect to the traffic aspects of Epping Road. This is in contrast to the contents of the e-mails that were received as part of the interaction with users of Epping Road (see Chapter 6). For example, the bus user forums related to Epping Road which were examined were concerned with ticketing and Hillsbus stops on Epping Road (Bus Australia 2010). However, the search was conducted in 2011, four years after the road layout was altered in 2007-2008. Therefore it is possible that comments posted at the time of the changes were no longer available.

In a qualitative study such as this, the opinions canvassed in interviews and received as a result of publicity are not expected to be statistically representative of motorists using

Epping Road (see s.5.2). It was felt that there might be merit in examining another source of opinion which was not statistically representative; that is, considering what the contributors to social media opined, unprompted by an interviewer. Clearly this is less satisfactory than interviews, e-mails or telephone calls, since it is not possible to set the topic of conversation and there is little opportunity to follow up comments, particularly when the posts are old (see s.5.6.2). Furthermore, respondents' on-line persona may not reflect their real-life persona (Wallace 1999, pp. 14-37; Suler 2004)). However, it has the advantage that opinions are naturally occurring data, contemporary with the events under discussion (and dated and timed) and not edited by third parties such as disc jockeys. It is also significantly easier to access opinion on social media than to persuade a substantial number of individuals to take part in a survey.

In using social media, it is necessary to remember that the topics discussed may be set by other people; and they may change, or diverge from the original subject, as the discussion progresses. The discussion may cause people to change their opinion over time. Equally well, if the site is not updated, opinions may alter without the changes being reflected in what appears on the site. Posts cannot be assumed to be a representative reflection of people's concerns or interests. Furthermore, few demographic details can be inferred from the comments recorded.

Nevertheless, social media proved to be useful to this study.

The social media sites listed in Table 5.2 were examined for insights. However, not all proved to be relevant.

Table 5.2 Social media examined for insights into the use of the narrowed Epping Road

Title	Source	Subject	URL
Lane Cove Tunnel (24/8/2006)	Sydney Morning Herald	Likelihood of Lane Cove Tunnel working	http://blogs.smh.com.au/newsblog/archives/your_say/005640.html?page=fullpage
Lane Cove Tunnel (26/3/2007)	Sydney Morning Herald	Initial experiences of the Lane Cove Tunnel	http://blogs.smh.com.au/newsblog/archives/your_say/010535.html
Epping Road's cycleway – good, bad or mad?	National Roads and Motorists' Association (NRMA)	Epping Road cycleway [*sic*]	http://www.mynrmacommunity.com/motoring/2008/01/18/epping-roads-cycleway-%E2%80%93-good-bad-or-mad/
CARR – Citizens Against Road Rip-offs	Ziggy Zapata (web site)	Motorists beating the government by avoiding toll roads and traffic cameras	www.carr.org.au
Sydney Cyclist	Damian M (forum about cycling in Sydney)	General forum - several threads cover SUP; of most relevance: potential for road traffic accidents on the Epping Road shared use path	http://www.sydneycyclist.com/forum/topics/epping-rd-bike-path-claims-another-victim?xg_source=activity&id=1321712%3ATopic%3A357808&page=1#comments
Epping Road Bike Path	Bicycles Network Australia - Australian Cycling Forums	Epping Road bike path [*sic*]	http://www.bicycles.net.au/forums/viewtopic.php?t=5149
[NSW] Sydney – is the new Epping Road bus lane ok for bikes?	Netrider	Use of the bus lanes on Epping Road by motorbike riders	http://www.netrider.net.au/threads/nsw-sydney-is-the-new-epping-rd-bus-lane-ok-for-bikes.89779/
Epping Road Services – Myzone tickets	Bus Australia	Myzone tickets and stops used by Hillsbus on Epping Road in Lane Cove	http://www.busaustralia.com/forum/viewtopic.php?f=3&t=50665&start=75

5.6.2 *Sydney Morning Herald* Lane Cove Tunnel forums

The *Sydney Morning Herald* (SMH) held a forum on the Lane Cove Tunnel on the 24th August 2006 (SMH 2006). Readers were asked whether they thought the tunnel would work.

There were 68 responses. Topics covered people's reaction to the Lane Cove Tunnel, attitudes towards the changes that Epping Road was to undergo and changes in travel behaviour.

The *Sydney Morning Herald* held another forum after the tunnel opened in 2007 (SMH 2007). This was open for three days and had 124 posts. Motorists detailed their reactions to the tunnel and to the remaining traffic on Epping Road. At this point, Epping Road had not been narrowed and therefore motorists were benefitting from an overall increased capacity in the Epping Road corridor. The tunnel was also toll-free for the first month.

5.6.3 NRMA Epping Road shared use path forum

On the 18th January 2008, the NRMA posted an article about the Epping Road SUP on their community blog (NRMA 2008). Comments continued for over 2½ years, although most were added in the first five months. Comments came from cyclists, self-declared would-be (utility) cyclists and anti-cyclists. About a third of the 65 individuals who commented declared themselves to be motorists (and/or members of the NRMA) as well as cyclists. The comments degenerated into a discussion of cycling which is not relevant to this study. However, two respondents, one of whom stated that he was a motorist, said that they had already or intended to change their travel because of the changes in the Epping Road corridor.

5.6.4 Citizens Against Road Rip-offs (CARR)

'Citizens Against Road Rip-offs' (CARR) (see Figure 5.3) is a web site established by Ziggy Zapata (Zapata 2008). It is concerned with a variety of ways that Mr Zapata feels that motorists are being unfairly treated by the NSW government, including:

- toll roads, which he feels should be free and are in some instances being forced on motorists;
- traffic cameras, which he feels are revenue raisers and do nothing for road safety;
- street parking charges, which he feels are merely revenue raisers for local councils; and
- 'school zone' signs, which he feels are not explicit enough because they do not list the days which are school days.

The web site listed 149 people as members of CARR at the 23rd February 2012.

5.6.5 Cycling forums

Bicycles Network Australia

This forum was concerned with the SUP as part of a longer cycle route. In part, it is a discussion of the experiences of several cyclists, some of whom are also motorists, on the SUP as the latter nears completion. These cyclists wanted to use the path for commuting. The path itself was an attractor – that is, it is not the narrowing of Epping Road that decided the contributors to move to cycling. Rather, they were interested in cycling already and the SUP element of the Lane Cove Tunnel scheme prompted them to use Epping Road in Lane Cove as part of their daily commute.

Sydney Cyclist

This forum was principally concerned with the design of the SUP beside Epping Road (which is part of a longer path between Naremburn and Ryde). In particular, it was concerned with the potential for conflict between cyclists and motorists.

5.6.6 Other sources of unsolicited opinions

Public enquiries are another example of studies which receive input from a variety of self-selected individuals and groups, in addition to the input which has been solicited. There are two main sources of opinion for the changes to Epping Road associated with the enquiries into the proposed Lane Cove Tunnel.

1. some responses of the Lane Cove Tunnel Action Group were accessible and have been consulted for this study (LCTAG 2002); and
2. respondents to the Joint Select Committee on the Cross City Tunnel (whose terms of reference were widened to include the Lane Cove Tunnel) also expressed opinions.

'Letters to the editor' of newspapers are another source of unsolicited opinion. However, there were surprisingly few letters to the local papers on the subject of the changes to Epping Road after the Lane Cove Tunnel was opened.

5.7 Summary

The topic of interest in this study is motorists' response to RRC. It was felt that the most appropriate approach to this topic was a qualitative study. It was decided that data would be gathered by interviewing, on an individual basis, motorists who used Epping Road.

However, attitudinal data from sources other than interviews was uncovered (that is, social media and responses to the first press release) and it was felt appropriate to take that into consideration. The (attitudinal) data gathering element of this study resolved itself into the following activities (not necessarily in this order):

- obtaining ethics approval for the study;

- undertaking a pilot interview to test appropriateness of questions;
- obtaining publicity for the study;
- follow up of responses to publicity;
- recruitment of interviewees;
- interviews;
- obtaining information from other involved parties;
- searching for information through social media.

The attitudinal data was obtained by means of a convenience sample. It was collected by means of ten semi-structured interviews supplemented by opinions solicited via local papers and other requests for information. These supplementary opinions were obtained via 18 e-mail conversations and two telephone calls and by analysing unsolicited opinions on one web site and five forums.

The transcripts of the interviews, the e-mails and extracts of relevant social media comments were coded into themes, so that attitudes on individual topics could be compared. This analysis forms the basis for the conclusions of the field study part of this thesis. The characteristics of respondents (e.g. whether a resident of Lane Cove or not) were also collected for use (if known) when analysing the answers.

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News

Researcher ready to hear everyone's complaints about Epping Road

In summary:

- UTS researcher Rosemary Sharples wants to interview people who changed their travel behaviour in the wake of the opening of Lane Cove Tunnel and the subsequent reduction in traffic capacity on Epping Road
- Her PhD will help road authorities plan how and when to intervene when they have to deal with road closures and how to more thoroughly asses the impacts of trying to change people's travel behaviour

Rosemary Sharples. Picture by Joanne Saad

If you've been grumbling about the changes on Epping Road since the opening of the Lane Cove Tunnel, now's your chance to get it off your chest.

UTS PhD student Rosemary Sharples is looking to interview motorists who used the stretch of Epping Road east of the Lane Cove River prior to the opening of the tunnel and have now changed their behaviour. The interviews will inform her research into what happens when road capacity is reduced.

Ms Sharples wants to find out how motorists reacted when construction of a shared cycle/footpath began in August 2007 and then in March 2008, when one lane for general traffic in each direction was converted into a bus lane.

Her work will help road authorities plan how and when to intervene when they have to deal with road closures and how to more thoroughly asses the impacts of trying to change people's travel behaviour.

"I want to know how motorists decide what they will do once road capacity has been reduced and why some motorists do one thing and others do something quite different," Ms Sharples said.

"It could be altering the way they drive, using another route, travelling at another time, changing to the bus, train, bike or walking... or even doing something quite different, such as working from home.

"The Environmental Impact Statement for the Lane Cove Tunnel project estimated that between the two stretches of road there would be an overall increase in capacity in that corridor, although on Epping Road itself the capacity for general traffic would decrease.

"Some of the motorists driving in this area can't use the tunnel – perhaps because their destinations are between the Lane Cove River and Longueville Road, or because they're not travelling to or from the city.

"I've already spoken to one person who travels to work in the Ryde area and who has moved house because of the traffic."

To participate in the study, phone Rosemary Sharples on 9514 2417 or e-mail Rosemary.A.Sharples@student.uts.edu.au. There is more information on a website set up for the study at www.reductioninroadcapacity.info

By:

Terry Clinton

Back to list of News

FEEDBACK

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Level 14,
Building 1,
15 Broadway,
Ultimo, NSW 2007
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View location

University of Technology, Sydney
P.O. Box 123
Broadway, NSW 2007
Australia

3:52 PM

Figure 5.1 Press release issued by the University of Technology, Sydney asking for volunteers for the Epping Road study

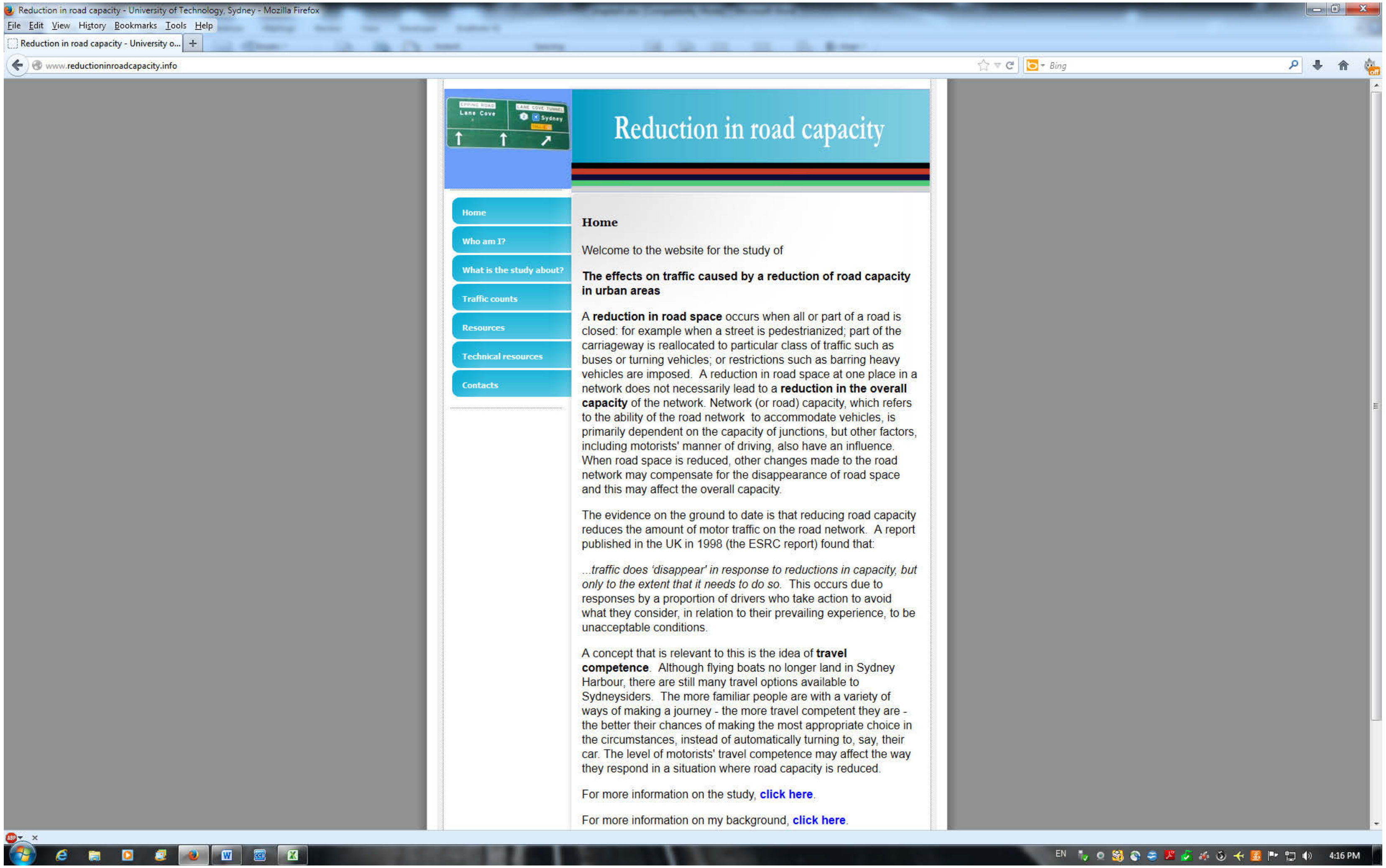


Figure 5.2 Study website's home page

CITIZENS AGAINST ROAD RIPOFFS
www.carr.org.au

SEND TOLL ROADS BROKE

NOTE: If you arrived at this page without seeing a menu, please click on this link - www.carr.org.au - to open the entire CARR website in a new window.

The author asserts his right to publish this information in the public interest
No responsibility is taken for consequences resulting from using any information contained herein

PUT THESE HIGHWAY ROBBERS OUT OF BUSINESS

NSW has the highest road taxes in Australia, plus that iniquitous fuel levy that was imposed in 1995 and was supposed to have been abolished one year later but was not. Despite the cost of car registration, driver licences and literally every other expense levied by the NSW government that is grossly higher than in any other state, the roads are appalling. Not only that, the NSW government receives all GST revenue from fuel sales and the federal government rips off 38 cents from every litre of fuel sold, but only returns 9 cents to motorists for road infrastructure.

NSW GOVERNMENT INEPTITUDE AND SCHEMING

What is worse is that even with the huge cash flow from taxes and charges connected with driving, the NSW government is incapable of funding decent freeways. It has resorted to contracting the building of such roads to private consortiums, which operate them as toll roads. In some cases, the government has actually turned over to those contractors parts of roads that were already built and paid for by NSW taxpayers, who now have to pay tolls to drive on those roads that they previously owned.

Not only that, the NSW government has embarked on a policy of trying to force motorists to use tollways instead of free roads, by adopting some despicable strategies, to the detriment of taxpaying drivers. Some through roads have been blocked to force motorists to either use expensive tollways or drive a lot further than they did before those roads were blocked. Roads have been narrowed to increase congestion, so as to make motorists drive on tollways, rather than be stuck in traffic on those narrower roads. Exclusive bus lanes have been established to cut down the number of available lanes to motorists. In all, the NSW government, in collusion with toll road consortiums, has been acting against the interests of drivers. Other states have the same problem.

FIGHT BACK

Despite the efforts of governments to force motorists to use toll roads, many drivers are deliberately avoiding them. In Sydney, the Cross-City Tunnel (CCT) is an excellent example of how people power can cripple such iniquitous schemes. The shortness of the CCT, coupled with the large toll, ensured that most motorists would avoid it at all costs. Literally one year after the CCT was opened, it went broke because of lack of patronage. The Lane Cove Tunnel (LCT) is in peril because despite the deliberate narrowing of Epping Road to try to funnel motorists into the LLC, many preferred to tolerate the slower trip through Lane Cove up to the Gore Hill Expressway to avoid the high toll. In Brisbane, the Airport Link toll road is going broke because motorists are boycotting it.

SEND THEM BROKE

Motorists need to fight back against the disgusting road policies of state governments. Short of kicking those fools out of office and electing politicians with the interests of citizens at heart, motorists can use the power of the boycott very effectively. The CCT has already felt the brunt of angry motorists that refuse to use it and it is now bankrupt. The LCT hopefully will go the same way, as will the Brisbane Airport Link. Then governments may be forced to take those toll roads back from the consortiums and turn them into freeways, as they should have been in the first place.

HOW TO DO IT EASILY

AVOID TOLL ROADS AT ALL TIMES - Just be proactive and ensure that you allow enough time for you to use free roads to get to your destination at the same time as if you had driven on a toll road. In many cases, the difference is only a few minutes. Here are some examples from NSW.

EXAMPLE 1 - BAULKHAM HILLS TO SYDNEY AIRPORT

According to GPS mapping by Wherels, the trip from Baulkham Hills in the northwest of Sydney to Sydney International Airport takes approximately 40 minutes using the M2 Motorway, Lane Cove Tunnel, Sydney Harbour Bridge and Eastern Distributor. As of January 2012, the tolls for the return trip amount to a whopping $24.26.

To do the same trip avoiding the tollways takes 46 minutes each way. So for an extra 6 minutes each way, you can save $24.26. Think about it - that is the equivalent of earning $240 per hour. This is serious money, especially if you make this trip frequently. If you have to make this return trip every weekday, avoiding the toll roads will save you over $121.30 per week or more than $6000 per year. Under the congestion toll increase for the Sydney Harbour crossing, if you drive south across the Bridge or Tunnel in peak hours, you can add another dollar to each trip, which is another $250 per year on your bill.

Figure 5.3 Extract from the CARR website

CHAPTER 6

Attitudes to the Epping Road Corridor and Behaviour Changes

Chapter 5 described the methods which were to be employed for this study and the data that was to be collected. It gave an outline of the participants' demographic details. This chapter discusses the finding from the interviews undertaken as part of the field study for this thesis. The findings are supported by quotations from the conversations with the interviewees and, where relevant, further supporting quotations from e-mail or telephone respondents. In some cases, supporting quotes have also been extracted from relevant social forums on the Internet or a relevant website.

Section 6.1 introduces the discussion of the findings. Section 6.2 provides a short biography and description of the elements of each interviewee's travel behaviour that are relevant to the reduction in width of Epping Road in Lane Cove. Section 6.3 gives a general overview of interviewees' travel behaviour before and after the narrowing of Epping Road. The following sections (6.4-6.15) discuss the themes (and within each theme, the topics) that were of concern to interviewees. Section 6.16 discusses the findings with respect to habits (and life events) in order to answer the first research question. Section 6.17 summarizes the findings, including the interviewees' changes of behaviour and the topics that were of interest to them.

6.1 Introduction

This chapter is concerned with interviewees' reactions to the narrowing of Epping Road, in the form of both behaviour and attitudes. On the subject of behaviour, it is concerned with both changes in behaviour and unchanging behaviour. The analyses are performed primarily on the responses of the motorists who were interviewed for the field study element of this doctoral research. Because it was not possible to probe, in any depth, for further information from the e-mail respondents, telephone callers or contributors to social media, their stories are not included here, although their comments are used to expand on points made by the interviewees.

This chapter seeks to ascertain the interviewees' behaviour and the reasoning behind it. This information will be used in Chapters 6 and *7* in order to answer the research questions:

1. How do motorists' reactions (in terms of travel behaviour) in a case of reduction in road capacity (RRC) relate to their existing travel habits?
2. How can the trips be identified, which, in order to reduce the volume of traffic to acceptable levels, are most likely to disappear after a network event such as RRC?

In order to obtain the information needed to answer these questions this chapter will:

- describe interviewees' attitudes to the narrowed Epping Road, and events and facilities associated with it, including the Lane Cove Tunnel; and
- describe interviewees' travel behaviour both before the road was narrowed and in the ensuing years.

The travel behaviour discussed will be confined to choice of mode, choice of route, time of travel, style of driving and choice of origin or destination as these were the behavioural changes of greatest interest to interviewees.

6.2 Individual story summaries

6.2.1 Introduction

Before the findings of this study with respect to attitudes and behaviour are described, brief biographies of the interviewees will be given. It should be noted that these biographies are only valid for the period up to which the interview took place (i.e. some time in the period 2011- 2012). Clearly, interviewees will have aged since then. Some may also, for example, have changed their employer (or retired).

Although e-mail and telephone respondents are quoted in ss.6.4 to 6.15, it was only possible to obtain biographical details, other than those which they supplied themselves (in varying amounts of detail), for a small minority of them (usually from the Internet). It was not possible to find even this small amount for the opinions given on social media, in part because the majority of respondents used aliases. Therefore, e-mail, telephone and social media comments are used only to support the interviewees' opinions and not as part of the analysis.

It should be noted that all interviewees drove a car along Epping Road, both before and after Epping Road was reduced in width. It may also be noted that no interviewee abandoned the car, although some increased their use of other modes during the years between the opening of the Lane Cove Tunnel in 2007 and the date of their interview in 2011 or 2012.

6.2.2 IN1

Interviewee 1 lived in Northwood and worked at Macquarie Park (Figure 4.1). She commuted to work along Epping Road. The only change of destination that IN1 mentioned was the Macquarie (shopping) Centre, the implication being that she did use it previously.

The problems with Epping Road in Lane Cove that IN1 was concerned with were the time required to travel along it (and hence the time she was obliged to leave home in the morning) and the nature of the intersections. She felt that the extra short lengths of lane at junctions (used to increase the number of vehicles which could pass through an intersection while the lights in a given direction were green) caused anger among motorists using Epping Road. She also supported the bus lanes but not? the cycle facilities. She called the changes disruptive and time-consuming. She felt that the changes to Epping Road were made in order to ensure that the Lane Cove Tunnel was used and people paid a toll. She was a person for whom the Lane Cove Tunnel was irrelevant.

6.2.3 IN2

Interviewee 2 lived in northern Lane Cove (Figure 4.1). She retired in 2004, so she no longer needed to drive to Artarmon station to commute by train to North Sydney. Her trips included visits to her children and social activities. She organized her time of travel to avoid the peak hours – although she did not travel by choice in the peak before Epping Road was narrowed. Apart from changing her time of travel, she felt that the narrowing of Epping Road has not affected her as much as it would have affected commuters.

Her Probus[10] club changed their meeting time because of traffic, although it was mainly for the benefit of people coming from other directions. Another of her social groups met at lunchtime instead of the evening in order to avoid peak hour traffic, but again it does not seem to be because of Epping Road specifically. She felt that traffic has not become worse, because it had always been bad.

Unlike some other interviewees, she understood what the RTA was trying to achieve by installing extra lanes on the approaches to intersections. She talked about using the left hand lane to depart the intersection on the Lane Cove side of the Mowbray Road West intersection (and at Centennial Avenue). She had had to reduce the amount of overtaking she does because of the reduction in the number of lanes. She did not let herself get stressed by the amount of traffic.

She learnt to use buses after she retired. She used them to go into the city because of the difficulty of parking there.

She used Mowbray Road West when driving west. This avoided the narrow sections of Epping Road. When returning from the west she used Epping Road or Mowbray Road West, depending on the amount of traffic she saw at the Lane Cove River, on the final stretch of her journey home. She always departed via Mowbray Road West because of the one-way road system around her block of flats. She was a person for whom the Lane Cove Tunnel was irrelevant.

[10] a social club for retired professional and business people

6.2.4 IN3

Interviewee 3 lived in Beecroft and travelled between Macquarie University and North Sydney TAFE[11] at Gore Hill (Figure 4.1) several times a week. He spent almost four days a week at Macquarie University.

He felt that the traffic conditions which prevailed after Epping Road was narrowed increased the cost of driving, because of the volume and stop-start nature of the traffic. Therefore, he changed from using a four wheel drive to a sports car, although he also used a motorcycle (except in winter). His choice of vehicle would be determined by the circumstances. He used the complete length of Epping Road, for commuting or when he went into town, although the latter was usually on a Friday or a weekend. He felt that if he missed his departure time by 12 minutes he would be late by at least 25 minutes. He said that if traffic got really, really bad he would consider changing jobs.

He considered that he did not need navigation systems because he knew the road. In unfamiliar situations he might use such a system.

He preferred to use main roads rather than back streets. The problem with using back streets was circuitousness and losing time. He would use River Road and go through Artarmon, Gladesville or Eastwood if the radio or television warned of problems before he left. Before bollards were installed, he would turn around and use the tunnel if he saw there were problems on Epping Road.

[11] Technical and Further Education

The Lane Cove Tunnel was relevant to his trips, but he felt he was being forced into the tunnel because he could not get back quickly enough using Epping Road. When coming from Gore Hill he used the tunnel if he saw traffic banked back to Reserve Road. He objected to the toll on the Lane Cove Tunnel. He stated that if the operators increased the tunnel toll he would try to just go to Macquarie and omit North Sydney, or go in for casual teaching only.

The bus and train were not convenient for where he lived. Nor do they provide the flexibility he needs. He did use the bus lanes on his motorcycle but he recognized that there was a safety problem with motorcycles. Motorcyclists and taxi drivers cut into the general traffic lane when a bus stopped. He said he would use buses if they came to North Sydney and went back to Macquarie University (there are two bus services on this route but they take longer than the 20 minutes he liked to allow and they involve some walking).

He had a large personal space and regarded the car as his personal space. He wanted to be able to drive at his skill levels (he watched five cars ahead), his timelines and his interpretation of what was happening on the road. He felt that he was being forced to do something out of his control. He considered that he drove differently since Epping Road was narrowed. Because it became one lane, he could not move around on the road (to bypass slow drivers, for example). He did not see many cyclists (maybe three or four in the morning) and was furious that space had been given over to so few cyclists.

6.2.5 IN4

Interviewee 4 lived in the Hills District. Before Epping Road was narrowed, she lived in Double Bay (Figure 4.1). She moved into the house she owned at Baulkham Hills about 18 months before the interview (i.e. end of 2009) because of the traffic on Epping Road.

The firm she worked for had offices in North Sydney before moving to Macquarie Park. She found the traffic over the time the Lane Cove Tunnel was being built was an ordeal, so she started going to work earlier and earlier. She started keeping a diary about it (to see what difference the changes in time would make) and got angry about it. She tried the bus. However, it became impractical because she injured her foot, which made it difficult to walk. She started driving again and for a while was carpooling with another girl. They could be waiting for two hours on Epping Road while the roadworks were going on. They tried alternate routes but the side streets were blocked as well.

She started coming in later rather than earlier, but that meant altering her leaving time and leaving became worse than arriving. She looked for alternative work which would not require use of Epping Road; she became stressed about it and considered leaving NSW. She learnt how to ride a motorcycle but was under the impression that motorcyclists were not permitted in the bus lanes on Epping Road. She did not use public transport because it was inconvenient for some of her trips. She tried a variety of short cuts to reach work, including navigating either by the sun or a feeling about what other motorists are doing. She did not have a high opinion of GPS (as it was at the time of the interview). She did not use radio or television. She knew how traffic varied by day of week.

She worked at home for several months because of her injury and over time increased her days in the office. She felt that she did better work, and was more productive and calmer for not having to deal with traffic.

She waited to see what the traffic was like before she determined her route. She was flexible and dynamic – unless she was in the type of mood where she did not care. Usually she would try to find another way, even if it meant cancelling appointments. She did not think that most people had the latitude to organize her work that she did.

She was thinking of putting her house on the market. She commented on people who come from countries where traffic is far worse and who are prepared to put up with congestion which drives her crazy. She liked going fast. She had worked out energy use for several routes to Macquarie Park.

She felt so strongly that NSW roads were inadequate (she described Queensland and Melbourne roads as having four lanes everywhere (for smaller populations), unlike the two on Epping Road) that she wanted to leave the state altogether.

Because the time using the Lane Cove Tunnel is roughly the same as Epping Road, she felt that using one or the other had become learnt behaviour and it was difficult to avoid the pay-to-drive roads, since the roads merge. She thought that people who were interested in alternatives would have known them from before the tunnel and occasional visitors were not going to bother trying to find out.

She had a professional interest in people's behaviour. She commented that some people get upset by traffic, whereas others just do not care. If they are having fun they will put up with the traffic. She felt that she had reached the stage where she was earning so much money and had so much freedom and so much support that it would be difficult to find a better job. She noted that traffic was the first topic of conversation in the office in the morning,

6.2.6 IN5

Interviewee 5 lived with his wife on one of the streets parallel to Epping Road in Lane Cove. He had a studio in Silverwater (Figure 4.1) so he did not commute along Epping Road. His attitudes were affected by the fact that he had been:

1. a member of the Lane Cove Tunnel Action Group, which campaigned for the construction of the tunnel and associated changes; and
2. a truck driver.

He was pleased with the ‘new’ Epping Road, both for the environmental benefits it brought and for the improvements to bus services. After the bus lanes were constructed he started driving more on Epping Road, whereas previously he had tried to avoid it, although he did not drive more overall. He had started using the buses if he possibly could because he felt that the bus lanes had enhanced the reliability of buses sufficiently to make bus travel an acceptable mode.

He also used toll roads and tunnels, and would go out of his way to find them so he could avoid driving in suburban streets, which he found stressful.

IN5 understood what the purpose of the short extra lanes at junctions. He also agreed that people who lived in Lane Cove would experience the ‘new’ Epping Road differently from those who were just passing through.

6.2.7 IN6

Interviewee 6 lived in the Hills District and, at the time of his interview, worked at Macquarie Park (Figure 4.1). He initially used his car to travel to work, but discovered that he had to avoid the peak hours in order to minimize his travel time. After gaining his motorcycle licence in 2007, he started using his motorcycle on his commute and found it quicker than driving his car in both peak and off-peak periods. He used Epping Road (west of Lane Cove) rather than the M2, although he used the bus lanes when they opened. He took advantage of the transit lanes/bus lanes on Epping Road when he used his motorcycle to avoid paying for the M2 or Lane Cove Tunnel (the tolled roads provided no advantage in elapsed time).

After he bought a new bicycle, he mixed cycling (on the M2) and riding his motorcycle for his commute. He went back to his motorcycle when the M2 was closed to bicycles in January 2011. In June 2011 he sold his motorcycle and returned to driving his car. However, while his car was in the garage for repair, he took the advice of some of his colleagues at work and started using the bus. He found it satisfactory. After that time he used all three modes (car, bicycle, bus). The mode chosen depended on daily requirements – the need to be at work on time or the need to dress for meetings. He was also interested in keeping fit.

He did not use Epping Road in Lane Cove very often but nevertheless felt that the effects of the narrowing there extended westwards. He felt that any extra traffic was likely to be due to expansion in the business parks, rather than the influence of the Lane Cove Tunnel. He would avoid Epping Road if he had to travel to Lane Cove during the peak periods and use Mowbray Road West instead.

6.2.8 IN7

Interviewee 7 lived in Lane Cove south of Epping Road (Figure 4.1). At the time of the interview, he was working in Milsons Point, although at the time of the narrowing of Epping Road, he worked in Macquarie Park. His employer had moved there from North

Sydney and the gradual development of parking restrictions at and around the new site meant that eventually it was no longer practicable to drive to work. As a result he tried several alternative modes, including lift-share, public bus, employer-provided bus and cycling. However, the employer-provided buses were aimed at transporting people from the city centre and did not stop along the route. Therefore, they were not appropriate for people who lived fairly locally.

Cycling became his main mode of transport for the commuting trip along Epping Road (although he sometimes used other modes (e.g. if it was raining). Once started on an alternative mode, he might continue using it until he felt a desire for the advantages of the bicycle again and he returned to cycling.) Before the shared use path (SUP) became available, he used a route along Mowbray Road West (starting at the Lane Cove River) and back down Centennial Avenue, in order to avoid the worst stretch of Epping Road.

For him, the principal reason for cycling was the reliability it offered in journey time. However, because Epping Road was not a problem at the weekend, he could do his shopping and take his children to school sports in a car at those times (although if the school sports were local he could travel by bike to circumvent parking problems). He also used a bike in order to maintain fitness and because it was enjoyable (although he was not a recreational cyclist). He felt that timing was not an issue before the tunnel opened. He noted that traffic became more congested after the lane closures on Epping Road.

He also noted that he would switch routes if necessary. He gave the example of reaching the intersection of Longueville Road and Epping Road, and taking a decision as to whether to continue over the intersection or turn onto Epping Road, on the basis of the amount of traffic on Epping Road. He had learnt these alternate routes while he was driving.

The Lane Cove Tunnel was irrelevant to his normal trips.

6.2.9 IN8

Interviewee 8 lived in northern Lane Cove (Figure 4.1). She has worked in Parramatta, Macquarie Park and North Ryde. Prior to the opening of the tunnel, she used Epping Road. Since the opening of the tunnel, she had started using Mowbray Road West. As a result, she shopped in the Macquarie Centre or at Chatswood rather than the Lane Cove shops. She used the bus to go into the city unless she knew she had parking and was enthusiastic about the changes that had been made for bus travellers. She also used the train at Artarmon after driving to the station. She sometimes drove to Neutral Bay to catch the ferry to Circular Quay.

Her concerns centred on the junction of Epping Road at Parklands Avenue (Figure 4.1), in particular, the green time allowed for motorists to exit Parklands Avenue. She felt that the timing of these signals improved after the tunnel opened, but then reverted to the previous situation. She felt that as a result of the narrowing of Epping Road to one lane, traffic took longer to travel between Parklands Avenue and Centennial Avenue than it used to. She began using using Mowbray Road West to bypass the single lane section of Epping Road, which is the reason she no longer shopped at the Lane Cove shops.

She feels that Epping Road was narrowed in order to force motorists to use the Lane Cove Tunnel. The tunnel is not convenient for people who live where she does. She also misses the azaleas that lined the stretch of Epping Road between Parklands Avenue and Centennial Avenue before it was narrowed.

She also mentioned moving around on the road. She says the Epping Road alterations have changed her style of driving. She was not a patient person and she preferred constant movement to sitting in traffic. As a result she knows lots of back routes. She used 'least delay' to plan her route.

6.2.10 IN9

Interviewee 9 lived in Lane Cove south of Epping Road (Figure 4.1). At the time of his interview, he worked in Milsons Point. He drove to work, but he already knew that his alternative would be the bus. IN9 only used Epping Road at weekends, or rarely, weekdays during the offpeak. He lived far away enough from Epping Road not to notice any flow-on effects from the narrowing, either traffic or air pollution related. He has noticed some problems at the Epping Road/Longueville Road intersection but the traffic volume at weekends was sufficiently low not to alter his driving. The Lane Cove Tunnel was irrelevant to his normal trips. He felt that Epping Road was narrowed in order to maximise tunnel revenue.

The only change in behaviour that IN9 described was his speed. This was dictated by the limits on Epping Road. His origin, destination, mode, route and time of travel all stayed the same.

6.2.11 IN10

Interviewee 10 lived in Epping and at the time of her interview, worked in Manly, on Sydney's Northern Beaches (a daily trip of 35 km each way) (Figure 4.1). She travelled on Epping Road east from Epping to Lane Cove Road, but felt that the narrowing of Epping Road in Lane Cove had affected the western stretch of Epping Road as far as Epping. She used Lane Cove Road or Delhi Road to get to Manly, although she used Epping Road in

Lane Cove when she was driving home. It was her experience that taking a longer route saved time in overall because the problems were created by the junctions.

Changing the general traffic lanes to bus lanes changed her travel pattern and behaviour. She only travelled in the peak. She took a short cut through Macquarie University to get onto Lane Cove Road from the western end of Epping Road. For a while she gave a friend a lift.

She felt that each time a change was made to Epping Road, it became more difficult to get onto Epping Road. Before that, it was smooth sailing. It was congested but the traffic was not at such a standstill; it was moving – slowly, but still moving.

She did not use the Lane Cove Tunnel because she did not need to go to the city.

Her husband worked at Lane Cove Council. He used back roads to reach Lane Cove from Epping in order to avoid Epping Road. They would both decide on the day which route they would take.

6.3 Overview of interviewees' travel behaviour

6.3.1 Introduction

The following sections summarize aspects of interviewees' travel behaviour which have already been discussed in the preceding sections. There is an initial summary of interviewees' travel behaviour changes in Table 6.1.

6.3.2 Route

By definition, all the interviewees had driven PMVs along Epping Road, since that was the basis for participation in the study. That is, their original routes included Epping Road and they continued to use it after it was narrowed. They may have used other roads at either stage. One interviewee (IN6) reported that he had increased his use of Epping Road after it was narrowed. Mowbray Road West is an alternative route to the north. Burns Bay Road is an alternative to Epping Road through the southern parts of Lane Cove. Route choice is discussed in s.6.11.2.

Table 6.1 Interviewees' reported travel behaviour changes after narrowing of Epping Road

Theme	Flexible	Initial change	Additional later change	Did not change	Not clear (when/ whether)
Route	IN2, IN3, IN4, IN7, IN8, IN10	IN5, IN8		IN1	IN6, IN9
Mode	IN6, IN7	IN4, IN5	IN4, IN6	IN1, IN2, IN3, IN9, IN10	IN8
Time of travel	IN6	IN4, IN1		IN9, IN2, IN7	IN3, IN5, IN8, IN10
Origin and/or destination			IN4, IN7	IN1, IN3, IN5, IN6, IN8, IN9, IN10	IN2
Manner of driving		IN3, IN8, IN2		IN1, IN6, IN7, IN9, IN10	

6.3.3 Mode

By definition, all the interviewees were motorists (both before and after Epping Road was narrowed), since that was the basis for participation in the study. However, some used other modes as well. This included buses (both public and those provided by their employer), train, ferry, car pool, bicycle and motorcycle. None of the interviewees mentioned walking as a potential means of transport, although two e-mail respondents did. Using the car as a passenger is another alternative mode that would be possible in the context of Epping Road, although it was only described as being used by a friend of one interviewee. The friend had been forced to give up driving because of ill-health and was only able to continue using cars as a passenger. Examples of alternate modes are given in s.6.12.2. Reasons given for using particular modes are given in s.6.12.3. The latter include:

- disability making it difficult to use a particular mode;
- flexibility required in accessing destinations;
- lack of experience with alternate modes;
- lack of car parking at the destination;
- freedom from the stress of driving;
- health benefits;
- need for predictability in journey time; and
- lack of practicable alternatives.

Several interviewees went to some lengths to drive themselves but acknowledged that circumstances might arise that would require them to use the bus. Section 6.12.4 gives examples of interviewees' experience of modes other than the car.

6.3.4 Time of travel

Time of travel varied. Trips mentioned during the interviews involved travel during the peak hours, off-peak and weekends. Weekend and off-peak travel on Epping Road was usually described as acceptable, but interviewees described how they changed their departure time in an attempt to avoid traffic during their commuting trips. This usually involved leaving home earlier. One local organization moved its meeting time to later in the morning to allow its members to avoid the morning peak hour traffic. One interviewee was able to arrange to work from home for part of the week, which enabled her to avoid driving. Another interviewee cycled in order to ensure consistency in travel time.

6.3.5 Manner of driving

In s.6.15.1, manner of driving is defined (for this study) as the use of road space, speed, smoothness of driving and use of on-carriageway facilities.

Clearly, interviewees could not use facilities (such as bus lanes) which did not exist prior to the narrowing. In general, though not in all cases, interviewees' descriptions of the way they drove was an unfavourable comparison between how they were able to drive before and after Epping Road was narrowed.

6.3.6 Origins and destinations

There were few changes in interviewees' origins and destinations, that is, where they:

- lived;
- had paid employment;
- shopped; or
- socialized.

Few interviewees gave any indication that changing origins or destinations was an option for them. One notable exception was the interviewee who moved from Double Bay (east of Lane Cove) to the house she owned in the Hills district, in north-west Sydney. Some interviewees had considered the possibility of changing paid employment in order to avoid the traffic that they encountered on Epping Road. Several interviewees described changing their choice of shopping centre.

In most cases, the trips that the interviewees described had origins or destinations in northern or north-western areas of Sydney. Only one trip required the interviewee to cross Sydney Harbour.

6.4 Results of the interviews

6.4.1 Introduction

Although the interviews undertaken in order to provide data for this study were designed to be semi-structured (see Chapter 5) and thus were approached with certain questions in mind, the interviewees also brought up subjects that concerned them with respect to Epping Road. These did not necessarily relate strictly to the narrowing of Epping Road in Lane Cove and any consequent changes in interviewees' behaviour. Two major examples of this are the traffic situation on Epping Road west of the Lane Cove River, in North Ryde and places further west, and the Lane Cove Tunnel. However, as interviewees' experiences were all gained within the context of the existence of these facilities or situations, their comments are included here.

In this chapter, 'themes' are defined as the broad subject areas that more than one interviewee wished to discuss or had an opinion on. These are the areas that concerned them (but are not necessarily related to behaviour). Within these themes are particular topics that the interviewees were concerned about or differentiated in their minds. The topics can be quite detailed (e.g. extra short approach lanes at intersections) or general (e.g. environmental benefits of the narrowing of Epping Road). A summary of the themes and topics extracted from the transcripts is provided in Table 6.2. The headings of 'what', 'where', 'when', 'why', 'who' and 'how' have been used for some themes in order to provide some structure to the discussion of the points raised by interviewees. Sometimes only a few of the headings may be relevant or several headings may be subsumed into one.

Extracts from e-mail and telephone respondents' comments and social media have been included to support (or contrast with) interviewees' comments where relevant. However, as it was not possible to discuss those responses in the same depth (if at all) with their originators as it was possible to discuss their comments with the interviewees, these extra comments have not been used as the basis for extracting themes. Thus, non-interviewees' comments have only been used to expand on interviewees' comments, rather than as findings in their own right. As a result, some topics which were not mentioned by interviewees have not been included in the discussion (e.g. politicians' responsibility for the current situation on Epping Road).

It is also worth noting that three of the social forums considered here (the *Sydney Morning Herald* (SMH) forums on the Lane Cove Tunnel and the National Roads and Motorists Association (NRMA) forum on the Epping Road cycleway [*sic*]) were set up before the Lane Cove Tunnel scheme was complete. Therefore, contributors to those forums did not have the benefit of experience of a complete working scheme from which to form their attitudes. Interviewees are speaking from experience, as are the contributors to the Australian Cycling Forum.

6.4.2 Themes discussed

The subjects from the discussions that were of concern to more than one interviewee fell into three main areas:

- the Epping Road corridor;
- affective reactions to the changes; and
- behaviour.

Respondents were concerned with the design of the Epping Road corridor, the facilities that were provided for each mode, and the resultant advantages and disadvantages.

They also discussed the changes (if any) in their behaviour that the new corridor had caused. Finally, they discussed how they felt about the changes and who or what they considered responsible for those changes.

Eleven main themes emerged from an analysis of approximately eight hours of interview recordings. They cover the following areas:

- Lane Cove Tunnel;
- design of reconfigured Epping Road;
- traffic on Epping Road;
- benefits of changes to Epping Road;
- responsibilities;
- affective reactions;
- route;
- mode;
- time of travel;
- origin or destination; and
- manner of driving.

Each theme is discussed below, using illustrative quotations.

Table 6.2 Themes of interest to respondents

Theme	Topic 1	Topic 2	Topic 3	Topic 4	Topic 5	Topic 6
Lane Cove Tunnel	how it came about	Lane Cove Tunnel is useful	Lane Cove Tunnel is a rip off, designed to benefit private concerns (e.g. politicians' friends)	Lane Cove Tunnel is just to extract money from motorists	Epping Road changes designed to funnel motorists into tunnel	tunnel not used on principle
Design of reconfigured road	narrowing of Epping Road (what): pro and anti	bus lanes (what): for and against; transit lanes better	bus interchange (what)	cycle lanes (what) for and against	traffic lights (what)	understood extra lanes at junctions (what): yes and no
Traffic	What traffic was like at first: (when)/but current increase	differences since tunnel – good/no change/worse/OK ->bad		volume of users – cycle lanes/bus lanes	Epping Road in Lane Cove affects Epping Road further west (where)	
Benefits of changes to Epping Road	benefits remarked on? (I) environmental	benefits remarked on? (II) bus lanes/SUP	benefits remarked on? (III) reinstated turns; easier to cross or enter	for whom? did not notice any/ more pollution/ motorists	removal of traffic: trucks/other modes/ (freed up space for motorists)	
Responsibilities	responsible for what? traffic, tolls, lost business opportunities	who bears the responsibility? RTA, politicians, private enterprise, the road itself, other developments	how were they responsible? (I) (I) by being stupid /not listening /providing for other modes	how were they responsible? (II) by allowing building development /development on the M2	how were they responsible? (III) poor design of Epping Road	flow-on effects
Affective reactions	well disposed	mixed feelings	frustration/stress	anger, road rage	moral aspect	attitude to Epping Road corridor

Table 6.2 Themes of interest to respondents (continued)

Theme	Topic 1	Topic 2	Topic 3	Topic 4	Topic 5	Topic 6
Route	moved to alternative routes (where)	five ways to generate routes (how)	when/where the decision on alternate routes is made			
Mode	other modes used or desired (what)	used car because: public transport inadequate (why)(I)	other reasons for use of car (why) (II)	reasons for use of alternative modes (why) (III)	when did they start using the modes? (when)	on which particular occasions did they use a particular mode? (when)
	complaints about users of other modes: (who) cyclists/pedestrians /motorists/heavy vehicles	cyclists' empathy with motorists/ incredulity at others refusing to cycle (who)				
Time	had to change routine (why) (I)	importance of timing (when) (I) hour of the day/day of week	travelling at the peak hour: (when) (II) can avoid	travelling at the peak hour: (when) (III) cannot avoid it	speed or consistent travel time: (why) (II)	
Origin/ destination	viability of destination	viability of origin	relevance of the Lane Cove Tunnel			
Manner of driving	changes to style of driving	changes due to new layout/moving about in lanes	speed of travel			

6.5 Lane Cove Tunnel

6.5.1 Introduction

Whatever their attitude towards it, no respondent was unaffected by the opening of the Lane Cove Tunnel. It was mentioned by all of the interviewees for this study.

> *Life changed when the Lane Cove Tunnel opened. (IN8)*

The Lane Cove Tunnel scheme was divisive. It attracted some very strong opposition although, equally, there were people who were in favour of it and who used it. Opinions expressed by the e-mail respondents and in social forums tended to be the most negative. Dislike of the tunnel tended to occupy more of their thoughts with respect to the whole Lane Cove Tunnel scheme than interviewees.

Even people not directly affected by the physical changes on Epping Road had an opinion about the tunnel:

> *Even though he is hardly affected by it, he resents the narrowing of Epping Road, regarding it as a cynical attempt to 'encourage' through traffic to use the tunnel so as to maximise tunnel revenue. Living where he does he cannot use the tunnel even if he wants to, and, having on rare occasions experienced the congestion on Epping Road in peak times, he knows he would be very unhappy about the narrowing if he had to use the road regularly in those busy times. (IN9)*

6.5.2 Opposition to the Lane Cove Tunnel

To a great extent, opposition to the Lane Cove Tunnel fell into one or more of three categories:

- some saw it as a scam, designed to **benefit private concerns** in general, or the friends of the politicians associated with it, in particular:

*I consider it sinful what they [*sic*] Department of Main Roads [*sic*] has done for the benefit of the Toll Operators (I assume) to the absolute and utter detriment of the users and accordingly, those who actually pay. (IN1)*

What I really object to is the fact that Epping Road has been both narrowed, and had its speed limit reduced from 80 km/h to 60, in order to 'force' motorists into the privately owned tunnel. (EM5)

Let's funnel all traffic down a public private partnership where the politicians involved will get $600,000/year jobs with private infrastructure firms as a result. (SMH 2006, Peter Payne)

- others considered it more generally, as **a way to extract money from motorists**, sometimes emphasizing the fact the motorists had to pay to use the road, whereas previously they had travelled for free:

"... the removal of two lanes on Epping Road. I know why it's been done, it's all about money ..." (IN8)

I avoid all Toll roads at all times. I avoid Epping Road unless I am going to Delhi Rd or Mowbray Rd. .... It is all about penalising and revenue raising not at all about transportation and getting people to work. (EM14)

I am totally opposed to any restriction on Epping Road – a public asset, which should not be downgraded in its usefulness to its owners – the public, just to boost the profits of owners of an asset that should have been financed out of public borrowing AND the huge taxes motorists already pay (SMH 2006, Eric Courtney)

- from a slightly different perspective, some respondents viewed **the narrowing of Epping Road as a way of forcing motorists into the tunnel**, rather than directly as a means of extracting money:

*I assume that the disruptive and time consuming nature of Epping Road is to ensure that as many as [*sic*] people as possible use the Lane Cove Tunnel with its exorbitant toll. (IN1)*

Epping Road rework was cobbled together with the sole intent of channelling a maximum of traffic via the Lane Cove Tunnel. (EM6)

*Stop being conned, the cycleway [*sic*] is just an excuse to funnel cars into the tunnel. (NRMA 2008, Judy)*

- None of the interviewees **refused to use the tunnel on principle**, unlike several of the e-mail respondents:

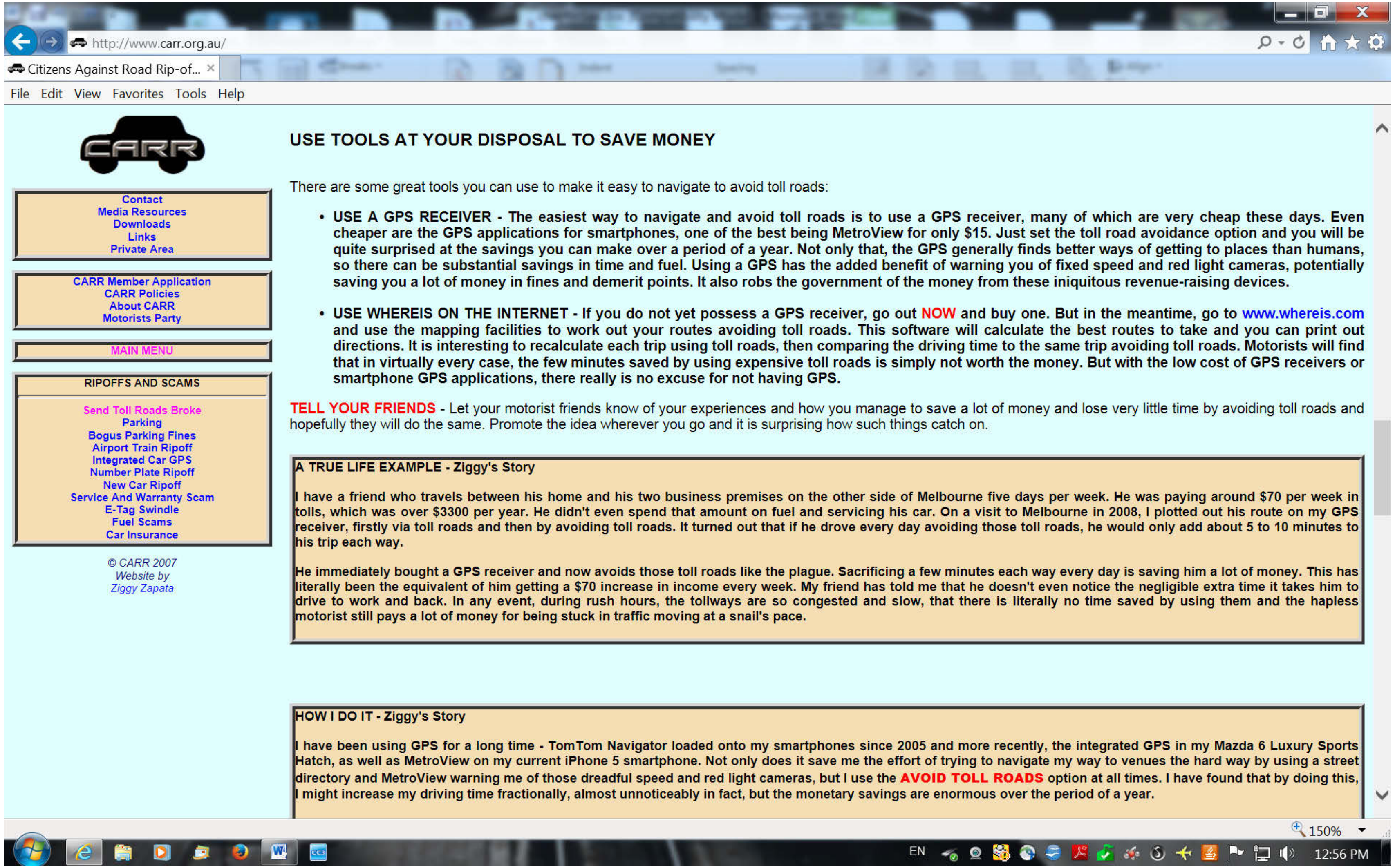
I live in East Ryde and continue (for my convenience) to use this route – but NOT use the tunnel (EM3)

*I never use the tunnel on principal [*sic*] (except in the rare instance when I might be running late and break this rule)... (EM5)*

This attitude pre-dated the opening of the tunnel:

*I will not use the Lane Cove tunnel [*sic*] if they close any lanes on Epping Rd. (SMH 2006, dave)*

Through his website, one individual advocates using electronic devices to plot a trip to avoid toll roads (Zapata 2012) (Figure 6.1).



http://www.carr.org.au/

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Website by
Ziggy Zapata

USE TOOLS AT YOUR DISPOSAL TO SAVE MONEY

There are some great tools you can use to make it easy to navigate to avoid toll roads:

- **USE A GPS RECEIVER - The easiest way to navigate and avoid toll roads is to use a GPS receiver, many of which are very cheap these days. Even cheaper are the GPS applications for smartphones, one of the best being MetroView for only $15. Just set the toll road avoidance option and you will be quite surprised at the savings you can make over a period of a year. Not only that, the GPS generally finds better ways of getting to places than humans, so there can be substantial savings in time and fuel. Using a GPS has the added benefit of warning you of fixed speed and red light cameras, potentially saving you a lot of money in fines and demerit points. It also robs the government of the money from these iniquitous revenue-raising devices.**
- **USE WHEREIS ON THE INTERNET - If you do not yet possess a GPS receiver, go out NOW and buy one. But in the meantime, go to www.whereis.com and use the mapping facilities to work out your routes avoiding toll roads. This software will calculate the best routes to take and you can print out directions. It is interesting to recalculate each trip using toll roads, then comparing the driving time to the same trip avoiding toll roads. Motorists will find that in virtually every case, the few minutes saved by using expensive toll roads is simply not worth the money. But with the low cost of GPS receivers or smartphone GPS applications, there really is no excuse for not having GPS.**

TELL YOUR FRIENDS - Let your motorist friends know of your experiences and how you manage to save a lot of money and lose very little time by avoiding toll roads and hopefully they will do the same. Promote the idea wherever you go and it is surprising how such things catch on.

A TRUE LIFE EXAMPLE - Ziggy's Story

I have a friend who travels between his home and his two business premises on the other side of Melbourne five days per week. He was paying around $70 per week in tolls, which was over $3300 per year. He didn't even spend that amount on fuel and servicing his car. On a visit to Melbourne in 2008, I plotted out his route on my GPS receiver, firstly via toll roads and then by avoiding toll roads. It turned out that if he drove every day avoiding those toll roads, he would only add about 5 to 10 minutes to his trip each way.

He immediately bought a GPS receiver and now avoids those toll roads like the plague. Sacrificing a few minutes each way every day is saving him a lot of money. This has literally been the equivalent of him getting a $70 increase in income every week. My friend has told me that he doesn't even notice the negligible extra time it takes him to drive to work and back. In any event, during rush hours, the tollways are so congested and slow, that there is literally no time saved by using them and the hapless motorist still pays a lot of money for being stuck in traffic moving at a snail's pace.

HOW I DO IT - Ziggy's Story

I have been using GPS for a long time - TomTom Navigator loaded onto my smartphones since 2005 and more recently, the integrated GPS in my Mazda 6 Luxury Sports Hatch, as well as MetroView on my current iPhone 5 smartphone. Not only does it save me the effort of trying to navigate my way to venues the hard way by using a street directory and MetroView warning me of those dreadful speed and red light cameras, but I use the AVOID TOLL ROADS option at all times. I have found that by doing this, I might increase my driving time fractionally, almost unnoticeably in fact, but the monetary savings are enormous over the period of a year.

150%

EN 12:56 PM

Figure 6.1 Advice on the use of electronics to avoid toll roads, from the CARR website (22/2/2014)

6.5.3 Support for the Lane Cove Tunnel

There was a group of people who were **in favour of the tunnel** and the changes that had been made to Epping Road. Some of their reactions are described in later sections of this chapter. One interviewee and one e-mail respondent, who were members of the Lane Cove Tunnel Action Group, had been campaigning for the tunnel for decades:

> *"I, wasted, ... unbelievable amount of time on this, ... eighteen years or something, right?" (IN5)*

> *... I had a 22 year involvement with traffic and road planning issues around Epping Rd. (EM9)*

They appreciated that it was necessary to involve private enterprise because there was not enough public money to build all the infrastructure desired:

> *"... it was the community; we built or pay for the government to buy, ... infrastructure, everybody benefits. .... But Thatcher and that sort of thing, ... the policy changed and these PP – these private public enterprise things came in, because people weren't prepared to actually .... be a community, put in to build infrastructure, so it had to become private .... infrastructure .... and so .... the only way, you're going to get private infrastructure .... is for those people are going to get some money from it: user pays; so they had to put a toll on it." (IN5)*

> *I realise that there is an articulate group of people who believe they should be able to drive anywhere and that they should never pay a toll to do so. (EM9)*

Some respondents noted the **benefits** the scheme had brought:

> *"If I can use it, if I can deviate to use a .... toll or a tunnel, ... I will go for it because .... I don't like driving through urban roads, they're much more dangerous, ... it reduces stress, it reduces danger ..." (IN5)*

"I got a friend who runs a semi-trailer[12] with a crane .... And he's running a truck, it's a very, very expensive business .... And I forget what he told me he spends $3,000 a month on tolls or something. .... Now, he's running a business .... he loves it because it saves him $3,000. I mean, for him to avoid them, ... in the end, this place operates so much more efficiently for paying two, three bucks, ... extra ..." (IN5)

The tunnel works well if you need to go to the city. (EM1)

When I drive, I use tollroads whenever I need to. They have their reasons to be there. We cannot fix overnight 30-40 years of underfunding in basic infrastructure – Roads & Public transport. (NRMA 2008, Yves)

or was expected to bring:

The tunnel lanes will have no traffic lights, effectively doubling the capacity. I'll be paying for no lights thanks. (SMH 2006, LCT GO)

6.6 Design of reconfigured Epping Road

6.6.1 Introduction

Certain features of the 'new' Epping Road received a lot of attention from the interviewees particularly the narrowing itself and provision for other modes. The traffic signals and the extra lanes at intersections also received attention.

6.6.2 Narrowing of Epping Road

As might be expected, the reduction in the number of lanes on Epping Road in Lane Cove was remarked upon. It had supporters or, at least, people who had come to terms with the new arrangements:

[12] Semi-trailers: type of heavy goods vehicles

"I must admit, when it was first done I thought this was the absolutely most ridiculous thing, but it's not as slow as I thought it would be." (IN2)

I think the change in the arrangements on Epping Road is great and if I had to make a complaint it would be that the whole process should have happened earlier. Or that the planning process could have avoided such a huge and expensive widening of Epping Road in the 90s. (EM17)

*As a resident of Lane Cove, I'm all for reducing the width of Epping Road. Before the tunnel, Epping Road was a complete nightmare, with wall-to-wall traffic. One of the promises of the tunnel for local residents was that it would remove much of the through-traffic from Epping road [*sic*]. That's only going to happen if the existing road is narrowed.*

Hey, some of us have to live in the suburb. How would you like a six-lane carpark next to your place? (NRMA 2008, Suzy Jackson)

It also had opponents. The opposition was often phrased in terms of the problems that narrowing Epping Road created and what should have been done instead. These are discussed in later sections of this chapter.

One interviewee felt the narrowed Epping Road was part of a wider phenomenon of narrow roads:

"... got to the point where I wanted to actually leave New South Wales altogether because of the roads here. Because when you go to Queensland or Melbourne, they have four lanes everywhere. And they've got like probably a third of the population in Melb- in, in Brisbane or something, or even a quarter, and yet they have four lane highways." (IN4)

Only a few people wanted Epping Road to revert to the same form that it had before the Lane Cove Tunnel.

*Epping Road should have been left with 3 lanes each way, with the Tunnel lanes INCREASING the no. of lanes to accommodate [*sic*] additional traffic. (EM3)*

Leave Epping Road as is (SMH 2006, JD)

6.6.3 Bus facilities

The facilities provided for buses and bus passengers along the narrowed Epping Road which received comment included bus lanes and a bus interchange, which allowed buses to pull off the road. Pedestrian overpasses and bus shelters received no comment. The lack of attention may be because of their lack of relevance to motorists.

Bus lanes

The bus lanes were accepted by most of the respondents:

... I can certainly appreciate that it is beneficial to have bus lanes. ... (IN1)

It's also good to have the dedicated bus lanes It's because of them that most buses go above ground and come close to where I am so it's usually only a short wait for a bus to the city. (EM17)

One wanted more (although note that some of the requested bus lanes do exist):

*This was a once in a lifetime opportunity to build an unobstructed bus coridor [*sic*] from Sydney's north west to the city. Where's the bus lanes on the M2 (east of Beecroft Rd), Epping Road and Gore Hill Fwy?*

Bus lanes would secure an efficient transport corridor for today and the future. Instead there's extra lanes which will be quickly filled to capacity with more and more cars. (SMH 2007, Iain)

Only one respondent objected unequivocally to the bus lanes:

If it were in my power, I would restore Epping Road to what it was and eliminate the bus lane also. (EM8)

Some would have preferred the bus lanes to be available to all motorists outside the peak hours, or at least be transit lanes:

"I'm wondering why they can't say to us, out of peak hour, ... for these particular times, you can use the bus lanes." (IN3)

Ideally, the bus lane is a T2 lane[13] *so That will take HALF the car[s] off the road ... (EM16)*

The use of the bus lane as a T2 lane has merit (NRMA 2008, David McIlveen)

The bus lanes are open to motorcyclists:

"The motorbike .... was very convenient and it was fun, so .... that's why I took that and it saved so much time, ... 10 to 15 minutes over the car. .... plus I could use .... the transit and .... bus lanes on Epping Road, ..." (IN6)

However, not everyone was aware of this:

"... you can't even put your motorbike in the bus lane ..." (IN4)

Bus interchange

A bus lay-by was built immediately north-east of the Epping Road/Longueville Road/Parklands Avenue intersection, adjacent to a bus lane:

"The Lane Cove Bus interchange has improved the frequency of buses and one doesn't have to stand up all the way now which used to be the case before. That is good even if they had to demolish the

[13] T2 (transit) lane – lane restricted to vehicles with two or more occupants

house on the corner to build it." (IN8)

No such special provision for buses was made on the opposite (southern) side of the road. Thus buses stopping here on their way west remain in the general traffic stream. Several respondents felt that this was a flaw in the redesign of the road:

*"... when the buses stop in front of .... just where Longueville Road, just where .... the Lane Cove Council is, the traffic banks up on the ramp .... So that bus lane [*sic*] is causing congestion, for all the traffic up to .... the ramp, up to Pacific Highway ..." (IN10)*

The RTA .... a much publicised and boasted about "Bus Interchange" at the junction of Epping Road and Longueville Road. Regrettably the achievement remains only 50% effective. A definite improvement was obtained for buses going east but no gain at all was made on buses going west. Every single westward bus stops at the LC [Lane Cove] Council Chambers bus-stop and in so doing blocks all access to Lane Cove. When a number back-up, as they do all day, they make access to the left turn lane impossible or dangerous, and encourage frustrated motorists to use a through traffic lane followed by an even more dangerous lane change in front of the buses [to turn left] into Longueville Road. (EM11)

6.6.4 Cycle facilities

Facilities for cyclists included cycle lanes or a SUP. Cyclists were also allowed to use the bus lanes. Several respondents explained how the SUP in the 'new' Epping Road had improved the situation for cyclists:

"... Well, it wasn't wide enough for cars and bikes ..." (IN7)

The shared user path allows cyclists to travel between North Ryde and Lane Cove and it is now much easier to commute to and from the city. Prior to the road space conversion it was simply too dangerous to cross the Lane Cove River on Epping Road on a bicycle. (EM2)

> *But if the current cycleway [*sic*] will deliver a safe cycle route from Lane Cove to Macquarie Uni[versity], my only comment is, why wasn't it there 25 years ago when I could have used it? Then I had no option but to use my car since no way would I ride on Epping Rd, even in the 70s or 80s. (NRMA 2008, Grant)*

There was less acceptance from motorists of the cycle lanes/SUP compared with the bus lanes:

> *... I cannot see how it is beneficial to the movement of traffic to have a full road width for the use of bicycles. ... (IN1)*

> *I think the cycleway [*sic*] is a waste at the price indicated [$7.5 million] and for the number of cyclists who use it.[14] [25, before it was opened] (NRMA 2008, David McIlveen)*

Some cyclists felt they could understand why. Mikebytes wrote:

> *And no wonder motorists are pissed off, there's hardly any room for motor traffic.*

fobfob (Australian Cycling Forums 2008) responded:

> *Yeah but the cycling path is hardly the main culprit. For much of the stretch, the cycle path has practically been "reclaimed" from gardens, pedestrian path, bush etc. OK there are also a few on road sections, but look at how the rest of the space is "used": luxurious median strips, double turning lanes (coming off a single line of through traffic), expensive and lavish gardens with sandstone borders, bus lanes, and absurdly wide pedestrian paths on both sides.*

[14] A survey conducted for the NRMA found an average of 25 cyclists a day using the SUP. See s.A.3.1.

6.6.5 Traffic signals

On a busy road such as Epping Road, with many intersections, traffic signals are used to ensure that the vehicles in each arm of the intersection are given an opportunity to pass through the intersection.

> *"But the thing is, the frustration of Epping Road is all the traffic lights, you know, with too much traffic in between each set of lights." (IN4)*

> *At first I found sitting at the traffic lights very frustrating but have got used to that now, and they are a necessary evil. (EM1)*

The green times associated with each set of signals along Epping Road were not specified in the Lane Cove Tunnel Environmental Impact Statement (SKM 2001). They were adjusted as necessary. Some motorists found this frustrating:

> *"Now the first issue for me was those Parkland/Longueville intersection lights, given, I understood why the light was only letting three cars through before priority had to be given to the traffic coming into the city along Epping Road from suburbs further west. But now that we were going to have this tunnel they were doing all this other work, therefore, we had every right to expect, as residents of north Lane Cove, that we would now have better access and egress - getting in and out of Lane Cove north. .... And for a moment, maybe a couple of months, six cars were getting through on a green light – a great result .... But then it was changed back again. .... It's just that if you waited for twenty minutes or something, you know, it really is frustrating." (IN8)*

6.6.6 Extra lanes at intersections

At the major intersections along Epping Road in Lane Cove, extra lanes were provided on each side of the intersection in order to maximize the number of vehicles which could cross the intersection when they had the green light. The function of these extra lanes was not always understood:

> *I cannot believe that it is considered that the continual lane mergers and re-opening of lanes can be beneficial to a main Sydney transport route. .... Apart from the time it takes it is more the anger of the users that is most concerning due to the continual mergers and re-openings and delays. (IN1)*

> *The other problem I have noticed is in Lane Cove just before Centennial Avenue, where the road goes from 1 lane to two, but then on the other side of Centennial it goes back to one again and there is always a bank up there. (EM1)*

> *The insane sudden merging of lanes is dangerous and serves no purpose. (NRMA 2008, Jools)*

However, those who did understand them were able to put their understanding to good use:

> *" ... Centennial Avenue. It's the same thing; two lanes that go into one. So I go, and the right one is the correct one, the left one is the blending lane, ... but I stick in the left one cause there's always less [sic] people in it and you can always blend in." (IN2)*

6.7 Traffic

6.7.1 Introduction

Respondents were concerned with the volume of traffic, both motorized and cycling. They were also concerned with the effects of the changes to Epping Road in Lane Cove on other roads, particularly Epping Road further west in North Ryde and Epping.

6.7.2 Initial effects

Some interviewees remembered confusion and congestion **after lanes were closed** in order to build the bus lanes and the SUP:

"That caused, that was a lot of congestion." (IN7)

This did not last:

"Once .... the bus lanes .... all changed, that was, ... a day or two, maybe, but that was much, much better .... the first couple of days, people didn't know what was happening ..." (IN5)

6.7.3 Volume of private motor vehicles and congestion

In the longer term, opinion was mixed on the amount of congestion on Epping Road. Some respondents were **pleased with the effect of the tunnel and narrowing** on traffic for traffic along Epping Road, both for **private motorists**:

"... definitively mostly positive, yes .... I don't think of something negative. .... the hard part is actually remembering what it was like. .... there's a lot of people who complained .... and .... it would be interesting to know what other reactions are, but .... it was just a nightmare .... anything, ... would have to be better." (IN5)

*Driving times seem better. There is still traffic but the constant peak hour gridlock that existed prior to the Tunnel is less seldom [*sic*] seen. (EM2)*

and **buses**:

"The other thing I do do, what it has done, it's actually the buses are so much better .... it was impossible, ... you may as well have driven in, ... as, catch the bus. .... But now, if at all I can possibly catch a bus, ... I just walk up to Cox's Lane into the city, it's magic!" (IN5)

I often take the bus into the city from the Lane Cove interchange and I find the system is reliable and on time. (EM2)

For the interviewee who tried to **avoid the peak hours**, the amount of traffic did not seem to have changed much:

> *"Congestion. .... I've found it's always been busy, on all of Epping Road, ... I don't think it's ever been different." (IN2)*

Some respondents felt that the traffic situation has become worse since the narrowing of Epping Road. This was blamed on the physical layout of Epping Road, as well as the amount of traffic:

> *"So that's why, previously, before all these changes had happened, it was smooth sailing, I used to just .... go up to travel from Epping to Delhi Road .... with virtually very few, just the red lights, ... the traffic was moving very smoothly, but ever since .... they have reduced the number of lanes, ... I've noticed that the travel, ... time has increased because that, during congestion period it's bumper to bumper traffic at peak time." (IN10)*

> *I have not found the traffic to have decreased since the bus lanes and lane cove tunnel [*sic*] have been implemented and I feel that losing that lane was the worst thing to have done. (EM10)*

While the Lane Cove Tunnel scheme had been devised because it was considered that Epping Road was beyond capacity (SKM 2001), some felt that Epping Road had **worked well** before the tunnel was constructed and that the changes had caused the situation to deteriorate:

> *If I could find the most appropriate words to express my disgust as to what they have done to one of the most efficient and best roads in Sydney it would probably be unprintable. (IN1)*

All very well being warm and cuddly about such environmentally pleasing issues but the warm and cuddlies were sucked in by the hard-nosed pollies and suits who were intent on strangling a proven efficient artery into the city despite there being no rail alternative. (EM6)

6.7.4 Volume of other modes

A survey undertaken for this doctoral study found over 130 cyclists using the cycle facilities in the a.m. peak (see Appendix A). However, motorists did not always appreciate the **number of cyclists** using these facilities:

"... cycle lanes .... rarely used by anyone during peak hours ..." (IN10)

*One lane effectively was taken for a 2-way cycle way [*sic*]. Did anyone commission a survey prior to build? Very doubtful as usage is pathetically poor. (Anyone since done a survey and published data?). (EM6)*

Interestingly, one e-mail respondent felt the same way about the **buses**, but the interviewees were enthusiastic about the **frequency of buses**:

What I have noticed is that the bus lanes hardly ever have a bus in them, even at peak hours when I travel to work in Lane Cove. (EM1)

"But now, if at all I can possibly catch a bus, ... I just walk up to Cox's Lane into the city, it's magic! .... They come ten, fifteen minutes ..." (IN5)

6.7.5 Flow-on effects

Some respondents felt that the changes on Epping Road in Lane Cove affected other roads. **Epping Road west of Lane Cove** (i.e. in North Ryde and Epping) was the road most commonly mentioned:

"All these events, particularly from .... the opening of Lane Cove Tunnel, actually affected my travel pattern because the fallback effect starts from Epping itself ..." (IN10)

We live at Carlingford and work in Macquarie Park.

Our home is only 7 km away.

It used to take us from 5:30pm - 6pm to reach home picking up the kids in the middle.

*Now, it took [*sic*] us from 5:20 pm – 6 pm to reach home on the same routine.*

At midnight with no car[s], I can go the same distance in 10 mins sharp. (EM16)

Others noticed changes on Mowbray Road West:

"Mowbray Road is increasingly getting heavy with traffic as well, now ..." (IN8)

Once the tunnel opened and Epping Rd traffic flow was reduced to one lane, there was a notable increase of trucks .... Gradually we have noticed more frequent use from cars as well. (EM18)

6.8 Benefits from changes to Epping Road

6.8.1 Benefits

The Lane Cove Tunnel brought both benefits and disbenefits to the users of Epping Road in Lane Cove. The disbenefits, including perceived congestion and restrictions on the ability to move around the road, are discussed elsewhere. The **benefits from the changes to Epping Road** which were mentioned by respondents included:

- the **environmental benefits** of less air and noise pollution:

  "... it personally was .... the reduction in traffic, the reduction in noise, ... the air quality improved, ... it was much easier to get on to Epping Road ..." (IN5)

... I have new sound reducing perspex windows as well as the glass windows to reduce the traffic noise from Epping Road. As you can imagine, any traffic noise reduction from Epping Road is good for me. (EM17)

*As a resident of Lane Cove, I'm all for reducing the width of Epping Road. Before the tunnel, Epping Road was a complete nightmare, with wall-to-wall traffic. One of the promises of the tunnel for local residents was that it would remove much of the through-traffic from Epping road [*sic*]. That's only going to happen if the existing road is narrowed.*

Hey, some of us have to live in the suburb. How would you like a six-lane carpark next to your place? (NRMA 2008, Suzy Jackson)

- the provision of **bus lanes**

"I'm all for the bus lane that was created there, absolutely. It's great, I go into the city on the bus and it's just beaut, you know." (IN8)

It's also good to have the dedicated bus lanes. It's because of them that most buses go above ground and come close to where I am so it's usually only a short wait for a bus to the city. (EM17)

- the provision of a **shared use path** for cyclists and pedestrians

"... yeah it was much easier to go Mowbray Road and then down Centennial, ... on a bike and then they built, opened up that lane so now they have that straight through .... yeah I crossed the road, get onto the lane, ... use the bike lane all the way into Lane Cove. Then just come off it. Far more convenient and quicker and more reliable." (IN7)

The shared user path allows cyclists to travel between North Ryde and Lane Cove and it is now much easier to commute to and from the city. Prior to the road space conversion it was *simply too dangerous to cross the Lane Cove River on Epping Road on a bicycle. .... On weekends the cyclepath [sic] also provides a safe recreational facility for families to ride. (EM2)*

Motorists got their two traffic-light free lanes under Lane Cove, bus commuters now have a good run into the city (leave the car behind) and cyclists get some decent facilities.

Good for all. (NRMA 2008, Greg Au)

- the **reinstatement of two right turns** (from Epping Road into Centennial Avenue, when heading west and from Epping Road into Parklands Avenue heading west)

He is aware that the Centennial Avenue intersection now permits right turns from Epping Road when travelling west but usually forgets it on the rare occasions when he could use it so he doesn't take advantage of that change! (IN9)

... there is now a right hand turn from Epping Road onto Parklands for motorists travelling west. (IN8)

These benefits include: .... Reinstatement of right turns that give local people ready access to their homes; ... (EM9)

- enhanced ability to enter or cross intersections on Epping Road

*"... we would expect as residents of Lane Cove, to have better access and egress and, and getting in and out. .... now what they did do out of Epping Road, they've given a left hand turn arrow to people going to the city, which is good out from Parklands onto Epping [*sic*] ..." (IN8)*

"... Cox's Lane is an interesting intersection. .... Cause you turn left. Because when .... you pull out, you stop, obviously, the corner there .... then you have the .... cycle lanes .... and ....

because you give way to cyclists .... you have to check that the cycle lanes. Then you've got to, then the bus lanes .... you got to make sure you give way to buses .... and then you've got to actually negotiate getting out into the traffic. .... that was a bit interesting to start, but, it works." (IN5)

Overall I think the road space conversion has been a great success on many fronts. It is easier to cross Epping Road now (by car, bike or walking) which gives those in Lane Cove North greater access to the rest of the community. (EM2)

One telephone respondent to the newspaper publicity reported that the redesigned Centennial Avenue/Epping Road intersection cut 20 minutes off her trip from the southern section of Centennial Avenue to Chatswood. She was not the only one:

*... the changes in Epping rd [*sic*] (ie the bus lane etc) have certainly impacted on my journey to and from work. .... Before the changes to Epping Rd I could wait two or three light changes at the Epping Rd intersection before getting across and indeed the traffic on Epping rd [*sic*] was often banked up across the intersection blocking our access. It was often the slowest part of my journey to Burwood. Since the changes my run is now MUCH smoother. I get straight across both morning and evening in one change of lights and the intersection is very rarely blocked. This is also true of my home journey any time from 5-6.30 pm. ...(EM7)*

6.8.2 Beneficiaries

The changes brought about by, and made in conjunction with, the construction of the Lane Cove Tunnel benefited different groups in different ways. Those who lived in the vicinity of Epping Road experienced certain environmental benefits, including less air and noise pollution, as described earlier in this section. However:

- the benefits **did not necessarily accrue to everybody in Lane Cove**. The Lane Cove residents who did not live close to Epping Road did not necessarily see any environmental benefit:

> *Essentially, he lives far enough away from Epping Road not to feel any flow-on effects from the narrowing. He lives too far away to feel any environmental benefit (noise, air pollution). (IN9)*
>
> *She hasn't noticed a change in air pollution because of the tunnel. (IN8)*

- **none of the respondents who lived further away (e.g. the Hills district), mentioned environmental benefits** from the scheme (although some interviewees felt that the changes that resulted from the narrowing of Epping Road led to more pollution from motor vehicles):

> *"... And then I look across to the right, and there are two bicycle riders and twenty thousand cars. .... And that infuriates me. I don't mind, you know if we put the whole damn road into bikes. That's fine. .... Make a decision. But don't do what they've done, because the amount of pollution we're creating by just idling and messing around there ..." (IN3)*

- some people felt that the changes had **improved the situation for motorists**:

> *"... for me it has made driving, ... easier; I wouldn't say I don't drive unless I have to. .... if I can possibly use public transport I will and it's meant I .... can use public transport more than I used to, so, ... I guess in the long run .... it actually means I do less driving, but .... I spend less time, ... idling in traffic, which is a good thing, and .... wasting fuel and .... it's got to be, from my point of view, ... it's a benefit." (IN5)*

*Driving times seem better. There is still traffic but the constant peak hour gridlock that existed prior to the Tunnel is less seldom [*sic*] seen. (EM2)*

I live in Lane Cove, and I for one am glad that we have the tunnel, to free up Epping Road for local residents. The bus lane and new bus interchange should help as well. (SMH 2006, Sarah)

6.8.3 Benefit mechanism

Benefits could accrue in several ways. Environmental benefits came about because of the reduction in the number of motor vehicles. Although some motorists felt that traffic was worse after Epping Road was narrowed than it had been before (s.6.4), one interviewee noted that it could have been worse:

"... if you didn't have these toll roads, ... and they didn't spend the money and no money was spent on upgrading and building freeways and tunnels, ... you might not get payment of [tolls] but you'd be sitting behind whole lot of trucks grinding along and you would be much more unhappy than you are now. .... I'm coming off being a truckie[15], I should clarify that." (IN5)

In fact, by removing buses from the main flow of traffic, capacity has been freed up for private motorists:

"... but it's not as slow as I thought it would be - I think because the fact that they do have the bus lane which also include taxis, motorbikes, I think, vans, hire cars ..." (IN2)

Most importantly, the introduction of 24 hour bus lanes has been a major improvement both to public transport and to the flow of private vehicles on Epping Road. According to the STA [State Transit Authority: bus operator], the bus lanes cut around twelve minutes from the peak hour trip along that

[15] Truckie: truck driver

part of the corridor. Shorter travel time attracts people to public transport which further increases the capacity of the corridor. (EM9)

6.9 Responsibilities

6.9.1 Introduction

Most respondents to this study were concerned with aspects of Epping Road or the Lane Cove Tunnel which made them unhappy in some way. Many of these considerations have been discussed in previous sections. They include:

- the amount of traffic (increased traffic on Epping Road or lack of traffic on bus lanes or cycle facilities);
- design features of the Epping Road corridor;
- tolls; and
- changes to behaviour brought about by the changes in the traffic situation.

A minority of respondents were satisfied with all or some of the changes (in particular, changes which had made travel easier for them), as described previously.

6.9.2 Responsible bodies

The bodies to which respondents apportioned responsibility for problems or enhancements included:

- state government (including state government agencies, such as the RTA (Roads and Traffic Authority, now Roads and Maritime Services));
- local authorities;
- private enterprise;
- Epping Road itself;

- the Lane Cove Tunnel; and
- other developments.

In only one case did an interviewee take responsibility for his own situation:

> *"I guess .... I'd much rather go down the main road – like Epping Road! <laughter> than use the back streets." (IN3)*

6.9.3 Mechanisms of responsibility

Many of the problems that respondents perceived have been discussed in other sections. This section looks in particular at how the organizations and infrastructure can be held responsible for the perceived faults.

Government bodies were considered to be responsible in many ways. The RTA, as the state government agency responsible for Lane Cove Tunnel scheme, came in for particular criticism:

> *"... the RTA were ... despots, they manipulated, ... they did unbelievably underhanded things because ... somebody, somewhere had decided, ... we don't want these things because of, for whatever reason and they were just adamant there wouldn't ... ." (IN5)*

> *Typical RTA signage inconsistency, eastbound Reserve Road exit not mentioned at all until you are right at the Pacific Highway exit, causing last second lane changing. (SMH 2007, Mark Elrick)*

One respondent was particularly scathing:

> *... RTA .... they will remain the most criminally stupid Government body in the western world. (EM11)*

One fault was perceived poor design:

He feels that the bus interchange on the southern side of Longueville Road should have been made at least partially off-road, as was done on the northern side. That would have relieved the severe congestion that occurs between the Pacific Highway and the Longueville Road//Epping Road junction. (IN9)

"Monorail would have been smarter .... down Epping Road. .... So really, it wasn't thought out well. Particularly those people who can't get any public transport find it infuriating." (IN3)

Existing developments (or allowing new developments) which generated traffic were felt to cause problems:

"I do generally think it is getting busier, ... however, I can't .... pinpoint that to being the Lane Cove Tunnel, ... it could just be .... there's more people going to work, ... and this business area picking up as well ..." (IN6)

Mowbray Road is increasingly getting heavy with traffic as well, now, because they're building all these new apartment buildings over there. And there is the school zone, but even so, it is actually better than Epping Road. (IN8)

*I have been travelling 18kms to work every morning and it takes me ¾ hr on a good day and 1 hr on some days even when there is no apparent reason for this, no accidents, breakdowns, etc. It is just the volume of traffic. The number of high rise developments approved in the Ryde Municipality and surrounds will increase the volume of traffic even further e.g. Rhodes, Meadowbank, Mobbs Lane Carlingford, Shaftesbury [*sic*] Rd Eastwood (the old brick pit not high rose [*sic*] but dense development). (EM14)*

At the time of interviews, the M2 was being upgraded and some interviewees recognized that this caused problems on Epping Road:

"... it's getting worse, simply because the M2 is being upgraded **....** *and people just refuse to pay $17 from out at Liverpool where they come from,* **....** *to come along the M2 and just sit there for hours." (IN3)*

Epping Road was 'blamed' for some surprising things:

"So that was my justification of the little sports car. <laughter> I blamed Epping Road. <laughter> How's that, eh?" (IN3)

Some of the problems which arose from the narrowing of Epping Road were consequences of traffic congestion, facilities for other modes or diversion of traffic. These included:

- losing staff because they were not happy with having to deal with traffic:

  "So I've already lost three, over .... parking and .... time on the road and all this related stuff, because .... the people I employ .... are all designers. And designers are not like normal, hum-drum people. Yeah, because they're more creative .... and they tend to be more impacted by things, ... like, emotionally impacted or creatively impacted by dramas in their day, ... whereas people who are more .... process based or more technical seem to take it better in their stride. I know the IT group now, they don't give a shit, they just don't turn up. They turn up when they want to, they turn up at midday or something instead. .... But they don't get upset ..." (IN4)

- reduced business opportunities because traffic has been diverted to the Lane Cove Tunnel:

  "... it's a big service station too, ... three cars or something like that for .... each one of those bays, it's something like five or six bays. .... when I went down the other evening, there ....

were two cars there, Macdonalds wasn't open, there was only one Indian guy on the counter, and the food section they used to have was closed as well. .... it's looking a bit like a ghost town to me. .... I've got that feeling too that .... they must be missing out on a lot of business .... it's got to do with the Epping upgrade .... Because you .... just didn't have to use the road then .... any longer. Because before that tunnel was made, trips from the city would go through Lane Cove and go through all those sets of lights .... and it was just easy to pull in ..." (IN4)

- loss of income because of parking being unavailable:

My mother-in-law has lived at the above address since the early 1970's. .... up until the narrowing of Epping Road, we could park outside her property .... the RTA went ahead with placing a bicycle lane instead. .... Due to so much bureaucracy I was unable to meet the June 2011 deadline so the car parking platform has not been constructed. .... The rent my mother-in-law receives has been drastically reduced due to lack of parking outside No. [...] (EM12)

- bad behaviour on the part of motorists:

Road rage is a very negative thing to create and I consider that Epping Road causes a huge negative mind set of aggressive driving. (IN1)

Some felt that problems could have been prevented if there had been better consultation:

" I can't understand why the government did not ask us what would be the better way to do this." (IN3)

6.10 Affective reactions

6.10.1 Introduction

It may be seen from respondents' comments that there were some strong feelings about Epping Road and the Lane Cove Tunnel among those expressing opinions on the subject. Some people were, overall, well disposed towards the changes that had been made:

> *"... mostly, definitely, definitely mostly positive, yes .... I don't think of something negative." (IN5)*

> *In general, I'm not too displeased by the traffic flow on Epping Road since the Lane Cove Tunnel went in. (EM5)*

One telephone caller said it had:

> *"... improved her life ..." (TP2).*

Some respondents could see both good and bad aspects:

> *"I'm all for the bus lane that was created there, absolutely. It's great, I go into the city on the bus and it's just beaut, you know. .... So, it's not the fact that they put a bus lane in, it's the fact that there were previously six lanes of traffic – three each way on Epping Road." (IN8)*

Nevertheless, there were certain aspects of the scheme which recurred as objects of respondents' criticisms. Some of these criticisms have been highlighted in previous sections. Other problems include the frustrations of driving along Epping Road and the anger that can be aroused when doing so. Some felt so strongly about the changes that they ascribed a moral aspect to them.

6.10.2 Frustration

Several respondents mentioned aspects of the operation of Epping Road that caused frustration. The operation of traffic signals came in for particular note, either because they existed, or because the way that priorities were organized:

> *"... the frustration of Epping Road is all the traffic lights, you know, with too much traffic in between each set of lights. " (IN4)*

> *"Now the first issue for me was those Parkland/Longueville intersection lights, given, I understood why the light was only letting three cars through before priority had to be given to the traffic coming into the city along Epping Road from suburbs further west. But now that we were going to have this tunnel they were doing all this other work, therefore, we had every right to expect, as residents of north Lane Cove, that we would now have better access and egress - getting in and out of Lane Cove north. .... And for a moment, maybe a couple of months, six cars were getting through on a green light – a great result .... But then it was changed back again. .... It's just that if you waited for twenty minutes or something, you know, it really is frustrating." (IN8)*

> *At first I found sitting at the traffic lights very frustrating but have got used to that now, and they are a necessary evil. (EM1)*

However, motorists who were no longer able to drive in their accustomed way, also experienced frustration:

> *"... that's so frustrating, for that person, on the phone or stuffing around .... or doing something silly – they're holding me up. They're taking my time and it's valuable ..." (IN3)*

Some people were better able than others to contain their frustration:

"... the one lane part .... I suppose is not that long; it's just a bit frustrating, I think, ... if I did it every day in the peak hour, I'd probably have a completely different <pause> .... attitude about it, but I might only do it once or twice a week, in the middle of the day." (IN2)

Closely related is stress. One interviewee felt that authorities were deliberately increasing stress on motorists:

"... and what they've done with Epping Road is that they've put enormous stress on us ..." (IN3)

Some interviewees were able to handle this better than others:

"No, I'm not, getting stressed at that, you know, ... I don't let it." (IN2)

6.10.3 Anger

For some people, the feeling was stronger than merely frustration:

"... I'm furious at what they've done with Epping Road." (IN3)

I certainly maintain a rage over this and refuse to use the tunnel myself preferring to go the long way around. (EM13)

I am furious yet my only outlet for my ï¿½ROAD RAGEï¿½ can be at the ballot box, very unsatisfying. (SMH 2006, Andrew)

This could even come out in their driving:

... I consider that Epping Road causes a huge negative mind set of aggressive driving. (IN1)

6.10.4 Morality

Some people saw a moral aspect to the reduction in road capacity of Epping Road:

*I consider it sinful what they [*sic*] Department of Main Roads [*sic*] has done for the benefit of the Toll Operators (I assume) to the absolute and utter detriment of the users and accordingly, those who actually pay. (IN1)*

I feel very strongly that it was wrong to reduce the road capacity on Epping Rd., - in order to 'force' us to use the Tunnel! In these days of increasing numbers of cars, to reduce the no. of lanes available to traffic is almost immoral. Epping Rd should have been left with 3 lanes each way, with the Tunnel lanes INCREASING the no. of lanes to accommodate additional traffic. (EM3)

*The closure of lanes on Epping Highway [*sic*] is a total obscenity. The Government is spending millions of dollars of taxpayers money to close lanes on a public road to force motorists into an overpriced private tunnel. There should be no bus lane and no cycleway unless it is continued to the City. .... (NRMA 2008, Richard (Banner))*

6.10.5 General attitude

It was clear that in some cases it was general attitude, rather than necessarily individual circumstances, that dictated people's feelings towards the Epping Road corridor.

"... people who complain about paying the toll .... I've actually got no sympathy for them. .... Basically, ... this is the system we've got." (IN5)

To this day, I have refused to use that tunnel but only because my choice has been virtually taken away. If somehow a developer could have been found to build the tunnel, while leaving Epping Road as it was, I would now be using the tunnel. (EM8)

6.11 Route

6.11.1 Introduction

The route chosen for a trip is of fundamental importance. It is connected to the choice of mode and temporal aspects of travel. The wrong route can make a trip longer than it might otherwise be; it may present barriers to the accomplishment of the journey, whereas a good route can speed a journey. Epping Road is important because it is a main road and therefore, by definition, used by many people as part of their everyday route.

6.11.2 Route choice

The narrowing of Epping Road **affected some people's choice of route**. Some used the road less:

> *Before the Lane Cove Tunnel she did the journey to work, shopping and social trips (at the weekend) using Epping Road. It used to be Epping Road all the way towards Ryde [*sic*]; now it's Mowbray Road West getting onto Epping Road where it widens to two and then four lanes. She's still going to the Macquarie Centre and to visit her girlfriend but she's changed her route. (IN8)*

> *I avoid Epping Road unless I'm going to Delhi Road or Mowbray Road. (EM14)*

> *I live at Eastwood now, near Epping road [*sic*] but now drive to Artarmon to work via Hunters Hill, it's quicker than the short route down Epping road [*sic*] and I drive home via Mowbray road [*sic*]. (NRMA 2008, Ian)*

However, one interviewee used it more often:

> *"... if I could have avoided it .... I would have avoided it before. Now I will use Epping Road." (IN5)*

Other effects on route choice are discussed in s.6.5, the Lane Cove Tunnel.

6.11.3 Devising a route

Interviewees described **five methods for devising routes**, either their own or ways in which they felt other motorists devised routes.

1. People who did not know the area would be likely to remain on a main road (in this case, Epping Road):

   "... if they're on their route to a corporate park and that's the only route they know,... then they're just going to sit in traffic and add to the problem." (IN4)

   *Signage is largley [*sic*] for people who haven't got used to the road... (SMH 2007, Mark Elrick)*

2. Some motorists had a palette of options for their journey. They knew several alternate routes which they could use to reach their destination:

   As a result of not liking to sit in traffic, she knows a lot of back ways. (IN8)

   "I'd rather do the back routes .... to get onto the road." (IN7)

   The one they chose depended on factors such as time of day, facilities en-route or amount of traffic:

   "And if I was to go there,... and on the day it was ... peak time and there was traffic,... you can actually go up, I think it's Mowbray Road, this one ... there's a back entrance to the place. I have been there a couple of times during the... work day but I would not go in the morning unless I really had to. Like, had traffic have been backed up, that's the ... path I would have taken." (IN6)

   "... No, no, it's just quicker, ... once I went to my motorcycle I found that I could take advantage of the bus and the transit lanes. .... that sped up my trip a bit." (IN6)

   "If it looks as though it's really busy, I can go along Mowbray Road ..." (IN2)

3. For the section of the flow which consisted of motorists who are prepared to use an alternative route at some stage of their journey (and who therefore are likely to have a good knowledge of the surrounding area) the presence of congestion or an incident such as a road traffic accident is a signal to take note of their surroundings and actively seek out an alternative route:

   "...the moment I get up into that, ... Lane Cove, you know where they split off, ... where the, ... Lane Cove Council is, ... where the Cameraygul Bridge is? .... That's banked all the way back, literally to Reserve Road. .... And I'm stuck. So what I do is I see that, and I go into the tunnel." (IN3)

   "As I come down towards Mowbray Road [from the west] I think 'Will I turn left at Mowbray or will I go straight ahead?' But, six of one and half a dozen of the other. But if the traffic's banked back, I would go Mowbray Road." (IN2)

   Epping Road is so congested in the evening that I have to turn off and take the back streets home. (EM10)

   Route switching is considered in more detail in the next chapter.

4. Desperation could result in people trying any route to bypass congestion:

   ... I got to a point where ... every morning I was trying a different short cut to see if I could get around the block ... cause I know the roads really well, ... like, it's being a country girl, I go by myself, sense of direction, ... I'll look for the direction, look where the sun is and go "OK, head this way, head that way and do this" or just start following cars that look like they're going fast and look like they know what they're doing ... then finding that they are actually going somewhere relevant. Yeah. Just getting a sense for that. I always do things like that. (IN4)

5. None of the interviewees questioned about it felt that GPS (satellite navigation systems) was relevant to them, although television and radio reports were found to be helpful:

> *"I won't use it [GPS] - it's crap. It doesn't work right." (IN4)*

> *"I have a television in my room here ... when it gets to time the news is on, ... it comes on,... there's a traffic report every 15 minutes on this particular channel ... it tells you, ... we're hovering over so-and-so. Forget it, you ain't going to make it home for two hours, etc." (IN3)*

> *"Yes, I can use River Road. Sometimes I go through Artarmon, yeah. .... Sometimes. When there're accidents and stuff like that and they warn me on the radio then I go through Gladesville." (IN3)*

(It should be noted that further sources of traffic information have become available since the interviews were undertaken (e.g. Google Maps: Figure 1.8).)

6.11.4 Timing of route decisions

- For those motorists who do have a set of alternate routes to choose from, the **decision as to which one to take** may be taken when (or where) the journey starts:

> *"[interviewee's husband will] decide on the day. It's the same with me. I ... decide on the day, at the time, whether I take off Epping Road,... to Lane Cove Road or I just go straight to Delhi Road.... And sometimes ... I decide, OK, today I'll take Delhi Road, ..." (IN10)*

- Alternatively, as described above, it may be taken on a junction by junction basis, as problems arise. Sometimes the necessity for diverting arises part way along a link:

> *"... when we turned right into Epping Road finally it was just chockas[16] and then I noticed that people were using the bus lane and that they'd said they had some little, I think it said you could use, I forget what the words were, but use the bus lane .... so people were using the bus lane, cause otherwise nothing was moving, you see." (IN2)*

In the longer term, a route may be tried or abandoned as the choice of origin or destination changes. This is described further in s.6.14.

All the interviewees had control over their choice of route. However, in some cases, such as buses and some company drivers, the **routes are determined in advance** by third parties:

> *"I got a friend who runs a semi-trailer with a crane, right? .... And he's running a truck, it's a very, very expensive business .... And I forget what he told me he spends $3,000 a month on tolls or something. .... Now, he's running a business .... He does, he loves it because it saves him $3,000. I mean, for him to avoid them, ... I mean, ... in the end, this place operates so much more efficiently for paying two, three bucks, ... extra, ..." (IN5)*

6.12 Mode

6.12.1 Introduction

A substantial part of each conversation was concerned with mode. This included those that the interviewee used and the facilities provided for the various modes. The behaviour of other motorists or cyclists was also mentioned. None of the interviewees commented on the behaviour of bus users.

[16] chock-a-block

Pedestrians' behaviour was only mentioned by the interviewees who cycled, although it was considered by several of the e-mail respondents. As the interviewees previously referred to discussed pedestrians' behaviour which affected cyclists, it is possible that motorists do not mention either pedestrians or bus passengers because they have no direct interactions with them (although the evidence of the survey of cyclists and pedestrians on the SUP on Epping Road (see Appendix A) suggests that few motorists will see a cyclist on the road either). One respondent to a social forum noted that the SUP was for pedestrians as well as cyclists.

It should be noted that although interviewees sometimes augmented their modal possibilities by using the bus or bicycle for some trips, none of them gave any indication that they had ever contemplated the possibility of not driving at all.

Given the extent to which discussion of mode permeated the conversations, some aspects will be discussed in this section and some in other sections of this chapter.

6.12.2 Modes used in addition to cars

By definition, all those interviewed were motorists. However, only one appeared to confine herself to a car as a means of transport. All the others spoke of **modes they used in addition to the car**:

> *"... I am back to the car and bus and bicycle now. .... I sold my motorbike in June this year [2011] ..." (IN6)*

Interviewees were not the only users of Epping Road who used several different modes:

> *It is easier to cross Epping Road now (by car, bike or walking) .... Driving times seem better. .... I often take the bus into the city from the Lane Cove interchange ... (EM2)*

*Anyone know the progress of the bike path construction? I saw it the other day when I was driving last week .... I wanna [*sic*] try it on my commute to work tomorrow if its [*sic*] open. (ACF 2008, Shandog)*

Some had tried a variety of different modes, before they found suitable ones:

"... I tried the bus, tried lift share .... tried driving myself, ... and the bike. So I think I tried four different ways. .... I even tried .... Bus into the city, got onto the free bus and came out, and I took twice as long, so I won't do that again. .... So yeah, it was probably the fifth .... option I tried. ..." (IN7)

Circumstances had led some interviewees to expand their range of modal options:

"... I've learnt more about buses since I retired cause I've been to the city a few time in buses .... cause you don't park in the city. So .... I'll use a bus to go into the city, ... or I get the train, from Artarmon, yes. .... There's nowhere to park in the city, anyway. ..." (IN2)

One stated that he would use public transport if it was available:

"If there was a bus and it came here, definitely." (IN3)

6.12.3 Reasons for choice of modes

The interviewees gave a variety of reasons for either using the modes they did, or for not using public transport. Two of the interviewees did use bicycles. However, none of the other interviewees explained why they did not cycle and none of the interviewees mentioned walking.

Some of the reasons given for using a car included:

- disability making the use of public transport difficult:

"... I moved to the bus .... And that became impractical because I fell off a roof and I broke my foot and .... I couldn't use public transport ..." (IN4)

- the need to arrive looking presentable and be on time for meetings:

  "... after looking at the times and .... saying to myself "OK, um, you know, what happens if you break down, what happens if you get a flat, do you have a repair kit um, can you sort of take a little bit of your business attire with you" .... as you go and things like that and once I figured out that was all OK .... I said OK, I can try it .... a few times a week, like I didn't take it every single day...if there's a .... really important meeting .... I'll take .... the bus, ... early, or I'll take the car ..." (IN6)

- the distance of the origin from a public transport service:

  "... those of us who don't have access to the buses from home .... and other places .... we are disadvantaged." (IN3)

  (One interviewee overcame a similar problem by driving to the bus stop and parking nearby:

  "I have walked before but it took about 35 minutes so, ... I now just .... drive to the closest position .... there's .... homes and things .... a few streets away, so I just go park there. ..." (IN6))

- carrying bulky objects:

  "... Shops, I use the car because I'm carrying, having to bring stuff back with me and can't fit it on my bike. ..." (IN7)

- speed (out of the peak hour):

"... the weekend is when I use the car, it's usually out of the peak and it's convenient and I can do what I need to do in a lot quicker time .... by using the car ..." (IN7)

- inadequacies of public transport:

  Either public transport did not run to the desired location (or if it did, infrequently), there had been delays or several changes were required to reach the destination :

  "... unfortunately, the bus service from there is very infrequent after, I think, 3 or 4 o'clock. It's .... on the hour and if for whatever reason it'll miss an hour and then you'll be sitting there for two hours. You can walk that distance in an hour. ..." (IN7)

  "... I don't use public transport much, I must admit, ... except to go into the city. Cause to get to my daughter's at Turramurra I'd have to walk to the station, get a train to Turramurra, then a bus from Turramurra to her place, ..." (IN2)

  Other sources also commented on the inadequacies of public transport:

  I have tried public transport but this has not worked out well. I have been late for work or it has taken me twice as long as trains have been cancelled. (EM10)

  For those who might say, "catch a bus", well I'd love to, but Sydney Buses doesn't provide. This year they cut services between the [Lane Cove] business park and Chatswood from six peak hour buses to just one (with no off-peak services). (SMH 2006, Cazza)

However, other modes had advantages:

- some people found using public transport less stressful than driving themselves, since it was not necessary to concentrate on the driving task or worry about tolls:

"... so I enjoy the fact that .... I can just sit on the bus, do whatever I want, I don't have to worry about .... paying attention to all the other cars on the road, drive around them, ... you've got your bus fare versus fuel, tolls, ... I don't see the tolls anymore,.... it's peace of mind I guess..." (IN6)

- other interviewees used public transport when parking at the destination was not easy:

  "... If I'm going to see the kids play the sports and it's close by, I'll definitely take the bike cause parking's an issue on Saturday morning. ..." (IN7)

- one related a story of a friend who had been forced to give up driving because of ill health and relied on lifts from others:

  "I've got a friend that's got Alzheimer's and she's just been told to stop driving. .... She can't drive anymore .... But her friends have been driving. Now she's had to go into a home, but we were driving around and taking her to things. .... she thought it was the end of the world, not being able to drive. She could understand that still; she could understand why, but she still hated it, you know? .... "I'm driving alright, I've never had an accident" and she'd get there, but she'd park her car at Macquarie and then forget where she'd parked it. .... she got locked in at Macquarie one night cause she couldn't find the car and walked home. And so they had to go out .... the next day and go and get her car and get it through security ... " (IN2)

- only three spoke of using bicycles or motorcycles:

  "... because I have commitments, I'm picking up kids at certain times, six o'clock and I have to be home by a certain time, I can guarantee that time on my bike. .... I cannot guarantee that time in the car .... in any way, shape or form. .... It's as simple as that. .... Other than the fitness aspects and it's much more enjoyable on a bike .... Et cetera. But the most important is the commitments that I have to meet .... I can't do that in the car ..." (IN7)

"... once I went to my motorcycle I found that I could take advantage of the bus and the transit lanes. .... that sped up my trip a bit..." (IN6)

The **narrowing of Epping Road** did prompt some people to try other modes:

"... for a while I tried the bus .... I went back to driving again. Then I was sort of carpooling with another girl and so the two of us had something at least to talk about and bitch about while we were waiting and waiting for our light. You know, ... up to two hours sometimes in traffic when .... those road closures all happened on Epping Road .... then .... I got a motorbike ..." (IN4)

However, for most it was the **provision for their chosen mode** which prompted a change, rather than the other way around:

"... actually the buses are so much better .... the buses; it was impossible, ... you may as well have driven in .... as, catch the bus. .... But now, if at all I can possibly catch a bus, ... I just walk up to Cox's Lane into the city, it's magic!" (IN5)

Regarding switching to cycling because of reduced road capacity on Epping Road, I'm pretty sure all who did switch switched because of the increased cycling capacity (i.e., the creation of the shared user path) and not because of reduced road capacity. (EM2)

The number of cyclists just waiting for this path to be completed is huge and we are expecting a surge of cyclists in this area. (NRMA 2008, Mark Pountley)

6.12.4 Amount of experience of other modes

- Some interviewees had used non-car modes **before Epping Road was narrowed** and were continuing to use the travel skills they already had:

"... I used to work at North Sydney and I always drove to Artarmon station and parked and got the train .... to North Sydney ..." (IN2)

One of the interviewees who cycled to work had started doing so before the SUP beside the narrowed Epping Road was constructed:

> *"... I started before the cycleway. .... and it was .... not the safest thing, so I would actually go down .... Mowbray Road .... to where it joins, where the river is .... let me put it this way, the bicycle path is built in bits, so the bit from the bottom of the river up was built .... but from there into Lane Cove it wasn't. So I would then use the paths, the footpaths or go Mowbray Road to .... to Centennial .... through the back ..." (IN7)*

6.12.5 Selection of mode

For those interviewees who were flexible, their choice of mode might be chosen to suit the circumstances:

> *"... buses .... are no use to me going that way unfortunately .... but going to the city, ... that's much, much better." (IN5)*

> *"I take the car or .... I just sort of take whatever [is] appropriate .... if there's a .... really important meeting .... I'll take .... the bus, ... early, or I'll take the car ..." (IN6)*

6.12.6 Other users

Interviewees also had opinions on other road users.

- one interviewee was concerned by some of the **motorists** she witnessed:

  > *... she is shocked by some dangerous drivers she observes. She feels everyone is in a hurry; more is demanded of people and they react accordingly. (IN8)*

- the two interviewees who cycled as well as driving had concerns about the relationship between cyclists and other users.

One of the cyclists was quite critical of his fellow-cyclists:

> *"Oh, I hate cyclists. .... I detest them, ... they make my blood boil when I see them all over the road, taking up lanes." (IN7)*

They empathized with motorists over the possibility of the two modes conflicting:

> *"... you don't want to be in anyone's way, ... being a driver and a cyclist I know that the drivers do get annoyed with a bicycle in the way, so I try.... my best to just stay out of their way whenever I can." (IN6)*

Nevertheless, they had difficulty in understanding why other people would not cycle, given its advantages:

> *"One of the ladies lives opposite the school, like myself and .... she works at Optus, the same, and we travel the same distance every day and she refuses to cycle, so I see her, because we pick up our kids from the same place and I'm in my cycling gear and she's in her work kit and I say "Why aren't you cycling?" "Oh, no, I couldn't cycle" and I get to work before her, and she says "Oh, the traffic was terrible," and .... I'm showering and back to my desk already and she walks in ten minutes later .... . So she knows, and .... she just said "No, it's not an option for me". ..." (IN7)*

- only the cyclist interviewees mentioned pedestrians and that was in the context of their relationship to cycling:

> *"I'd rather be zipping between pedestrians even though they don't like it ..." (IN7)*

Other sources were more objective:

A single line of PMVs (personal motor vehicles) is much easier for foot-travellers to cross. (EM4)

*And by the way, the Epping road [*sic*] path is for pedestrians too. (NRMA 2008, John)*

- Several respondents considered that **heavy goods vehicles** caused problems:

"... all the big transport, all the big trucks, semis, all that kind of stuff, Tuesdays, Wednesdays and Thursdays and Friday afternoons and .... they contribute to a huge amount of crap that happens on M2 – Epping Road." (IN4)

6.13 Time

6.13.1 Introduction

Time was a theme that recurred in the interviews. It is of importance because the temporal aspect is one of the fundamental attributes of a trip – both the duration of a trip and the time at which the trip is made. Anything which increases the duration of a trip is likely to be unwelcome. Anything which causes the starting time of a trip to be changed may create problems for the traveller.

6.13.2 Time of travel

Some respondents felt that the changes on Epping Road had led to them having to change the timing of their own routines:

It is impossible for me to get to work within a reasonable time if I leave after 7.30am and similarly impossible for me to reach my home within a reasonable time if I leave my work place at 5.30pm (or even after 5pm). My expected work hours are a minimum of 8.30am to 5.00pm. I now leave home no later than 7am each morning and attempt to leave work at 4.55pm to miss that dreadful intersection at Lane Cove Road and Epping Road (as a starter). (IN1)

I have worked in Chatswood for the last 4 years and since the tunnel and bus lanes, I have had to leave earlier so I can miss the bumper to bumper traffic heading down Epping Road. (EM10)

Interviewees were aware of the difference that the start time of their journey could make to the elapsed time of the trip:

"Now, if I miss my time window by twelve minutes, **....** *I'm blown out of the water at this end by at least twenty-five. .... My time must be spot-on." (IN3)*

In addition to time of day, the day of the week affected the amount of traffic on the road and hence congestion:

"... you know as soon as you go onto the road whether there's something going on or not. If there's, if you leave at the same time, roughly, you know that Monday's light <pause> in the morning, ... Friday is light in the morning, Friday is heavy in the afternoon, Wednesday is the worst, ... Tuesday and Thursday are nearly as bad as Wednesday .... and that all the public, all the big transport, all the big trucks, semis, all that kind of stuff, Tuesdays, Wednesdays and Thursdays and Friday afternoons and they .... contribute to a huge amount of crap that happens on M2 – Epping Road." (IN4)

6.13.3 Peak and off-peak travel

The respondents spoke of the difference between travelling in the peak hour and the off-peak.

Some did not usually need to travel on Epping Road during the peak periods:

... he does sometimes use Epping Road at the weekend and occasionally during the week but at off-peak times. However, the traffic at the weekends is not heavy enough to cause him to alter the way he drives: ... (IN9)

One mentioned specifically avoiding Epping Road during the peak:

> *"I wouldn't consider going that way, ... if I could go down that road,.... to meet a friend or something during, ... a peak period on a weekday, I would avoid Epping Road, ... because of just the traffic that would be going .... going down Epping Road .... and the fact that there is a bus lane, so you're restricted to only one lane .... for quite a long period of time" (IN6)*

One interviewee, who was a retiree, made a point of avoiding peak traffic if she could:

> *"... there again, as I said, I don't do it in the peak hour." (IN2)*

She felt that the problems caused by the narrowing of Epping Road were not as serious for her as they might be for people who needed to commute:

> *"But I think I'd be a lot more affected if I was a commuting driver. I think - retiring driver - Epping Road hasn't bothered me too much, put it that way." (IN2)*

Several of the groups to which this interviewee belonged had rearranged their activities so that members did not need to travel in the peak hours:

> *"I'm in North Ryde Probus and we meet at North Ryde RSL[17], which is in .... Pittwater Road, just off Epping Road .... and our meetings were 9.30 and they changed it to 10 because there was still bad traffic coming back along .... [and] .... sometimes on a Friday night, ... now, we've actually changed it now to lunch-time mostly, because we're all retired, but this group I'm in .... - we often go to the Ranch Hotel ..." (IN2)*

However, sometimes travelling in the peak hour was unavoidable:

[17] Returned & Services League

My expected work hours are a minimum of 8.30am to 5.00 pm. I now leave home no later than 7 am each morning and attempt to leave work at 4.55pm to miss that dreadful intersection at Lane Cove Road and Epping Road (as a starter). (IN1)

There is no choice [in travel time]. The elder needs to be at school only at 8:30 am; and wife's official office hour is till 5:30 pm. She has altered her hour to allow herself to leave at 5:10-5:15 and that is already the best we can do. The lucky thing is that we both work in the Macquarie Park.

So .... we have no choice. (EM16)

6.13.4 Elapsed time

Some people were primarily concerned with speed:

She likes the quickest possible time. (IN8)

However, it was also noted that elapsed time is not necessarily directly related to the distance travelled:

"... the number of kilometres that I travel is longer, but time taken to travel is shorter if I avoid Epping Road." (IN10)

One interviewee chose to use a bicycle primarily because of the consistency in elapsed time that it offered:

"... because I have commitments, I'm picking up kids at certain times, six o'clock and I have to be home by a certain time, I can guarantee that time on my bike. .... I cannot guarantee that time in the car .... in any way, shape or form. .... It's as simple as that." (IN7)

6.14 Origin and destination

6.14.1 Viability of origins and destinations

Some respondents talked about the potential or actual **viability of various locations as destinations or origins** for employment, shopping or personal business as a result of the changes in traffic that occurred after Epping Road was narrowed.

> *"... I was living at Double Bay, ... I've got a house in Baulkham Hills .... I moved back into the house, ... properly about eighteen months ago, [i.e. 2009].... but when .... I had to drive from Double Bay to here every day .... it's Epping Road the whole way and .... it's like, twenty minutes to get to maybe here if you leave at the right time in the morning, ... the masses of normal traffic's gone because they've got to be at work in time .... and then this part here, ... anywhere up to twenty minutes to get up here, turn around and come back, ... which is really essentially two or three blocks .... it's horrible,.... horrible." (IN4)*

> *"...I may as well get a job closer to home." (IN3)*

> *In addition, there is no way on earth I would consider using Macquarie Centre as a? shopping site for me due to the nature of Epping Road. (IN1)*

> *One change in behaviour for me is that I go to the city a bit more often because it's a little easier catching the bus there. (EM17)*

Interestingly, one contributor to a social forum felt that the narrowing of Epping Road would make Lane Cove a better place to live:

> *As a FORMER resident of Lane Cove, it was the constant traffic jam almost at my front door and the poor public transport into the city that contributed to my decision to leave the area four years ago.*

> *The changes to Epping Road should make things much better! (SMH 2006, Andrew)*

6.14.2 Relevance of Lane Cove Tunnel to trips

Several interviewees noted that because of where they lived, the Lane Cove Tunnel was essentially irrelevant to their trips. Accessing it would require them to go out of their way:

> *Living where he does he cannot use the tunnel even if he wants to (IN9)*

This also came out in the responses to the newspaper publicity received by the study:

> *... hasn't changed her behaviour, but the Lane Cove Tunnel was not convenient for her trips ... (TP1)*

and the social media comments:

> *... If i [*sic*] was working up near windsor [*sic*] i'd [*sic*] find the tunnel much more useful than i [*sic*] do working in the lane cove [*sic*] area ... (SMH 2006, Michael)*

6.15 Style of driving

6.15.1 Introduction

Style of driving refers to the way in which one motorist's behaviour differs from another's. This includes:

- use of road space (proximity to other motorists, lane changing behaviour, attitude to traffic signals, reactions to incidents (road traffic accidents, road rage));
- speed of travel;
- smoothness of driving; and
- use of the facilities provided along the route (e.g. merging lanes, bus lanes).

As certain aspects are discussed elsewhere in this chapter, only speed and use of road space will be discussed in this section.

Some interviewees felt that the changes to Epping Road had changed the way they drove:

The new Epping Road has changed her style of driving. (IN8)

"It created dramatic changes in my driving habits. .... and what they've done with Epping Road is that they've put enormous stress on us .... to change the way we do our normal travel .... and in fact, the way we drive is now different .... and it's becoming, a little bit more competitive now shall I say for the space in front of you." (IN3)

6.15.2 Changes due to the layout of Epping Road

One interviewee felt that his driving had changed because the new layout of Epping Road had put restrictions on his driving:

"[Previously] I could drive at my skill levels, ... at my timelines, etc .... and my interpretation of what is happening in front of me but now, I'm forced .... into a situation where I have to obey the fact that there's a bus lane and whoever's in front of you ..." (IN3)

In particular, because Epping Road had become one lane for long lengths, it was no longer possible to move in and out of traffic:

"... you can't overtake ..." (IN2)

"Well, before we had .... three lanes; we could do what we wanted. You see .... I could go up the inside lane, and do all sorts of things; get to work on time. Ah, if people were a little bit slow, we can get around them, but no longer. You're forced at the pace of the slowest person." (IN3)

6.15.3 Speed

Speed was a concern to the respondents, although speed limit changes were not a part of the original Lane Cove Tunnel scheme (SKM 2001).

The old Epping Road had three lanes. It was faster (80km speed limit) and she could move around on the road. (IN8)

What I really object to is the fact that Epping Road has been both narrowed, and had its speed limit reduced from 80 km/h to 60, in order to 'force' motorists into the privately owned tunnel. (EM5)

However, speed is not solely determined by speed limits. Delays, including those caused by motorists turning into side roads and traffic signals, can affect the overall journey speed. One of the interviewees found that the ability to use the bus lanes on Epping Road in Lane Cove when he was on his motorcycle, negated the advantage of the Lane Cove Tunnel as far as speed was concerned:

"I've been on a bike and .... coming back from .... North Sydney, ... me and my friend, ... who both have motorbikes, ... this wasn't during peak times, this would .... have been on a Sunday night, ... we didn't take the Lane Cove Tunnel because we didn't have E-tags and we just went up Epping Road .... and our friends took .... Lane Cove Tunnel in their car .... and they just kept going down the M2 .... and then at Delhi Road me and my friend, we got onto the M2 .... and at Baulkham Hills, ... we were about the same time so, ... because the ....bus lanes .... on Epping Road, so we, ... beat all the traffic ..." (IN6)

6.16 First research question

6.16.1 Introduction

In this study, the first research question asks how motorists' reactions to the narrowing of Epping Road, in terms of travel behaviour, relate to their existing travel habits. This section considers first the reactions of interviewees and then relates them to habits and life events. Life events are considered because they can be a way of breaking habits (s.3.3).

As this is a qualitative study, it is not possible, based on the data given, to suggest any percentage of travellers for whom a life event would cause a reassessment of travel behaviour or who might have a particular travel habit. It is likely that, for some motorists, several categories of changes would be applicable simultaneously.

6.16.2 Categories of reactions

The reactions of interviewees, in terms of their travel behaviour in the aftermath of the narrowing of Epping Road, can be divided into four categories:

1. no reaction;
2. reactions to the physical changes (in this case, narrowing) in the road;
3. reactions to changes to traffic that respondents feel have arisen as a result of the reduced road capacity; and
4. reactions to the other aspects of the scheme of which the reduction in road capacity is a part (in this case, the provision of facilities for buses, cyclists and pedestrians along Epping Road).

For example, one interviewee felt that he lived too far from Epping Road to be affected by the changes (s.6.2.10). Another noticed little change as she felt that Epping Road had always been congested (s.6.2.3).

In the second category, it can be seen that the narrowing of Epping Road, of itself, affected some motorists' style of driving because they were unable to move around on the road or overtake other vehicles in the manner to which they had been accustomed (ss.6.2.4 and 6.2.9).

Most of the interviewees' reactions were in response to the perceived change in the amount of traffic (or, in the case of travelling to the city, the amount of traffic they expected to encounter). A majority of interviewees perceived more traffic after the narrowing than before, although this was sometimes observed in the section of Epping Road west of Lane Cove (i.e. west of the Lane Cove River). However, one interviewee felt that there had been a decrease in the amount of traffic on Epping Road, which made it more likely that he would drive on Epping Road.

Some interviewees described their use of the facilities for other modes that were implemented as part of the scheme (i.e. more cycling and use of the bus (ss.6.2.6 and 6.2.9)).

6.16.3 Timing of reactions

Some reactions to the changes in Epping Road were immediate and some were delayed (s.3.3.3). For example, some interviewees started experimenting with different routes quite quickly (s.6.11.3) but IN4 did not move home for over a year. IN3 stated that he moved to a car that was cheaper to run because of the changes in Epping Road. However, it is likely to have taken some time for the extra running costs to become apparent. It would have been necessary for him to have had experience of how things had changed before he took action. By contrast, people who changed route may have been taking action immediately to avoid the extra traffic that they perceived on Epping Road.

The changes that happened quickly were those which were easiest to implement, such as changes in time of travel and route. They would have been implemented in order to avoid excessive traffic. The changes which happened later were not actions which had to be taken straight away. In some cases it was not practicable to make the changes that the interviewees felt were necessary or desirable immediately. IN5 clearly did not feel that it was practicable to use the buses until the bus lanes were opened, over five months after Epping Road was narrowed (s.6.12.3).

It should be noted that what is a small change for one person may be a significant change for another, depending on, amongst other things, their existing knowledge, skills and (where necessary) access to a vehicle – that is, their existing palette of options. An example is change of mode. Changing to a known mode may be merely a continuation of an existing practice for one person. For a person who is unfamiliar with that mode, and who has to learn how to use it, changing mode may be a significant step and therefore not likely to be undertaken while other, less onerous changes are possible (Mokhtarian *et al* 1997). TravelSmart and similar programmes are an attempt to enlarge travellers' palettes of options. This is considered further in Chapter 8.

6.16.4 Habits

In order to discuss interviewees' travel habits, it is first necessary to decide which of their travel behaviour could be classed as habitual. When discussing habits, it is necessary to distinguish between habits and their consequences (e.g. the habit of going to work on a weekday and then the planned behaviour of deciding which mode to use on a particular day. Holidays, sickness and strikes may interfere with this behaviour pattern). Verplanken and Aarts' (1999) definition (s.3.5.2), has four criteria that a behaviour must fulfil to be called a habit. The behaviour must:

1. be learned behaviour;
2. be an automatic reaction;
3. be cued; and

4. have a goal.

Each of these criteria will be considered in turn.

1. Learned behaviour

All the travel behaviours under discussion (see Table 6.1) are repeated (i.e. learned) behaviours and therefore fulfil the first of the four criteria of a habit.

2. Automatic reaction

'Automatic' is interpreted here as meaning without conscious deliberation. Interviewees' reported travel behaviour was sometimes automatic and sometimes not. The evidence for each type of behaviour is considered individually.

Route choice

It was clear from the descriptions interviewees gave of designing a route that some were ready to change routes whenever they felt the traffic was uncomfortably heavy, in contrast to other motorists, who appeared to accept congestion. In particular, some interviewees spoke of switching route whenever they felt that traffic on the original route was too great. When they had decided that they should change route, they considered which alternate route to take. Thus route switching behaviour had two elements:

- a mindset that allowed for the possibility of changing route en-route (habitual behaviour); and
- a deliberate choice of which route to take from that point onwards (potentially planned behaviour).

One interviewee (IN10) would choose her route at the start of the journey. Route switching and route changing behaviour is considered in greater detail in Chapter 7.

Mode

For some interviewees, choice of mode was conscious whereas some automatically used the car. Some people had one mode for most trips but another mode for particular trips (e.g. going into the city).

Time

Interviewees' descriptions suggest that after Epping Road was narrowed, time of travel was often consciously chosen, at least initially. However, one interviewee described her travel as always being done out of the peak, if possible, even before Epping Road was reduced in capacity.

Origin and destination

Origin and destination cover a wide range of locations, which vary in nature from places which may be changed easily (such as supermarkets) to locations which require a considerable investment in time, money and effort to change, such as housing and place of employment. Housing and paid employment are locations that will be automatic choices for origins or destinations of many trips. However, because of their unique nature, origins and destinations relating to housing and paid employment will not be considered here, even though they appear to fulfil the requirement of habitual behaviour to be an automatic choice of origin or destination.

Style of driving

Several interviewees mentioned that they were no longer able to move around on the road as they used to (ss.6.16.2 and 6.16.3). One interviewee spoke of the changes the narrowing of Epping Road had made to his driving habits (s.6.15.1). In this case, the desire to overtake or move around the road appeared to be automatic, the implication being that he would do it whenever he was driving. Clearly he could not do it on a suburban street with only one lane. However, that situation was unlikely to have the same amount of traffic, so such behaviour would be unnecessary. He spoke of watching the car five ahead, with the implication that he would only need to do it if there was a lot of traffic around.

3. Cues

The cue for much of the behaviour described was the (excessive) volume of other traffic. Interviewees chose routes to avoid traffic. In the case of IN3, his preferred style of driving was to move about on the road, passing cars that were holding him up. A combination of the other traffic and the redesign of the road which gave only one lane to general traffic prevented him from moving about (e.g. overtaking) in the manner he preferred. That is, although it appeared that he was cued to behave in a particular manner, the layout of the road did not permit the exercise of that behaviour.

4. Goals

All interviewees had the goal of reaching their destination. Some had subsidiary goals. Individual interviewees also gave additional goals to explain aspects of their behaviour. These included:

- avoiding congestion;
- driving with as little delay as possible;
- finding an alternate route;
- driving in their accustomed manner;
- ensuring consistency in travel time;
- keeping fit/obtaining exercise; and
- getting in and out of the shopping centre as quickly as possible.

Potentially habitual behaviour

Table 6.3 lists interviewees and the behaviour they described which appears to conform to Verplanken and Aarts' (1999) definition of habit.

Table 6.3 Potential habitual behaviour amongst interviewees

Interviewee	**Possible habitual behaviour**
IN1	Choice of mode
IN2	Choice of mode; travel time; route switching
IN3	Moving about on the road; route switching
IN4	Route switching
IN5	Choice of mode; new habit being established
IN6	
IN7	Route switching
IN8	Choice of mode; route switching
IN9	Choice of mode
IN10	Choice of mode; route switching

It can be seen that the habits described by the interviewees could fall into Verplanken and Aarts' (1999) categories of either generalized or specific habits. The use of the bus to go into Sydney city centre, which several interviewees (IN2, IN5, IN8) mentioned, is clearly a habit that is specific to a particular trip. However, route switching is a generalized habit (s.3.5.3), as are driving itself and moving around on the road.

6.16.5 Life events

Events causing disruption

A life event was defined in s.3.3.2 as 'an infrequent event that interferes with routine behaviour and can cause people to reconsider their current behaviour'. Table 6.4 lists some of the travel behaviour changes that interviewees reported and indicates whether or not interviewees felt the changes were related to the narrowing of Epping Road. It can be seen that narrowing Epping Road caused some of the interviewees to change their behaviour in a variety of ways, but others continued as before. That is, for a group of interviewees the narrowing of Epping Road was a life event, but other interviewees remained unaffected.

Table 6.4 The narrowing of Epping Road as a life event

Interviewee	Reported alterations in travel behaviour	Reported as relating to the narrowing of Epping Road
IN1	Altered time of travel; shopping destination	Y
IN2	Little change personally; time of Probus meeting changed	N
IN3	Altered choice of motor vehicle; altered style of driving	Y
IN4	Experimented with modes/routes/time of travel. Changed origin. Changed frequency of travel/reverted to car	Y N
IN5	Addition of Epping Road to palette of route options; addition of buses to palette of modal options	Y
IN6	Addition of motorcycle and bus to palette of modal options	N
IN7	Experimented with modes for commuting trip	Y
IN8	Altered route and style of driving	Y
IN9	Forced change in speed of travel	N
IN10	Experimented with routes	Y

Interviewees also experienced life events which caused them to change their travel behaviour independently of the changes arising from the incident of RRC. In one case a life event caused significant disruption:

> *"... because of my injury, I was able to work from home for some months, ... Six months, I had to stay in bed. .... I broke my heel in five pieces .... and I had to learn to walk again, ... so when I introduced myself back to work, ... I weaned myself gradually, ... I was in a wheelchair for .... probably another three, six months after that .... I had to have somebody drive me to work .... when I was able to walk again, I .... only worked from here two to three days a week .... when I came back this year I decided .... to be physically present four days a week .... that worked well, but again, you have to be able to .... manage your time that way." (IN4)*

In another case the change happened because of a more minor event, albeit one that was disruptive:

> *"... my car actually went into the workshop to get .... a transmission overhaul .... and so I was carless for about a week and a half .... and some of my colleagues at work said 'why don't you just try*

catching the bus? These are the numbers, the bus numbers that .... come to work and this is where they sort of end, down .... the end of the M2' .... so I thought OK, I'll give that a go .... I tried the bus for about .... a week and a half, ... it was actually not bad." (IN6)

Some people experienced both types of life events. IN4 is one example of this. She felt that congestion worsened after Epping Road was narrowed. Then she injured her foot. Each event caused a change in her travel behaviour (s.6.2.5).

It can be seen from Table 6.3 that there is no simple relationship between the changes in travel behaviour and life events. Interviewees for whom the narrowing of Epping Road was a life event all reacted differently. They reported different combinations of alterations to mode, route, time of travel, style of driving, origin and destination.

Life events or personal choice?

In deciding whether or not an event should be classified as a life event, it is not possible to know what (objective) constraints the interviewees were operating under. For example, one interviewee reported that he had only 20 minutes available to travel between two sites. It is not possible to determine from an interview whether this is an objective constraint or whether other arrangements could have been made if required. Without such information, it is impossible to say how much the narrowing was responsible for changes and how much was personal choice. Nor is it possible to know in detail what other events fed into the decision to change travel behaviour. In the absence of such information, it is necessary to treat the narrowing of Epping Road as a life event.

In the general case, this makes it difficult to predict, at a disaggregate level, the long and short term outcomes of an episode of RRC. It is also difficult to predict the economic costs of RRC. However, it can be said that the better the person's knowledge of the mechanisms of alternate behaviour (e.g. whether they already know how to use buses, when bus lanes are installed) the easier it will be to take advantage of the new opportunities that are presented when the capacity reduction takes place. This topic is considered in greater detail in Chapter 8.

Distinguishing the event which triggers changes

It should be noted that as the closure of lanes on Epping Road to begin construction of the bus lanes and SUP was a separate event from opening of the bus lanes and (later) the SUP, it cannot be assumed which of the events was the trigger for altered travel behaviour, without specific information. One interviewee (IN4) specifically mentioned the roadworks as the reason for moving house (s.6.2.5) but most who were unhappy about the changes to Epping Road were not specific about the date on which the problems began. It should also be noted that during the approximately five month period between lanes being closed for construction of the bus lanes and the opening of the bus lanes, general traffic had to share the remaining lanes with buses, taxis, motorcycles and cycles. Previously these latter groups had been able to use the transit lanes. Therefore during the period in which the bus lanes were constructed, motorists would have been forced to share with other modes in a way they had not had to in the past and have not had to since.

6.17 Summary

The comments from the interviewees and other sources of opinion indicate that these people were not able to consider the Lane Cove Tunnel and the changes to the road network and traffic associated with it, and consequent on it, independently from the narrowing of Epping Road in Lane Cove. In particular, respondents saw Epping Road as a whole; they did not distinguish Epping Road in Lane Cove from Epping Road west of the

Lane Cove River, nor changes made at the time of the opening of the tunnel from subsequent changes. Attitudes to the Lane Cove Tunnel affected some people's attitudes to the narrowing of Epping Road.

Interviewees' comments indicate that they were all affected by the opening of the Lane Cove Tunnel and subsequent narrowing of Epping Road to some extent, even if only to cause them to take a stance on the tunnel. For some it made things better, but for others, worse.

Comments suggest that most (but not all) interviewees, when they made decisions about travel behaviour, principally took into account individual needs and local concerns, in the context of the road and its traffic. Although interviewees were concerned about the pollution emitted by traffic, their concerns were local and limited to the way pollution affected them (or their pocket). That is, for most interviewees, the scope of their concern was the road, not the planet.

As noted, most interviewees changed their travel behaviour to some extent after Epping Road was narrowed. Change of route and change of time of travel were the most common responses. Although interviewees used the car before and after the narrowing of Epping Road, it was also clear that most had experience with modes other than cars, although this experience may have only been in particular situations (e.g. commuting). Some increase in the use of buses after the narrowing of Epping Road was mentioned by the interviewees (and e-mail respondents) although this appeared to be due to the construction of bus lanes rather than the narrowing of Epping Road. The cycling interviewees used bicycles before the shared use path was built, although in Lane Cove, part of Epping Road could be avoided by using Mowbray Road West. Furthermore, changes were not confined to individuals. One organization changed its meeting times because of the difficulty that traffic was causing to its members.

Although many of the changes that interviewees made in their travel behaviour were a reaction to the traffic, some changes were made independently of the traffic, including those made because of life events which occurred independently of the alterations in Epping Road.

There was a variety of affective reactions to the Lane Cove Tunnel scheme and the associated narrowing of Epping Road. Some respondents were pleased with the changes, whereas others were discontented. In some cases their feelings had a direct effect on their travel behaviour. For example, some e-mail respondents stated that they refused to use the Lane Cove Tunnel on principle. In other cases, the changes led to a long term discontent, as the narrowing of Epping Road took away people's ability to drive in their accustomed manner. For example, on the one-lane sections of the road, it is no longer possible to overtake other vehicles, which can be frustrating for drivers who are accustomed to the style of driving which multiple lanes allows.

When considering the research questions, it can be seen that there is no simple connection between motorists' behaviour and the life event of reduced road capacity. However, there may be some regularities in their reactions to reduced road capacity and certain of their existing habits. Those who have had the habit of switching routes as soon as they perceive something that is likely to delay them on their original route, continue to do so. Those who have a habit of moving around the road were unhappy that Epping Road had been narrowed to one lane, which prevented them driving in their usual manner.

If considering only existing habits, it would appear that two reactions are of consequence here. Part of the frustration that some interviewees complained of can be assigned to the narrowing of Epping Road which prevented them driving in their accustomed manner. The disappearance of some traffic from Epping Road can be assigned to the habit of switching routes when the amount of traffic on the route become uncomfortable for them. Both of these are generalized habits which the interviewees implied would be used on any occasion that justified them.

Some interviewees had developed a new habit of using the bus when going into the city centre. This habit developed as a result of the new facilities that were provided by the Lane Cove Tunnel scheme, rather than by the reduction in capacity on Epping Road.

CHAPTER 7

Consequences of Route Switching with Respect to Reduced Road Capacity

This chapter seeks to answer the research question that is concerned with identifying trips which have the potential to disappear after an incident of reduced road capacity. As part of the answer, two hypotheses have been formulated, based on the data that was collected as part of the field study. These hypotheses attempt to explain the observation that any chaos on the roads, as a result of a reduction in road capacity, is short lived. In doing this, they provide an answer to the second research question.

Section 7.1 introduces the chapter. Section 7.2 discusses the Epping Road motorists' methods of devising a route. Section 7.3 discusses the habitual nature of this flexibility. Section 7.4 discusses other researchers' findings with respect to the propensity to switch routes. Sections 7.5 and 7.6 postulate two hypotheses to account for the lack of enduring chaos when road capacity is reduced. Section 7.7 answers the second research question, to the extent that the findings of this field study allow. Section 7.8 concludes the chapter.

7.1 Introduction

7.1.1 Scope of chapter

The findings of the field study for this thesis were discussed in Chapter 6. That chapter reported interviewees' descriptions of, and reasons for, changing their trips on Epping Road, either in terms of time of travel, route, mode or origin and/or destination. In this chapter it is proposed to consider one particular behaviour observed in Chapter 6 and explore it further, in order to provide an answer to the second research question which asks:

> How can the trips be identified, which, in order to reduce the volume of traffic to acceptable levels, are most likely to disappear after a network event such as a reduction in road capacity (RRC)?

There are three main elements to this question:

1. what is an acceptable volume of traffic?
2. what is meant by disappearing trips; and
3. how can these trips be identified?

Each element will be briefly considered in the following sub-sections.

7.1.2 Acceptable volume of traffic

Interviewees' comments suggest that it is not possible to give a numerical figure for an 'acceptable' level of traffic, since the same amount of traffic may be viewed as better, worse or much the same by three different people (s.6.7.3).[18] Therefore, the measure of acceptability used in this study is a personal, subjective one. A traffic situation is deemed to be acceptable if the motorist remains in it instead of trying to change (improve) it, assuming that the motorist considers that there may be a feasible alternative. If there is no practical alternative, it is not possible to say whether the trip is 'acceptable' or not.

[18] Nevertheless, it should be noted that road authorities have definitions of 'levels of service' which attempt to give objective views of how well a road (link) is providing for traffic in terms of volume/capacity ratio, speed, density of traffic and maximum rate of service flow per lane under ideal conditions (TRB 2000).

7.1.3 Disappearing trips

'Disappearing' trips refers to trips that are no longer in the traffic stream under consideration. The trips may still exist on the wider network. Motorists may have disappeared temporally:

- changed their time of travel;

or spatially:

- used a different route;
- changed their origin or destination;
- changed mode; or
- foregone the trip altogether.

The change may be temporary or permanent.

7.1.4 Identifying these trips

The remainder of this chapter will examine and identify the disappearing trips.

In order to do this, it is necessary to return to the stage at which motorists decide on their route.

7.2 Epping Road motorists' choice of route

7.2.1 Introduction

In the course of describing the way they had been affected by the reduction of road capacity on Epping Road, interviewees mentioned five methods of determining a route for a given trip, either as used by themselves or perceived to be used by other motorists:

1. using the road authority's recommended route between two points (a principal route);
2. selecting from a palette of routes between two points based on pre-trip information;
3. switching route at junctions or at the site of disruptive incidents;
4. random use of the network; and
5. accepting a route determined by means of electronic aids.

7.2.2 Principal route

A principal route, as recommended by the road authority, fulfils some criteria for the traveller travelling between two points. It may offer ease of use, speed or directness. It may also be the only route of which the traveller is aware. In this study, Epping Road was the principal route:

> *... I think most people that know the alternative, would have known the alternative prior to the change .... and anyone that doesn't know that there's another way is not probably ready to experiment, especially if they're from another part of town. Like, so if they're on their route to a corporate park and that's the only route they know, ... then they're just going to sit in traffic and add to the problem. (IN4)*

> *"So I don't know. I guess I'd .... much rather go down the main road – like Epping Road! <laughter> than use the back streets." (IN3)*

Another interviewee chose to use Epping Road on a motorbike because the bus lanes made his journey quicker:

> *... No, no, it's just quicker, ... once I went to my motorcycle I found that I could take advantage of the bus and the transit lanes. .... that sped up my trip a bit. (IN6)*

It was observed that many people are prepared to tolerate congestion and find a use for the delays:

And it's interesting for the differences in, ... what people will endure, because .... I almost go crazy. I just sit there and .... I seriously feel like stopping the car and jumping out and walking, ... cause I get so annoyed by it, ... and other people, they seem to be putting on their makeup and they're doing things and they're just treating the whole thing like it's their own personal downtime ... (IN4)

7.2.3 Selection from a palette of routes

Some people have a set of alternate routes between their origin and destination. They can choose the most appropriate one for the conditions:

And if I was to go there, ... and on the day it was .... peak time and there was traffic, ... you can actually go up, I think it's Mowbray Road, this one .... there's a back entrance to the place. I have been there a couple of times during the .... work day but I would not go in the morning unless I really had to. Like, had traffic have been backed up, that's the .... path I would have taken. (IN6)

As a result of not liking to sit in traffic, she knows a lot of back ways. She uses least delay as the criteria to plan her route. (IN8)

They may have a variety of reasons for choosing one route in preference to another. In the case of the Lane Cove Tunnel, they may have strong feelings about toll roads and the tunnel. This could be either against:

*... the narrowing of the Epping Highway [*sic*]. I certainly maintain a rage over this and refuse to use the tunnel myself preferring to go the long way around. (EM13)*

or for:

" ... I wouldn't even consider trying to avoid it, that would .... be insane. If I can use it, if I can deviate to use a .... toll or a tunnel, I'm the opposite, I will go for it because .... I want to avoid, I don't like driving through urban roads, they're much more dangerous, ... if I was using a sat nav., ... I would use toll roads .... [in the] long run, ... it reduces stress, it reduces danger, ..." (IN5)

Motorists decide at different stages whether they are going to try a different route:

[interviewee's husband] starts off by using Epping Road anyway because .... that's the easiest and the quickest way to travel .... He has tried going from inside, ... [North] Ryde itself, ... but then .... what happens is sometimes the internal roads, because they're all 50 and school zones etc .... it's slower to negotiate that internal traffic .... rather than go on Epping Road .... it's not a .... very good situation anyway, you know .... He'll decide on the day. It's the same with me. I .... decide on the day, at the time, whether I take off Epping Road, ... to Lane Cove Road or I just go straight to Delhi Road. .... And sometimes .... I decide, OK, today I'll take Delhi Road, ... (IN10)

Because I try different routes to come back home .... to try and save time .... but what I've realized is that each route has its own problems ... (IN10)

7.2.4 Route switching

For the section of the flow which consists of motorists who are prepared to use an alternative route at some stage of their journey (and who therefore are likely to have a good knowledge of the surrounding area) the presence of congestion or an incident such as a road traffic accident is a signal to take note of their surroundings and actively seek out an alternative route:

... when I get to the stop that's Longueville, I can see down there; I can see .... the flow; ... and if it's backed all the way up I know to go straight on and then do one of the back routes, and go up the one

way street and all that kind of stuff. .... and carry on at the top. If I can see clear, I know I can get a run down .... So, I don't .... everyday do that, ... it's a mish-mash of both, depending on the traffic flow. (IN7)

... doesn't like sitting in traffic, preferring constant movement .... finds back streets .... being on the move is more important than the actual time it takes. (IN8)

" ... that's happened to me quite a lot, I've gone down, ... turned off on, I'm trying to get through Lane Cove and I think 'Oh, my goodness' and they're all banked back now. Before they put bollards in, ... many of us simply just did a U turn, went back .... and went through the tunnel .... just did a U turn and went back and just went through the tunnel. I've done that many occasions. .... Because I know what's happening .... I can see it – they're all banked back, they're all going 'Oh, my God' so .... May as well use the tunnel." (IN3)

It should be noted that it is possible to reach route switching from different initial states. Interviewees IN3 and IN7 had alternative routes in their minds before they started whereas interviewee IN8 generated her route as she went. As far as the network operation is concerned this may make no difference, although if this behaviour was to be modelled, it might be necessary to treat each option differently. Quantitative research enables the researcher to find out how the behaviour comes about.

7.2.5 Random use of network

Desperation could result in motorists trying any route to bypass congestion:

... I got to a point where ... every morning I was trying a different short cut to see if I could get around the block ... cause I know the roads really well, ... like, it's being a country girl, I go by myself, sense of direction, I'll, I'll look for the direction, look where the sun is and go "OK, head this way, head that way and do this" or just start following cars that look like they're going fast and look like they

know what they're doing ... then finding that they are actually going somewhere relevant. Yeah. Just getting a sense for that. I always do things like that. (IN4)

No, I just wait and see what the traffic's doing. ... even if I get out to ... the first street that I have to turn left into and I see anything I'll turn right.... I'm really flexible, right. (IN4)

7.2.6 Electronic aids

Electronic aids mentioned by interviewees included:

- broadcast traffic reports (radio, television);
- variable message signs; and
- GPS (global positioning satellite) units.

Smart phones and certain sites on the Internet, although not mentioned, can also provide traffic information. Interviewees discussed only routine trips, for which they knew (alternate) routes. However, if there were alternatives, the electronic aids were sometimes used to decide which route to take before the trip started (television) or whether a diversion was in order (radio):

I have a television in my room here .... when it gets to time the news is on, etc, it comes on,... there's a traffic report every 15 minutes on this particular channel .... it tells you, you know, we're hovering over so-and-so. Forget it, you ain't going to make it home for two hours, etc. (IN3)

*Yes, I can use River Road. Sometimes I go through Artarmon, yeah. **....** Sometimes. When there accidents and stuff like that and they warn me on the radio then I go through Gladesville. (IN3)*

The commuter cyclist also used a radio on his bike, to get information on traffic:

I listen to the radio on the bike, so I get all the news and... I can see them all sitting in their cars. (IN7)

None of the interviewees mentioned using electronic devices to provide them with an entire route. However, as described in Figure 6.1, the CARR website does suggest using an on-board navigation system to plot a trip to avoid toll roads (Zapata 2012). However, not everyone was impressed with GPS:

> *I won't use it - it's crap. It doesn't work right. (IN4)*

7.3 Habitual nature of flexibility in route choice

It can be seen from these descriptions that some motorists are more flexible in their route choice than others. Some are perceived never to leave a preselected route, while others exhibit varying degrees of flexibility, not only about the time at which a different route is chosen (on a trip by trip basis or at key junctions) and which roads are used (main only or back streets as well) but also with respect to the amount of pre-planning (or prior knowledge) which goes into alternative route choices.

From the comments of the interviewees, it can be seen that route-switching (whether on a junction by junction basis or a day by day basis) is normal behaviour for some motorists when driving. It fulfils all the requirements of the definition of habit given by Verplanken & Aarts (1999) (s.3.5.2):

- due to the knowledge of alternate routes, it is behaviour that is likely to have been practised;
- interviewees' comments suggest that, for some motorists, it is an automatic reaction to congestion;
- it is cued by the sight of significant amounts of traffic; and
- the goal is to avoid the congested traffic.

The consequence of these route switching habits is that each time motorists with these habits drive between a particular origin and a particular destination, their route may vary. Papinski *et al* (2009) assume that the home to work route has been planned in advance. From the comments quoted in s.7.2.5, it can be seen that the results of this field study suggest that this is not always the case. That is, although the origin and destination are known in advance, some motorists are prepared for the possibility that their route may change as they progress.

Because interviewees experienced congestion that they perceived was due to the reduction in the number of lanes on Epping Road, it is not surprising that this habit was practised after Epping Road was narrowed. It should be remembered that it was not the only response to perceived congestion. Other interviewees changed their time of travel, route and trip origin. One talked of changing his destination by changing his pattern of employment (s.6.14.1).

7.4 Observed propensity to switch routes

The motorists on Epping Road are not unique in their tendency to change route. Other researchers have observed similar phenomena.

Polydoropoulou & Ben-Akiva (1994), in a survey of 898 motorists covering 3218 morning commute trips, found that two-thirds of the trips made presented opportunities for route-switching. However, in only 6% of that 67% of trips did motorists actually switch routes. Of that 6% of trips where the motorist switched routes, only 8% received additional traffic information (from the radio) before switching even though en-route information was received in 24% of all trips. Thus, the survey found that route-switching occurred in only a very small percentage of trips and even fewer drivers switched because of the information they had received. In fact, 62% of motorists who switched did so because of what they saw.

Dia (2002) also found that changing route was not a very frequent event. The responses to his survey of peak period drivers found that, over the month of the survey (i.e. having undertaken more than 40 work-related trips) 25% of respondents did not change route at all. The remaining drivers changed route from once (~10%) to six and over (11%) times in the month. The modal value, at ~17% of respondents, was changing route twice in the month.

Papinski *et al* (2009) examined 21 home-to-work trips made over a two day period and found that 20% of drivers diverted from their planned routes. Abdel-aty *et al* (1994) found that only about 15% of 944 survey respondents in California sometimes changed their route to work.

In no case have researchers found a large number of motorists switching routes. However, it should be noted at this point that although some of the behaviour described here may be regarded as a habitual response to traffic, for the minimal chaos hypothesis this is not necessary. Any reason for the behaviour is sufficient.

7.5 Route switching hypothesis

Bearing in mind the observations from the field study, as well as the results of other researchers described above, it may therefore be hypothesized that:

> **There is a continuum of route-switching behaviour amongst motorists, which varies from none, through occasional, to switching routes whenever the situation exceeds a personal threshold of difficulty.**

This does not necessarily imply that the motorists switching route have a good local knowledge of the area. They may instead have sufficient self-confidence to be sure that they can find an adequate route (perhaps by using on-board navigation systems, following other people or navigating by landmarks or compass directions).

At one extreme, it is hypothesized that some motorists will disappear from the road if they perceive a problem. At the other extreme, some motorists will not change, perhaps because they:

- do not know any alternative;
- prefer to leave experimentation to other people ('wait a while and it will sort itself out'); or
- feel that other people should change rather than them ('somebody else's problem').

Some will change route if they are given explicit instructions about where to go.

It is hypothesized that there are people between these two extremes, with differing propensities for experimentation. Some may be prepared to try something different after one experience of the new situation (e.g. use a different route or travel at a different time of day). Those who wait before attempting any changes may also have different thresholds for change. They may change after two days, or a week. There are motorists who will change slowly (e.g. who will keep using a route until they are convinced that the situation will never improve) through to motorists who will change frequently (i.e. at every junction if necessary).

Some people have many alternate routes. They use them already to take action on their own initiative and actively leave problem situations. For them, RRC is just another cause of congestion.

7.6 Minimal chaos hypothesis

7.6.1 Introduction

If it is assumed that all motorists lie somewhere along this continuum of propensity to change route, it is possible to offer an explanation of the reason traffic chaos either does not happen, or if it does, does not last long, in cases where road capacity is reduced because the road has been narrowed.

In a case of RRC, it is helpful to divide the traffic flow into three groups, as follows:

1. motorists who do not change route;
2. motorists who make significant changes to their route; and
3. motorists who only make changes to their route as they think necessary.

7.6.2 Motorists who do not change route

Some motorists:

- will not realize what the RRC means for them;
- (possibly from outside the area) may not be aware of the impending road narrowing; or
- are not able to avoid the route along which capacity has been reduced because they have origins or destinations there.

Therefore, a certain element of the traffic will not leave the area of reduced capacity.

7.6.3 Motorists who make significant changes to their route

Motorists who make significant changes in a case of RRC can be divided into two groups. The members of the first group are not present when the reduction in capacity takes place. Members of the second group make deliberate changes in their route to avoid the RRC.

It has been observed that a seemingly steady flow of traffic is in fact changing all the time. Surveys '... have suggested that no more than half the vehicles present on a given day will be present at the same point on the following day' (Bonsall *et al* 1984). Therefore, it seems reasonable to assume that some of the traffic that might normally use the narrowed route will not be there when the capacity is reduced. The new layout is not immediately relevant to these motorists. They can wait and observe the changes. When the flow has settled down, they can re-enter the traffic.

A second group will have chosen to avoid the route to be narrowed, perhaps because of publicity (e.g. Marinelli & Watson 2009; Ye *et al* 2010). These absentees may, for example, take a completely different route, use a different mode, reassign the errand to someone else or travel at a different time (see Table 2.1). They have a low threshold for route change, that is, a high propensity to change.

These are the people to whom Kruse (1998) is referring when she points out the need for flexibility in transportation systems when making major changes in traffic patterns.

7.6.4 Fine tuners

Some of the motorists who do use the road with reduced capacity will have a route switching habit of greater or lesser strength. Other work (s.7.4) suggests that these people form a minority of the traffic. However, given the absences of the motorists who have made significant changes, this minority, with a tendency to leave a route that is uncomfortable for them, may be sufficiently large to prevent the long term confusion that is so often predicted, but not experienced, in these situations (Cairns *et al* 1998, p. 6).

Although narrowed roads are not the same as missing infrastructure, it seems reasonable to assume that a ripple effect (s.2.3.8) will occur if there are alternative routes which drivers can use. That is, the process which occurred on the road where capacity was reduced will be repeated in places which experience the overflow. Clearly, the possibilities for this are dependent on the topology of the individual network.

7.6.5 Statement of hypothesis

Comments from one interviewee suggest that the disruption that was experienced in the first few days after lanes on Epping Road were withdrawn from use occurred because motorists were unsure about the actions they should be taking at any particular point.

Motorists may be unsure of what to do and where to go (in spite of road authority information), because the conditions to which they have become accustomed no longer hold (e.g. the network layout has changed). Their usual behaviour has been disrupted. As the network layout has been changed, their routes, in particular, will have been affected.

The minimal-chaos hypothesis states that:

> **Route switching by a percentage of motorists, in combination with other motorists leaving the route or changing their time of travel, results in changes which tend towards the minimum necessary required to avoid on-going disruption.**

That is, disruption only occurs in the initial phases of the RRC, until motorists have become accustomed to the new conditions. Therefore, it is possible to propose a conceptual model of traffic using a road which has been reduced in capacity, to explain the observation that traffic disappears, but only to the extent that it needs to (s.2.3.5):

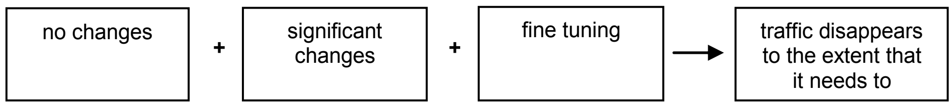


Figure 7.1 Conceptual model of disappearing traffic

7.6.6 Other types of reduction in road capacity

It will be appreciated from Figure 1.1 that there are many ways, both planned and unplanned, in which road capacity can be reduced. This field study was undertaken in a situation where there were alternative routes to the road on which capacity had been reduced.

In some situations it is not possible to have an element of the flow which makes no (or minimal) changes. All the previous travellers will have to make changes if the only bridge across a river has become unusable, which may happen if the bridge has been damaged (e.g. by an earthquake), or is structurally unsound. If there is only one road into a peninsula, all travellers wishing to access the peninsula will be affected if the road is reduced in capacity. In such cases, the 'no change' and 'fine tuning' elements of the traffic flow reduce to zero and any disappearing traffic will be composed entirely of motorists making significant changes.

7.6.7 Other switching behaviour

The discussion with interviewees in this field study led to hypotheses concerning switching of routes which had not been planned at the outset of their trip. It is theoretically possible that other trip parameters could be changed in this way as well. For example, mode switching could occur if the travellers made an impulsive decision to park their car and switch to the train or bus in order to finish their journey. Time switching would involve travellers making part of their trip and stopping for a period before resuming and completing the trip. Both mode-switching and time-switching could contribute to trips disappearing after an incident of reduction in road capacity.

None of the interviewees mentioned anything which could be construed as mode switching or time switching and further work on the topic is outside the scope of this thesis.

It should be noted that any such changes have the potential to ripple out across the network in the same way that route-switching has been demonstrated to affect other motorists.

7.7 Second research question

The second research question of this study asks how trips may be identified which have the potential to disappear after a reduction in road capacity, since some authorities wish to decrease the volume of traffic, thereby reducing congestion and the use of private motor vehicles (Scott 2004). In an ideal situation, it would be possible to state with some precision which motorists and/or trips should be targeted if it was desired to reduce the amount of traffic on the network. However, this study can only answer that question in a very general way, in terms of traveller (i.e. personality and route switching thresholds), rather than trip, characteristics.

In s.7.6 it was hypothesized (for a network which allowed some route choice) that motorists could be divided into three groups after an incident of reduced road capacity:

1. those who did not leave the route;
2. those who made significant changes; or
3. those who kept driving but changed route as necessary to avoid situations which caused them discomfort.

Thus it may be seen that according to this hypothesis:

- the first group of motorists will not disappear;
- the second group will disappear from the route in either time or space; and
- the third group may be temporarily, but not permanently, absent from the route.

People who continue driving after RRC give a baseline of people who will not change, however difficult that may be. They value the driving experience very highly. The reason may be practical (e.g. there is no other way to reach their destination or they are expected to always use a car) or affective (e.g. they dislike mixing with other people or having someone else control their travel). Route switchers are flexible drivers, but they clearly also value driving highly and find alternative responses unsatisfactory. It follows that the people in the second group value driving (in the way it used to be carried out before the instance of RRC) less highly than groups 1 or 3. They may only change the time or route they take, but equally, they may also forgo driving altogether.

Hence, it is clear that the second research question is only relevant to the second and third groups of motorists. Nevertheless, it is still necessary to identify the members of these groups.

7.8 Summary

This chapter has discussed the five different methods that the interviewees gave for designing a route, in order to lay the groundwork for answering the second research question. The motorists' habits with regard to route choice have led to two hypotheses: the *route switching hypothesis* and the *minimal chaos hypothesis*. These are suggested as explanations for the observed lack of extensive chaos when road capacity if reduced.

The route switching hypothesis states that:

> **There is a continuum of route-switching behaviour amongst motorists, which varies from none, through occasional, to switching routes whenever the situation exceeds a personal threshold of difficulty.**

The minimal chaos hypothesis states that:

> **Route switching by a percentage of motorists, in combination with other motorists leaving the route or changing their time of travel, results in changes which tend towards the minimum necessary required to avoid on-going disruption.**

A conceptual model was derived, which provided an explanation for the disappearance of traffic after an incident of reduced road capacity, in the case where there are alternative routes to the one on which capacity has been reduced.

The second research question asked:

> How can the trips be identified, which, in order to reduce the volume of traffic to acceptable levels, are most likely to disappear after a network event such as reduced road capacity?

This was answered at a general level, in terms of the groups making changes in their travel behaviour after an incident of reduced road capacity. The results suggest that the answer to this question should not be viewed in the light of trip characteristics but rather in terms of the personality of the traveller and their route-switching threshold.

CHAPTER 8

Implications for Sustainability

This chapter considers the research question which asks how reducing road capacity can contribute to a sustainable urban future, particularly in the context of travel demand management. It discusses the definition of sustainable transport as one part of a sustainable urban future. It asks whether the former is achievable in the modern urban setting and considers some possible alternatives. It describes the advantages and problems of the existing passenger transport modes and suggests ways in which it may be possible to achieve a more sustainable passenger transport system. In particular, it describes how reducing road capacity can aid in this. The chapter introduces the term 'travel competence' and gives an example of how enhanced travel skills and techniques to manage travel demand lessened the impact of an episode of reduced road capacity.

The chapter begins (s.8.1) with a brief historical introduction to the concept of sustainability. It then (s.8.2) discusses environmental sustainability with respect to passenger transport and explains why modern forms of passenger transport, in the modern Australian urban environment, can never truly form a sustainable transport system. Section 8.3 explains in greater detail, and at the level of the individual traveller, the attractions of the private motor car, which is the dominant form of transport in Australian cities. It also discusses the problems associated with the car and how other forms of transport present similar problems. Section 8.4 discusses briefly the implications and consequences of reduced road capacity for sustainable transport and relates it to the field study on Epping

Road. Section 8.5 introduces the term 'travel competence' and explains it in greater detail. It defines the concept and explains how dispelling ignorance of a mode can encourage greater use of that mode. Section 8.6 gives an example of how enhanced travel competence (produced by means of a TravelSmart programme) minimized the disruption associated with a case of reduced road capacity in Brisbane: the case of the damage to the Brisbane Riverside Expressway in 2006. Section 8.7 summarizes the arguments in this chapter.

8.1 Introduction

Just as reducing road capacity for environmental reasons is not new (s.2.2), neither is sustainability a novel concept. The *Oxford English Dictionary* (OUP 2009), which provides an historical record of the English language, gives 1611 as the earliest example in print of the word 'sustainable' (meaning 'abideable'). Nevertheless, sustainability is not a term, or a concept, that has always been at the forefront of people's minds:

> ... his constant reference to the needs of those to come, generations of people who would live in the twenty-first century. .... While he spoke of the future, they spoke almost always of the present, ... The twenty-first century could look after itself. (Angus 1975, p. 49)

More than 35 years have passed since these words were first written, and the need to consider sustainability – that is, the implications of current human behaviour for the future well-being of the planet and its inhabitants – has become a mainstream concern (e.g. WCED 1987; Daly 1992; Beder 1996; Davis 1996; Ampt & Rooney 1998; Brindle 1998; Bayliss 2002; Pears 2005; DoEWHA 2008; Transurban 2012; ISF 2011; DoSEWPC 2012; Hydro Tasmania 2012; St George Bank 2013) (see also Dresner 2002).

The concept of sustainability can be applied to any activity or system (Pollalis *et al* 2012). One of the research questions for this study speaks of a sustainable urban future. The latter subject encompasses many individual topics including transport, building, water, waste, food supply and governance. This chapter addresses the aspect of sustainability concerned with transport. It suggests a way in which reducing road capacity can be of help in enhancing the sustainability of urban transport. To do so, it is necessary to first define 'sustainable transport'.

8.2 Sustainable transport

8.2.1 Definition

In 1987 the World Commission on Environment and Development (WCED) published a report entitled *Our Common Future* (the Brundtland report). The Commission's brief was to examine the critical environmental and developmental problems of the world and to suggest some realistic proposals for solving them. It listed three broad areas of concern with respect to human activity (p. 4):

- environmental;
- social; and
- economic.

The Brundtland report was concerned with sustainability; it defined sustainable development as development "...that meets the needs of the present without compromising the ability of future generations to meet their own needs." (*ibid.*, p. 43).

In particular, the concept of sustainability can be divided into the three areas described in the Brundtland report: environmental; social; and economic. It can be seen from Figure 8.1

that environmental sustainability encompasses social sustainability (no society can exist without an environment in which to live) which in turn encompasses economic sustainability (every society runs according to some sort of economy, whether market, planned, co-operative or other (Bromley *et al* 1992)).

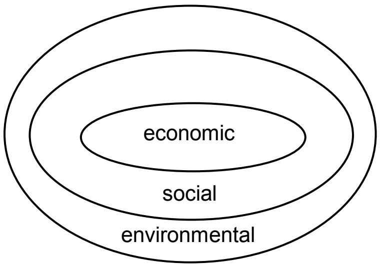


Figure 8.1 Aspects of sustainability and their relationship to each other
Source: After Lane (2011), p. 117, Figure 2

Although this diagram is normally presented as three intersecting circles, the presence of discrete circles suggests that each sphere can operate independently of the others. However, Lane notes that:

> In reality, however, the environment actually forms the biophysical context to all the other aspects: all resources come from the physical environment, all societal endeavours occur in a physical setting and all economic activity is ultimately dependent on physical components. Likewise, the economy is but one subsection of the whole society, so should be represented not as an overlapping sphere, but one that is nested. (*ibid.*)

The Brundtland definition of sustainable development has been used as a starting point for definitions of sustainable transport by many writers (e.g. Daly 1992; Beder 1996; Kroon 1998; Richardson 1999; DoEWHA 2008; VTPI 2013). That is, sustainable transport can be defined as transport which meets the needs of the present without compromising the ability of future generations to meet their own transport needs. This is considered by some writers to be the most important issue in urban transportation (Sohn 2011).

Some authors have attempted to produce a more precise definition of transport sustainability (e.g. Whitelegg, 1993; Richardson 1999; OECD 2002; Sperling & Gordon 2009); (see also VTPI 2013). The definition used in this thesis is from the Organisation for Economic Co-operation and Development (OECD), which defines a sustainable transport system as one where:

> Transportation does not endanger public health or ecosystems and meets needs for access consistent with a) use of renewable resources below their rates of regeneration, and b) use of non-renewable resources below the rates of development of renewable substitutes (OECD 2002, Annex II).

It can be seen that this definition touches upon all three aspects of sustainability:

- environmental (ecosystems, material resources);
- social (public health, need for access); and
- economic (financial resources, need for access).

Nevertheless, it does not consider directly factors such as economic activity, productivity, employment, equity, quality of life or aesthetics.

For further discussion of the definition of sustainability and sustainable transport see, for example, Daly 1992; Brindle 1998; Dresner 2002; Toleman & Rose 2007; Banister 2008; Black 2010; VTPI 2013.

Writers discussing transport are sometimes mainly or only concerned with environmental sustainability (e.g. Kroon 1998; Regan 2004; Tight *et al* 2005; Moriarty & Honnery 2007; Bonsall 2008; Sperling & Gordon 2009; Black 2010, p. 12) and that is the principal aspect that will be dealt with here. Nevertheless, it should be borne in mind that sustainability is the end result of a strategic vision, not merely the result of solving a series of problems (Brindle 1998). It is not suggested that the proposals offered in this thesis are in any way a complete solution to any problem.

It should also be noted that describing an activity as environmentally sustainable does not mean that that activity has no effect on the environment. It means that the environment is left in a state suitable for future generations, who may have different requirements from the current generation ('use of renewable resources below their rate of regeneration' (OECD 2002)). For example, while walking may intuitively appear to be the most environmentally sustainable mode of transportation, since it can be accomplished without using any resources other than the clothing that the walker uses in their normal day to day existence, repeated use of an unpaved route for walking (either, one person many times or many people once each) can cause erosion of the land (see, for example, Chiu & Kriwoken 2003). That is, walking may be sustainable for half a dozen people, but not half a million. However, erosion can be repaired so that future generations can also enjoy the environment in question, whether in the way the current generation does or in some new way (e.g. walking and mountain biking instead of only walking, in the example quoted).

8.2.2 The feasibility of sustainable transport systems

Transport systems based on motor vehicles are currently largely dependent on petroleum or diesel (produced from oil) as the source of energy, although alternative sources of power are under development.

Current oil (and coal and gas) deposits have taken millions of years to form (Morgan & McCrystal 2009, pp. 39-40) and it would take millions of years, under the right conditions, to regenerate the oil, coal and gas which have been used. Therefore, for practical purposes, neither oil, nor coal, nor gas are renewable.

The current alternatives to oil or liquefied gas as a fuel for transport purposes are primarily based on electricity (batteries), biofuels or hydrogen fuel (*ibid.*, pp. 212-213). In some cases electricity comes from 'green' sources such as hydro, solar or wind, but in 2009-2010 in Australia, 90% – that is, the vast majority – was generated from finite resources (coal, gas) (BREE 2012). These methods of electricity generation produce greenhouse gases as an exhaust product. Hydrogen fuel produces water as an end product. Water vapour is also a greenhouse gas (Morgan & McCrystal 2009, pp. 213, 241). The greenhouse gases (such as CO_2 and H_2O) are currently implicated in changing the Earth's climate, which has implications for the ability of future generations to support themselves (e.g. WCED 1987; Morgan & McCrystal 2009). Hence, hydrogen fuel has the potential to increase levels of greenhouse gases. Therefore, in terms of environmental sustainability alone, motor vehicle based systems do not fit either of the definitions of sustainable transport given in s.8.2.1, whichever form of fuel is used.

A more environmentally sustainable transport system might be based on cycling, which uses human power for locomotion[19] (e.g. Tight *et al* 2011). This is a sustainable source of energy if viewed on an aggregate rather than individual scale, since there will always be individuals coming forward to replace those who are no longer able to provide power. Cycling as an activity does not cause irreparable harm to the environment (see, for

[19] Clearly, battery-assisted cycles, which use a non-renewable resource as a source of power, are not as environmentally sustainable as pedal-only cycles.

example, Chiu & Kriwoken 2003). However, other aspects of cycling are less sustainable than the power source. The materials used in construction, associated equipment and the ability to recycle components are also important.

Cycling itself could be said to be (environmentally) sustainable if:

- the activity itself created no damage that could not be fully repaired;
- the power source was renewable;
- the components of cycles were recyclable;
- the lubricants and other consumables (e.g. handle tape/grips, lights and power sources (batteries), brake blocks, tyres, helmets) currently derived from petroleum-based products or finite resources were instead manufactured from renewable materials (see, for example, Green-Oil UK Ltd 2013); and
- the other equipment and facilities used by cyclists, such as clothing, parking stands and cyclepaths, were also sustainable in themselves (for example, the production of concrete, of which cyclepaths are sometimes made, produces greenhouse gases (Flower & Sanjayan 2007)).

The OECD definition of sustainable transport (*op. cit.*) requires that it not endanger public health. Cycling meets that criterion of social sustainability (BMA 1992; de Hartog *et al* 2010).

The OECD definition of sustainable transport also requires the system to meet all the needs of society for access. Cycling does not do this, given that the distances, speeds and load carrying capacities which have become normal, and therefore expected, in a modern, urban society such as Australia are not always practicable by cycling (e.g. Sharples 2009).

In Australia, access is also a problem for walking, because of the distances and speed expected, and for public transport, because of its limited range and set of destinations. For example, in Sydney, trains do not run to many suburbs, particularly on the Northern Beaches and the eastern suburbs. Buses run to more locations, but are slower than trains (*ibid.*).

Indeed, it can be argued that it is unlikely that the conditions for a sustainable transport system, as defined by the OECD, will ever truly be met. In order to ensure that the public health and ecosystems are not endangered, it would be necessary to have complete control over all aspects of an activity in order to be able to ensure that everything operates as intended. Such control is not possible : human beings are fallible and it is not possible to completely control, or even make allowance for, Nature (e.g. weather systems, volcanoes and earthquakes).

Thus in no case does any current mode of transport fulfil all the requirements of the OECD definition for sustainable transport. However, use of some modes fulfils more requirements, or fulfils them to a greater extent, than others and there is potential to make these modes more sustainable by altering other aspects of society (see, for example, Brindle 1998; IEAust 1999; Black 2010).

A hierarchy that has been given for the sustainability of urban modes of transport is (Kay 2011):

1. walking;
2. cycling;
3. {bus, rail, ferry}; and
4. (other) motor vehicles, particularly private motor vehicles.

The discussion above implies that in order to meet the OECD's criteria for transport sustainability, it would be necessary to either modify society's expectations of what is a reasonable need for travel, or make the existing means of transport more environmentally sustainable, or both. In this study, it is proposed to consider principally environmental aspects of sustainability, that is, methods of making existing transport more environmentally sustainable. However, obvious elements of social or economic sustainability will be mentioned when relevant.

8.3 Existing urban passenger transport modes

8.3.1 Introduction

In s.8.2, transport and sustainability were discussed in overall terms. In this section, transport sustainability will be discussed at the level of an individual transport user and individual modes.

8.3.2 Advantages of private motor vehicles for individuals

Currently, the private motor vehicle[20] (PMV) is the dominant mode of personal transport in Australia, providing almost 90% of motorized passenger transport in the capital cities (BITRE 2009), as can be seen from Figure 8.2 (for example, surveys indicate that, in comparison with figures for motor traffic, there is very little walking and cycling done in Sydney (Sharples 2009)).

[20] Cars, light commercial vehicles and motorcycles

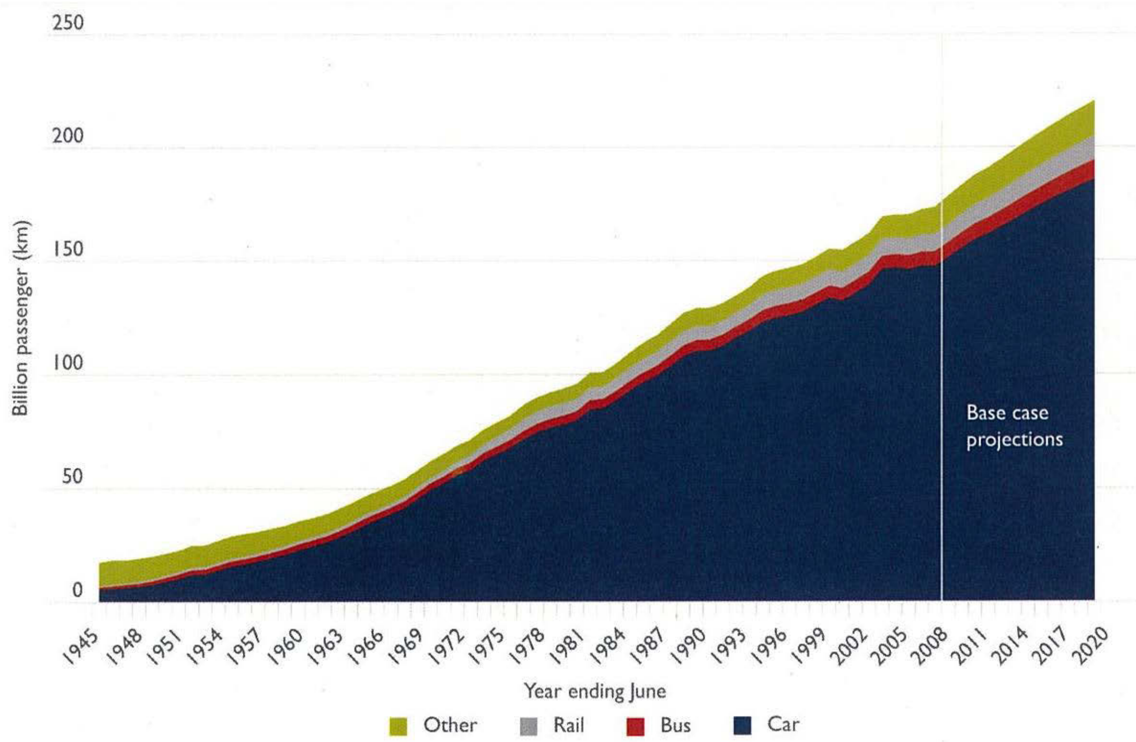


Figure 8.2: The eight Australian capital cities' motorized passenger task, 1945-2008 and projection to 2020
Source: BITRE 2009

This is not surprising. For the driver (e.g. Poulenez-Donovan & Ulberg 1994; Tertoolen *et al* 1998; Stradling 2002; Hiscock *et al* 2002; Gardner & Abraham 2007; Redshaw 2008; Lucas 2009; Hoye *et al* 2011, pp. 22, 28), PMVs provide:

- independence in travel;
- personal control (over travel and the immediate environment of the vehicle);
- privacy;
- convenience; and
- flexibility.

These attributes are available to a much lesser degree with public transport or car pooling/sharing, where the routes and/or timetables are generally fixed and where the vehicle is shared with (many) other people, the choice of whom is outside the individual passenger's control[21].

However, PMVs share these particular advantages (except physical privacy) with walking and cycling. The attributes that give the PMV practical advantages over these two modes are:

- potential faster speed – and hence more time for other activities (*ibid.*, p. 22). This includes travelling to more distant destinations – that is, the ability to take part in activities over a greater spatial domain; and working to pay for the PMV (Whitelegg 1993). In uncongested road conditions, motor vehicles are the fastest mode of travel over the distances frequently expected of people in urban situations (Sharples 2009);
- less physical effort;
- protection of the traveller from the weather (in particular, rain and snow);
- privacy;
- the ability to transport several people at once, and more articles than can conveniently be carried by one person (e.g Hoye *et al* 2011, p. 22);
- the opportunity to display personal wealth or status (or project a particular self-image) by choice of vehicle and accessories (Redshaw 2008; Stradling 2002); and
- cultural acceptability. In the Australian context, it can be seen from Figure 8.2 that driving is a normal activity (that is, the majority of (motorized) trips are done by a PMV and almost 84% of eligible adults in NSW have a driver's licence (RTA

[21] Exceptions exist: for example, taxi services (using a variety of vehicles).

2009a)) whereas, for example, cycling, at less than 1% of all commuting trips in NSW in 2006 (Lehman *et al* 2009), is not.

Other advantages of driving a PMV include:

- psychological benefits (Stradling 2002); and
- promotion of general health in individuals (Macintyre *et al* 2001).

Hence, it may be seen that PMVs have substantial advantages for the individual who drives, compared with those who rely on public transport, walking or cycling. While the active modes provide health benefits (e.g. BMA 1992; de Hartog *et al* 2010), these are a long term consideration and may be of insufficient short term significance to outweigh the advantages of the PMV in a person's day-to-day activities. The dominance of the PMV is not, therefore, surprising.

8.3.3 Problems posed by the private motor vehicle for society

Although PMVs are convenient for the individual, they cause problems for society in general, which may or may not have implications for sustainability. It has been suggested (Whitelegg 1993; Vandenbulcke *et al* 2011) that these include:

- emission of pollution (including air and noise) in use and manufacture;
- contributing to other health problems, including obesity, stress, injury and premature death;
- depletion of scarce resources, including: fuel; energy and materials for manufacturing; land for infrastructure (including driving, parking and storage facilities); road space (congestion); and individuals' time;

- financial implications for both the public and private spheres, including the cost of imported materials and operating costs for both vehicles and the associated infrastructure; and
- inequities in mobility between those who have access to a PMV and those who do not.

However, in the particular case of congestion, which is a transitory phenomenon, it should be noted that current roads do not produce a problem all of the time in all places. Traffic congestion is a concentration of any type of traveller so large that it produces an excess of demand for (road) space over supply of (road) space.

The problem of the concentration of motor traffic which produces congestion is usually an urban problem which manifests itself principally at peak hours (the parameters for which vary, since by definition, peak hours are when there is a problem). If all the 2.626 million PMVs in the Sydney statistical district (BTS 2013) were transported to the Simpson Desert in Central Australia and evenly distributed around its 176,500 square kilometres (Geosciences Australia 2012), there would not be a problem of congestion, since there would be only about 15 vehicles per square km with little infrastructure or other types of vehicles to restrict their freedom to drive anywhere. It is unlikely that (non-greenhouse gas) air pollution would reach dangerous levels. Indeed, under normal circumstances, congestion does not occur at, for example, 3 a.m. in Sydney. Mogridge (1990, p. 279) refers to this as 'ghost town' conditions.

8.3.4 Problems posed by other modes

It has been noticed for many years that all modes which use an engine (not just the PMV) can cause problems because of noise pollution and exhaust:

> People always seem to be wanting to go from one place to some other place, and nobody wants to walk. A few, like postmen, ride bikes. A few, like stockmen in Queensland, the Northern Territory, and the Kimberleys, ride horses. But the rest of us, millions of us, want engines.
> We want motor-cycles, or scooters, or cars, or taxis, or trains, or trucks, or semi-trailers, or buses, or ferries, or aeroplanes – or we even, as in Melbourne, want trams. And all of these things are noisy, and with the exception of trams, all pollute our beautiful eucalyptus scented atmosphere. (O'Grady 1971, p.76)

In fact, as discussed in s.8.2.2, no mode of transport is without problems with respect to sustainability. For example:

- animal powered modes of transport produce **pollution**. This may be in the form of excrement[22], which can generate unpleasant odours and attract insects. The latter may be vectors of disease, either by biting people or by polluting water sources. Dead animals whose bodies are not cleared away also generate unpleasant odours and attract insects. Remedying this pollution has a **cost**. Animal traction also creates noise, which may present a problem (Carcopino 1956, pp. 61-63; Morris 2007);
- public transport (in the Australian context), in the form of taxis, buses, trams, trains and ferries, requires a fuel source, which may overall be more or less **polluting** than an equivalent number of PMVs. For example, it has been suggested that the trams in Melbourne, which are powered by electricity (partly) generated from brown coal, are significantly less energy efficient than buses, heavy rail or

[22] Human beings sometimes need to urinate or produce excrement while travelling. However, there are formal systems for dealing with human waste in these situations, which do not exist for animals.

motorcycles and only marginally more energy efficient than cars (Kaspura 2009). It should be noted that this has been disputed (PTUA 2010). The operation of an engine also produces noise;

- all modes of transport require other **resources**. Some resources are finite; in some cases, greenhouse gases are emitted when the resources are transformed into the final product (Black 2010; Flower & Sanjayan 2007). For example, although timber to build ships is outside the scope of this thesis, timber can be used in railways, as sleepers, fuel and bridges, and to build bridges for other modes. Concrete can also be used in constructing infrastructure for any mode. Steel is needed for railway lines and the vehicle bodies for trains, ferries and buses. Bicycles are constructed of steel. Plastic and/or glass are also used in cycle, bus, ferry and train vehicle body construction;`
- **road traffic accidents** are not unique to the users of PMVs, nor are they a new phenomenon ('Rusticus' 1879; Morris 2007; Black 2010, pp. 17-19). Any mode of transport is liable to unwelcome incidents, since in most cases they are caused by faulty human judgement (O'Flaherty 1986, pp. 459-460) (it should be noted that an attempt is being made in Sweden to create a road system in which it will be difficult to die as a result of a road traffic accident (Toleman & Rose 2007, Toleman & Rose 2009)). Road traffic accidents come at a **cost** for society (Connelly & Supangan 2006);
- **congestion,** or demand for space for travellers and their vehicles (if any) outstripping supply, is not a new phenomenon, as described in s.2.2 (Carcopino 1956, pp. 61-63; Lay 1993, pp. 176-177; Weinstein 2006). Animal powered vehicles

may create congestion if sufficient of them come together at one place (Morris 2007) (see also s.8.3.3); and

- **inequities in mobility because of access to means of transport** are not a new phenomenon. Pooley and Turnbull (1998, p. 64) note that: 'In the past, as in the present, the rich could travel much more easily than the poor ...'.

8.3.5 Practical perspectives

The discussion above reiterates the arguments of s.8.2.1, in that while it can be seen that PMVs do not fit the definition of transport sustainability, neither does any other mode. Even walking is not a truly sustainable form of transport in modern urban environments if walking infrastructure (Flower & Sanjayan 2007) and equipment are taken into account.

It can also be seen that PMVs have many attractions for travellers. It is clear (e.g. Figure 8.2, Stradling 2002; Sharples 2009) that people make a great deal of use of them. Investigation shows that there is a range of strengths of attachment to the use of the PMV and some people do not see any alternative, for themselves, to using cars (at least to some extent) (e.g. Anable 2005; Clennell & Baker 2006; Lucas 2009; Hoye *et al* 2011; Currie & Delbose 2013). Nevertheless, although absolute transport sustainability cannot be achieved under current conditions, as technology and urban planning grow more sophisticated, it may be possible to create a more sustainable transport system than currently exists, particularly if society's demands on, and/or expectations of, transport change.

However, because of the problems that the current level of use of PMVs does cause, some authorities wish to reduce car travel (e.g. NSW DoP 2013, p. 70).

8.4 Reducing road capacity

8.4.1 Implications for sustainability in the general case

Because of the problems described in s.8.3.3 and s.8.3.4, there are implications for sustainability in reducing road capacity. This includes both direct and indirect implications.

The authors of the report on highway capacity reduction (HCR) discussed in Chapter 2 identify three different network outcomes after road space has been reduced (Cairns *et al* 1998, p. 57). The likely impacts on transport sustainability are as follows:

- if the capacity for PMVs has not actually been reduced by the reduction in road space, and therefore there is little change in the traffic on the network, any impact on sustainability in the area (e.g. change in the volume of air pollution) will depend on non-PMV traffic factors (which are outside the scope of this study);
- if the capacity in the treated area has been reduced, but there is still adequate capacity on alternative routes, traffic disappears on the treated routes but reappears in other places or at other times. Therefore, any problems are likely to be relocated; and
- only if there is not adequate capacity on alternate routes, or at another time, and the prevailing levels of congestion and comprehensiveness of the network changes are such that driving in the area becomes unacceptable to motorists, will traffic disappear.

Only in this last case can it be expected that an episode of reduction in road capacity (RRC) will reduce the volume of motor traffic (and potentially increase the volume of public and active transport), thus (potentially) enhancing environmental sustainability in the vicinity of the road network. However, the authors of the HCR report felt that:

> It would be wrong to use as a universal rule-of-thumb a presumption that 16%, or 25%, (or any other standard percentage) of traffic will conveniently disappear as a matter of course whenever road capacity is reallocated. It would also be wrong to assume that *no* traffic will disappear, particularly in situations where continuance of existing traffic levels would imply significant changes to traffic speeds. The effects of a particular capacity reduction will be substantially influenced by the circumstances of the case. (emphasis as in the original) (*ibid.*, p. 56)

Beneficial implications

Referring back to ss.8.2.1 and 8.3.3, it can be seen that if the volume of PMVs is reduced, the direct beneficial implications of an episode of RRC for sustainability can include:

- reduced pollution – by reducing use of the modes which emit the greatest amount of pollution in use (including particulates and noise) and thus are the greatest danger to public health and the environment, the road network at the point of RRC becomes more (environmentally) sustainable. If needs for access are met by public transport instead of PMVs, the extent of the reduction in pollution will depend on whether the pollution from any increase in the number of public transport vehicles needed to service the travelling population outweighs the pollution caused by the now disappeared PMVs;
- safer roads – the presence of fewer PMVs implies less exposure to PMVs for all modes, which in turn implies less potential for road traffic accidents (Cairns 1999a);
- greater use of more environmentally benign forms of transport (Cairns 1999b);
- potential better health – if the traveller changes to a more active mode of transport, their overall health may improve. However, it should be noted that surveys have not found a consistent effect from the use of active transport:

> Targeted behaviour change programmes can be effective in changing the transport choices of motivated subgroups, but the social distribution of their effects and their effects on the health of local populations are unclear.
> Evidence that other types of intervention have been effective is inconsistent, of low validity, based on single highly contextual studies, or non-existent. (Ogilvie *et al* 2004);

- less use of personal resources – fewer PMVs can lead to less congestion with consequent savings of time and temper;
- less use of material resources – by reducing use of PMVs, there is a reduction in the use of fuel, which in the case of petrol, liquefied gas or diesel is a non-renewable resource. There is less wear and tear on the road and vehicles. It may be possible to redirect use of land to uses other than PMV based. Note that it is **not** being suggested that there will be a reduction in the number of PMVs in use. The comments in s.8.3.4 with respect to pollution regarding public transport vehicles also apply here; and
- less use of financial resources – as well as less money spent on (imported) fuel, reduced road space implies less money spent on repair and maintenance of infrastructure. The reduction in spending by private individuals may be offset by the finance needed to support and maintain any increase in public transport or active transport.

The indirect beneficial implications are that by encouraging people to think about their travel, and shifting land uses away from car dependent ones, reductions in road capacity can reduce the desire to use PMVs in other situations.

Adverse implications

Direct adverse implications for transport sustainability are likely to be centred on the (perceived) loss of access.

It is necessary to distinguish here between accessibility and mobility. A reduction in road capacity may make it more inconvenient for an individual to reach a site by car, but may at the same time make it easier for a large number of people to gain access to that site – perhaps by removing car parking and allowing more space for pedestrians, who have reached it by public transport. Hence a perceived loss of access for an individual may actually only be a loss of (one form of) mobility for that individual.

In a follow up article to the HCR report (Cairns *et al* 2002) the authors point out that reducing the road capacity does not necessarily reduce accessibility. For example, the changes brought about as part of the Oxford Transport Strategy (that is, parking restrictions, bus priority, road closures and park-and-ride services (HCR *op. cit.*, p. 185)) caused a reduction in the number of vehicles entering the central area. However, monitoring showed that although the number of people arriving and parking declined by about 700-800 per day, the number of people arriving by bus increased by about 2000. That is, the changes resulted in more people entering central Oxford by bus than had previously entered by car. Furthermore, longer term monitoring of the area around the roads that were closed shows that in many cases the reduction in traffic has continued over a matter of years.

Indirect adverse implications for sustainability may include negative attitudes towards more environmentally benign forms of transport as a result of newly installed infrastructure.

Additional benefits and disbenefits

Particular instances of reduction in road capacity may have additional benefits (or disbenefits) unique to that situation. For example, after the demolition of the Cheonggyecheon expressway and roadway in Seoul, South Korea, in 2002, the exposed stream was landscaped. In addition to the benefits of reduced air and noise pollution from motor vehicles, the natural environment has been enhanced because wildlife has returned to the area. By 2006 the local air temperature had been reduced by between 3.3-5.9°C (Cervero 2010).

8.4.2 Additional consequences

If there is a change from PMVs to more sustainable modes, or trips are in some way suppressed or eliminated, there may be consequences additional to those described in s.8.4.1.

Land use changes

There may be land use changes which:

- change the practicable land uses to ones which do not necessarily require access to the street by PMV at all times (e.g. hardware store to café);
- allow roads to be used for other purposes, such as markets, housing or social spaces. A sufficiently large decrease in motor traffic might permit new modal corridors (such as bus lanes, cycle lanes or space for light rail) to be created; and/or
- reduce the need to make provision for the servicing of PMVs and their occupants. Although it is not within the scope of this study to enquire further into the background of the change in land use, it is worth noting that a proposal has been

made to replace the Shell service station on Epping Road in Lane Cove with a residential and commercial development (NSW DoP 2014).

Timing effects

It is also worth noting that if the capacity that has been eliminated from the road is to be used for other modes instead (as happened on Epping Road), it will not be possible to create the new facilities quickly. Thus, there will be a period when motorists may be making changes to their travel behaviour in the (possible) absence of improved alternative facilities. There is need, therefore, to consider the changes motorists are likely to make while new facilities are under construction.

At this point, it may be instructive to consider the case of Manchester (England) Metrolink, even though it was a rail development rather than a road project. In 1992 two heavy rail lines were replaced by light rail and a short stretch of street running light rail was installed to join the two ex-heavy rail lines. Buses were used to replace the heavy rail service while construction proceeded. Surveys found that only about half the former rail users moved across. However, the line attracted people from cars and generated leisure trips (Knowles 1996). That is, the new mode induced trips and there was a ripple effect related to the existing modes, in both directions.

If these results are replicated in road schemes, the implication is that, to maximize the use of alternate modes, facilities for these alternate modes should be available before the capacity is reduced. In the case of Epping Road, the bus lanes and shared use path were constructed after the road was narrowed. The heavy rail line which might have been relevant to some of the motorists on Epping Road in Lane Cove was not constructed until 2009 (s.4.9.6).

8.4.3 Implications for sustainability in the Epping Road area

Note that the following discussion relates only to Epping Road. It is recognized that the presence and use of the Lane Cove Tunnel has different effects on traffic and residents.

After the capacity of Epping Road was reduced, and bus lanes and a shared use path (SUP) were created, the number of motor vehicles counted travelling along Epping Road decreased and the number of buses and cyclists increased (Chapter 5). In terms of the OECD's definition of transport sustainability (s.8.2.1), this led to the following benefits:

Environmental benefits

- the decrease in motor vehicle traffic on Epping Road led to a reduction in air and noise pollution. Several right turns were reintroduced. This allows for more direct (and therefore shorter) trips which may lead to further decreases in overall pollution:

  "... with the bus lanes .... it personally was the .... reduction in traffic, the reduction in noise, ... the air quality improved ..." (IN5)

  Reinstatement of right turns that give local people ready access to their homes (EM9)

- the decrease in motor vehicle traffic also led to a reduction in congestion and delays at certain intersections:

  Since the changes my run is now MUCH smoother. I get straight across .... in one change of lights and the intersection is very rarely blocked. (EM7)

- the number of bus users in the Epping Road corridor has increased, with attendant (mental) health benefits (but note the caveat in s.8.4.1):

"I can just sit on the bus, do whatever I want, I don't have to worry about .... paying attention to all the other cars on the road, drive around them .... you've got your bus fare versus fuel, toll, whatever .... I don't see the tolls any more .... it's peace of mind ..." (IN6)

"I don't drive more. The other thing I do do, what it has done, it's actually the buses are so much better .... And I, so I don't have that .... that's less driving, much less stress, that's the great thing." (IN5)

When I come from the airport (quite often) I come by public transport because it's so good. (EM17)

- there was a substantial increase in the number of people using bicycles to commute along Epping Road; the number of cycle trips in the a.m. peak increased from an average of 6 in 2001 to an average of about 139 in 2011 (Appendix A) with possible attendant health benefits (BMA 1992; de Hartog 2010) (but see the caveats in s.8.4.1):

*Prior to the road space conversion it was simply too dangerous to cross the Lane Cove River on Epping Road on a bicycle. .... Companies like Optus in North Ryde now have 200-300 employees riding to work every day and many of them travel on the Epping Road cycle path [*sic*] to get there. (EM2)*

Social benefits

- the reduction in the volume of motor traffic has enhanced equity for the residents of Epping Road and adjacent streets by removing some of the waste products of other people's mobility (see above). This also improves the residents' quality of life:

The narrowing of Epping Road has been very welcome for us .... it's still a relief that the road is a little more like it used to be. (EM17)

- the reduction in the amount of air and noise pollution, due to the reduction in the number of motor vehicles, has health benefits:

"... if people are inconvenienced by .... the reduction in .... lanes, ... the benefit is communal health" (IN5)

- the narrowing of Epping Road allowed space to be allocated to bus and cycling which has benefits for the community in more than just a straightforward transport context:

*On weekends the cyclepath [*sic*] also provides a safe recreational facility for families to ride. (EM2)*

- the improved provision for buses and cycling may have increased equity for anyone without access to a PMV, by providing a wider choice of transport modes[23];
- the narrowing of Epping Road and the installation of new pedestrian lights has made it easier for pedestrians to cross:

It also encourages me to shop at local shops, I'm no longer divided from half the municipality by a swift-flowing river of cars. A single lane of PMVs (personal motor vehicles) is much easier for foot-travellers to cross. (EM4)

[23] By definition, this study was unlikely to encounter such people, since it was concerned with motorists.

Economic benefits

- reduced pollution benefits society by reducing the number of harmful influences on human health. This has economic benefits in reduced demand on, and costs for, the resources of the medical system and (potentially) increased employee productivity; and
- an increase in the number of buses enhances employment by requiring more bus drivers and more bus maintenance staff.

Nevertheless, there are some disbenefits to sustainability associated with the narrowing of Epping Road in Lane Cove.

Environmental disbenefits

- for some, the narrowing of Epping Road damaged the aesthetics of the area and thus affected the quality of life:

> *"There was also .... a lovely set of azalea bushes, flower bushes all along that block of Epping Road which got removed and was never replaced and it was just beautiful to drive down there ..." (IN8)*

- some problems have been shifted to nearby routes since vehicles carrying dangerous goods are not allowed in the Lane Cove Tunnel:

> *Once the tunnel opened and Epping Rd traffic flow was reduced to one lane, there was a notable increase of trucks, particularly in the mornings from 6am leading in to peak hour going up the hill from Epping Rd and also in the afternoons going down the hill. Gradually we have noticed more frequent use from cars as well. The increase in noise and garbage left along the gutters is considerable. (EM18)*

Social disbenefits

- negative attitudes towards other modes:

> *... if it were in my power, I would restore Epping Road to what it was and eliminate the bus lane also ... (EM8)*

Economic disbenefits

- reduced rental returns owing to the lack of street parking:

> *... My Mother-in-law has had to go into a nursing home and No [...] Epping Road is now leased to pay for her nursing home costs. The rent my mother-in-law receives has been drastically reduced due to the lack of parking outside No. [...] (EM12)*

8.4.4 Timing of alterations in travel behaviour

It has been explained in Chapters 3 and 6 that an incident of RRC can act as a life event for some people (s.3.3.2). However, the reduction in capacity of Epping Road occurred in three distinct stages, as described in Chapter 4. This gave the opportunity for three distinct events to be the life event associated with the reduction in capacity on Epping Road (although it is possible for an individual motorist to experience more than one life event).

Compared with the pre-tunnel situation in the Epping Road corridor, the three capacity changes, in terms of lanes available for general traffic, were:

1. capacity in the Epping Road corridor was increased when the Lane Cove Tunnel was opened in March 2007. The existing lanes on Epping Road, including tidal flow transit lanes, were still available. The capacity on Epping Road itself did not change;
2. capacity on Epping Road was reduced when lanes were closed in August 2007 in order to construct the bus lanes (open to buses, taxis, motorcycles and pedal cycles)

and shared use path. Buses, taxis and motorcycles (and initially pedal cycles) had to use the general traffic lanes. Therefore, the capacity of Epping Road was reduced in two ways:

- fewer lanes available for PMVs; and

3. PMVs sharing the space that was available with vehicles that had previously used the transit lanes, including buses, taxis, motorcycle and pedal cycles; the bus lanes opened in March 2008 and buses, taxis, motorcycles and most pedal cycles transferred to the dedicated bus lanes. Therefore, the capacity on Epping Road itself was slightly increased in comparison with the previous stage of the works on Epping Road.

The changes are summarized in Table 4.2.

Possible travel behaviour changes associated with these events include:

- using the Lane Cove Tunnel as an alternative to travelling on Epping Road;
- making changes (to route, mode, time of travel, etc – see Table 2.1) by people who could not practicably use the tunnel, or who refused to use it on principle, but whose threshold of acceptability of congestion was exceeded (Chapter 7); and
- changing modes by people who wanted to use the new facilities (for buses, motorcycles and cycles).

The changes that people made, if any, would have depended on:

- the facilities that were available to fulfil their travel requirements; and
- the choices that people felt were open to them.

For motorists who did not want to use the Lane Cove Tunnel, the most likely time to change their behaviour was when Epping Road was narrowed. This was the time when the situation would have been most confused and motorists would have been trying out alternatives until they found a satisfactory way to proceed. It is less likely that the opening of the bus lanes or the shared use path would have caused them to make a substantial change to their driving, although they may have tried the buses or cycling.

Previous research suggests that when people feel the need to make changes to their travel behaviour, they make small changes before they make bigger ones (Mokhtarian *et al* 1997). Examples of small changes by the interviewees were changes in time of travel and route (ss.6.13 and 6.11). IN4 tried both of these before she made the more significant step of moving home (s.6.14).

Hence, if transport planners wish to generate life events to encourage people to use more sustainable modes of transport than PMVs (in particular to make use of any facilities that they provide) the take-up of these new facilities is more likely to occur if any change can be regarded as a small step rather than a large one. That is, it will be necessary to ensure that people's palette of choices include the modes that authorities are trying to encourage.

8.5 Travel competence

8.5.1 Introduction

It has already been noted that when people feel the need to make changes to their travel behaviour, they make small changes before they make bigger ones (*ibid.*). It can therefore be seen that travel is not an effortless activity. Undertaking even the most routine journey involves a cost for the traveller; at a minimum it requires the traveller to expend energy, and sometimes money. Costs are incurred as a result of using resources. Those resources can be divided into two types, physical and mental (Stradling 2002).

Physical resources required by a traveller in order to carry out a journey may include one or more of the following:

- equipment, including appropriate clothing;
- access to a vehicle; and
- appropriate physical abilities (health, strength, use of faculties) for the chosen mode.

Mental resources required to undertake a trip include the cognitive skills of:

- planning the trip (route, time of travel, choice of mode, etc);
- navigation or way-finding; and
- dealing with emergencies or devising ways of overcoming obstacles to the satisfactory completion of the trip.

The mental resources needed for trip-making also include affective effort, that is, the emotional energy expended on preparation for, and execution of, the trip. These emotional considerations include concern about uncertain aspects of the trip. Examples include:

- whether the train or bus will arrive on time;
- whether there will be a car parking space available at the destination;
- whether the pedestrian will encounter delays en route; or
- whether the cyclist will have an unpleasant exchange with a motorist en route.

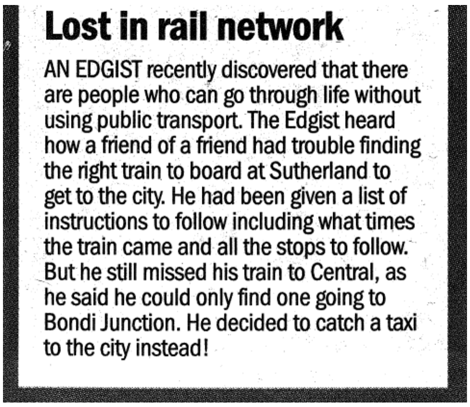
Using a familiar procedure (i.e. doing the trip in the same way that it has been done many times before, with the same mode) might be expected to reduce the amount of mental effort required for the trip. Conversely, using an unfamiliar mode might be expected to require more mental effort than is normally expended on a trip. It might be expected that people would not make an effort to acquire new skills of travelling unless they feel they would be rewarded in some way for their trouble – that is, the activity was worth while.

Knowledge and lack of knowledge can shape attitudes. Research has shown that people can be deterred from trying modes with which they are not familiar by unrealistic ideas of those modes (e.g. motorists may have unrealistic ideas of how long a train journey will take (Fujii *et al* 2001; Brown *et al* 2003; Fujii & Gärling 2005; JMP Consultants 2009; van Exel & Rietveld 2009)). Gardner & Abraham (2007) also consider motorists' misconceptions regarding public transport journey times. These misconceptions with regard to unfamiliar modes also apply to people travelling along Epping Road:

> *"... prior to me selling the motorbike, I wouldn't have even considered the bus, just cause I, I didn't know, ... until you .... do it, you don't know that it's an option. Like you think .... it'd mean I'd have to get to the bus stop, it'd mean all this waiting, people I've heard that this on the news, this and that, people complain about having to wait .... it's all cramped in the morning, so many people want to go .... you think you'll be standing up all the time and then you have to wait, weatherwise you have to wait, rain, then you have to wait for buses, buses are late, and then, but it's actually the buses run quite on time and things like that, so having .... been forced into that path, because I had no transport that week, ... I then realised OK, it's a viable option." (IN6)*

Therefore, if decisions on modal choice for any trip are to be based on rational factors (as assumed in transport models (Ortúzar & Willumsen 1990, p. 245)), it is necessary that travellers have current knowledge of all available and appropriate modes.

Given that the vast majority of trips in Australia are currently undertaken by PMVs (s.8.3.2, Figure 8.2), 'common knowledge' (that is, knowledge that it would be reasonable to expect all the members of any particular group to have) no longer includes the skills of using the other non-walking modes – cycling, bus, rail and ferry, nor walking for anything other than very short trips. If the authorities wish to encourage the use of public transport, walking and cycling, then, in the absence of such common knowledge, it will be necessary to deliberately introduce people to the other modes so they can learn to use them with confidence (both for utility and recreational travel). It is also necessary to teach newcomers (e.g. visitors, tourists and immigrants) how to use the transport system in a particular location: e.g. how to purchase tickets for the public transport system or pay tolls on toll roads. This need is illustrated by an anecdote from a local Sydney newspaper (Figure 8.3):



Lost in rail network

AN EDGIST recently discovered that there are people who can go through life without using public transport. The Edgist heard how a friend of a friend had trouble finding the right train to board at Sutherland to get to the city. He had been given a list of instructions to follow including what times the train came and all the stops to follow. But he still missed his train to Central, as he said he could only find one going to Bondi Junction. He decided to catch a taxi to the city instead!

Figure 8.3 An example of ignorance of the Sydney rail network
Source: *St George and Sutherland Shire Leader*, 26th April 2012 ('Lost in rail network' 2012)

The novice train user described in this newspaper cutting did not know the Sydney rail network (http://www.railmaps.com.au/sydney.htm). He wanted to go to Central Station from Sutherland (in the south of the conurbation) but was clearly not aware that, in Sydney, all the major passenger rail lines (i.e. except the Cumberland, Carlingford and Olympic Park lines) pass through Central Station. Instead of boarding an Eastern Suburbs train which said 'Bondi Junction' on the front (which would have passed through Central about 13 minutes before it reached Bondi Junction) and alighting at Central, he took a taxi to the city, which involved a long road trip (about 27 km north along the Princes Highway of approximately 50 minutes). The (25 km) train trip would have taken 30-45 minutes (depending on the number of stations at which it stopped). It appears that the traveller felt confident that a taxi would deliver him to his destination, but was not confident as to which train would. He was clearly not able to use the other aids to journey planning available at the station (Figure 8.4), including the staff in the ticket office, the wall-mounted indicator boards (Figure 8.4 - top) which are situated opposite the station entrance and the ceiling mounted indicators on the platform (Figure 8.4 - bottom). At the time this incident took place, there would also have been wall mounted timetables on the platform.

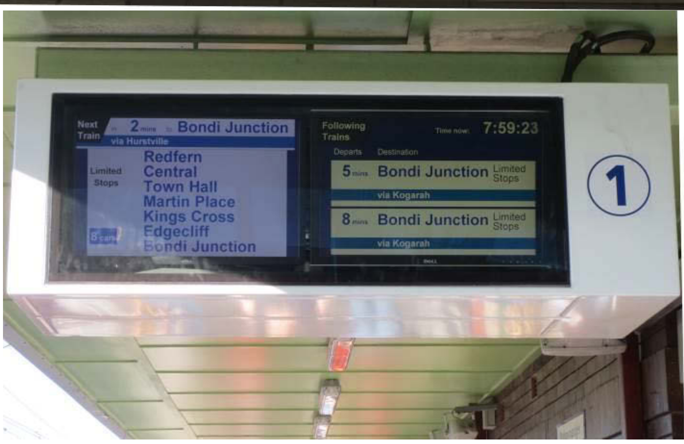


Figure 8.4 Information sources available at Sutherland station
These include: (top) wall mounted indicators in the entrance to the station and (bottom) ceiling mounted indicators on the platform

8.5.2 Travel competence – definition and description

The term 'travel competencies' is proposed as a shorthand description of the skills and attributes people need to use transport. The specific travel competencies needed will vary from person to person and location to location, depending on the person and modes available.

In particular, the term 'travel competent' is proposed as meaning the ability to make informed choices between the available modes. A traveller who has the travel competencies relevant to their situation can be described as travel competent[24]. This skill will be necessary if the transport system is to move away from an overwhelming reliance on the PMV as shown for the capital cities of Australia in Figure 8.2.

Travel competence can be divided into two parts:

1. trip planning competencies (information only – it does not require physical possession of a vehicle); and
2. trip execution competencies (confidence to use the mode and physical requirements – physical ability to use the mode, physical occupation of a vehicle, skills in using the mode).

In order to be able to use more sustainable modes of transport, it is necessary for people to be confident in their use. Acquiring new travel competencies expands the choices available to people; it empowers them by diversifying their transport options and therefore their

[24] Clearly, the ability to use, for example, suburban trains, is irrelevant if the city in question has no such train system (e.g. Hobart, Darwin, Ballarat). Similarly, the ability to use a ferry is impractical, and therefore not relevant, for a person who is prone to seasickness. The law does not permit people with certain disabilities or medical conditions to drive a motor vehicle (Austroads 2011).

ability to undertake other activities, including employment, shopping, social and recreational activities, especially when a life event occurs.

8.5.3 The importance of travel competence

The need for greater travel competence was illustrated in s.8.5.1. Use of the term 'travel competent' suggests a realization that it is not enough to continue learning how to use the various modes of transport in an *adhoc* fashion (just as demonstrating specified proficiencies in driving eventually became a requirement for obtaining a driver's licence (Broomham 1996, pp. 12, 67)). For example, as workplace travel schemes become more widespread (PCAL 2011) it will be important to be able to use a variety of different modes for the journey to work. The term highlights the fact that using transport is a skill, which can be performed well or badly.

An umbrella term emphasizes the fact that these programmes are related to the single issue of accessibility. This is the ability to reach destinations, as distinct from mobility, which is the ability to move. It further emphasizes the fact that, in the future, it may not be possible to drive everywhere. It may become necessary to use public transport to reach some destinations. One of the interviewees in the field study noted that:

> *"... or they may end up saying 'Epping Road is such an important arterial system .... that it's going to be all public transport ...'" (IN3)*

In addition to considerations of social and environmental sustainability, economic sustainability is affected by the ability of people to use modes other than the car. People who cannot use the car may expect some provision for transport to be made available for them. It is likely to be less expensive to train a person to use route based public transport than provide community transport for them when they are no longer able to drive (Stevens *et al* 2013).

8.5.4 Specific travel competencies

The (most widely required) competencies for personal travel in Greater Sydney are summarized in Tables 8.1 (private modes)[25] and 8.2 (public modes)[26]. It is assumed that in each case:

- the user is
  - physically;
  - cognitively; and
  - financially capable of using the mode;
- the user is aware of the legal considerations involved in the use of the mode, including where and when any vehicle may be used; and
- the vehicles and other necessary equipment (if any), such as helmets and lights, are
  - physically sound; and
  - meet the legal requirements of the jurisdiction in which they are to be used.

[25] Other private modes known (anecdotally) to be used in Greater Sydney include private boat (tinny), helicopter, skateboard, roller blades and scooter. Billycarts, while also vehicles, are used predominantly for playing rather than transport. A pram is a vehicle but is restricted to transporting infants.

[26] These modes are found in other cities and competencies required are expected to be similar.

Table 8.1: Travel competencies for the most widespread private modes of transport in Greater Sydney

Mode	Planning competencies (knowledge of)	Execution competencies
walk	route (including gradients, road crossings, short cuts and potential dangers (e.g. dogs, magpies))	
	optimum time to travel	required aids – appropriate shoes, sticks, etc
	speed of walking and likely delays	
wheelchair	route (as for walking, but also dropped kerbs, etc)	access to wheelchair (manual/ electric)
	time, speed etc as for walking	helper, where necessary
	availability of accessible vehicles, where necessary	accessible vehicle
motorized mobility scooter	as for wheelchair	access to scooter of appropriate size
		appreciation of limitations of scooter
(pedal) cycle	route and time as for walking	access to a cycle
		ability to cycle
		ability to cope with expected volume of traffic
motorcycle	route	access to a motorcycle
	potential or actual delays	ability to operate machine
	likely tolls en-route and payment methods	access to toll payment method and credit
	parking options at the destination	licence to operate motorcycle
		ability to cope with expected volume of traffic

Table 8.1: Travel competencies for the most widespread private modes of transport in Greater Sydney (continued)

Mode	Planning competencies (knowledge of)	Execution competencies
car/light commercial vehicles (driver)	route	access to a car/light commercial vehicle; • own • household vehicle • borrowed • company car • hired • share scheme
	potential or actual delays	ability to drive
		licence to operate vehicle
		ability to cope with expected volume of traffic
	likely tolls en-route and payment methods	access to toll payment method and credit
	parking options at the destination	ability to use additional equipment for the vehicle (e.g. navigation systems)
car/light commercial vehicles (passenger)	destination	access to willing driver not suffer from travel sickness
		ability to influence driver
car share	as for car (driver) PLUS	as for car (driver) PLUS
	knowledge of car share origin and destination requirements	knowledge of car share conditions
	pre-planning of requirements	
carpooling (ride sharing)	desired destination	contact with appropriate others personal acquaintances through matching service
	desired time of travel	supply requirements e.g. identification

Table 8.2: Travel competencies for the most widespread public modes of transport in Greater Sydney

Mode	Planning competencies (knowledge of)	Execution competencies
taxi	destinations	
	payment methods	knowledge of fares, concessions
	access and egress points	
car hire	as for car (driver) PLUS	as for car (driver) PLUS
	car hire origin and destination requirements	knowledge of car hire conditions
kiss'n'ride	as for car (driver and passenger) PLUS	as for car (driver and passenger) PLUS
	stopping (drop-off) knowledge may be needed instead of parking knowledge	availability of driver
		appropriate public transport competencies
park'n'ride	as for car (driver) PLUS	as for car (driver) PLUS
		appropriate public transport competencies
public bus	destinations	naming, numbering and signing conventions for location in question
	payment methods	knowledge of fares, concessions and ticketing methods
	scheduling	ability to obtain and read timetables/use automated journey planners
	bus stop locations	knowledge of appropriate travelling locations within vehicles
school bus	timetable	
	payment methods	knowledge of fares, concessions and ticketing methods
	bus stop locations	ability to indicate a wish to board/alight
	permitted passengers	
rail bus	awareness of use	knowledge of boarding/alighting locations
		ability to indicate a wish to board/alight

Table 8.2: Travel competencies for the most widespread public modes of transport in Greater Sydney (continued)

Mode	Planning competencies (knowledge of)	Execution competencies
free bus	awareness of use	knowledge of boarding/alighting locations
	awareness of scheduling	knowledge of bus stop locations
		ability to indicate a wish to board/alight
coach	destinations	naming, numbering and signing conventions for location in question
	payment methods	knowledge of fares, concessions and ticketing methods
	timetable	ability to obtain and read timetables/use automated journey planners
heavy rail – suburban	destinations	naming, numbering and signing conventions for location in question
	payment methods	knowledge of fares, concessions and ticketing methods
	timetable	ability to obtain and read timetables/use automated journey planners
	access and egress points	knowledge of appropriate travelling locations
light rail	destinations	naming, numbering and signing conventions for location in question
	payment methods	knowledge of fares, concessions and ticketing methods
	timetable	ability to obtain and read timetables/use automated journey planners
	access and egress points	knowledge of appropriate travelling locations

Table 8.2: Travel competencies for the most widespread public modes of transport in Greater Sydney (continued)

Mode	Planning competencies (knowledge of)	Execution competencies
heavy rail – long distance	destinations	naming, numbering and signing conventions for location in question
	payment methods	knowledge of fares, concessions and ticketing methods
	timetable	ability to obtain and read timetables/use automated journey planners
		ability to use request stops
	access and egress points	knowledge of platform lengths
cycle on rail	as above, plus knowledge of cycle carriage rules	as above, plus knowledge of long/short term cycle parking options
ferry	access points	naming, numbering and signing conventions for location in question
	payment methods	knowledge of fares, concessions and ticketing methods
	timetable	ability to obtain and read timetables/use automated journey planners
		knowledge of appropriate travelling locations
cycle on ferry	as above, plus knowledge of cycle carriage rules	
water taxi	destinations	
	payment methods	knowledge of fares, concessions
	access and egress points	resistance to sea sickness/tolerance of motion

8.5.5 Selected competencies in greater detail

Private motor vehicles

Motorists need to be able to plan their route. The planning may:

- use existing personal knowledge,
- be specified by a third party;

- use maps (paper or electronic);
- require the help of a passenger or other sources of information; or
- be done by an electronic navigation system.

A route may develop as the trip progresses:

- a known route may be disrupted by incidents experienced (or information received) en-route;
- a diversion may be required from a known route to bypass anticipated delays on the basis of information received (e.g. advanced traveller information systems (ATIS) or traveller observations);
- it may be generated in response to the presence of landmarks, signs or compass directions; or
- it may be generated by random turnings or following other motorists.

As the trip proceeds, there may be disruptions (e.g. the motorist (or a passenger) may recall an errand which must be completed in the course of the trip; or the motorist may take a wrong turning). Alternatively, the motorist may see or hear something which suggests that there will be a disruption to their trip (e.g. congestion) if they continue on the route they are currently using.

In planning the route it will be necessary to know what delays and tolls the driver can expect to encounter en route. Although in Australia there is generally no restriction on the time the motorist is permitted to travel, there may, for example, be delays at certain times for bridges to open for marine vessels or bans on access for motor vehicles in particular areas (e.g. pedestrian malls). At the destination, drivers need to know where they can leave their vehicle while they conduct their business.

To carry out the trip, the motorist clearly needs access to a vehicle (which is fit for use), the ability to drive and, if using public roads, have a driver's licence. If the trip is likely to use a road with electronic tolling, the vehicle should be equipped with the necessary equipment and the driver should be in credit.

It may also be necessary to take unforeseen action in order to cope with emergencies or unexpected obstacles to completion of the trip. Information on the state of the traffic, warning of areas to avoid or reporting on areas which are operating smoothly, is sometimes broadcast on radio or television and may also be available on the Internet.

Cycling

Many of the comments on route planning for PMVs also apply to cycling. Delays are not always as important for cyclists as motorists because of the ability of cyclists to carry their vehicle around obstacles. However, it may be more important to know of facilities which might aid journeys, including cyclepaths and traffic signals, or places to avoid, such as roundabouts.

Route based public transport – general

In general, it is necessary to plan ahead when using public transport in Australia because, unlike driving a PMV or cycling or walking, buses, trains and ferries have timetables (except on high frequency routes). The traveller has to fit in with schedules, so, having found a route that serves their purpose, they need to find out how frequent the service is and, in particular, when the service runs.

There are a variety of methods of ticketing for public transport, which include paying on the vehicle (driver, guard or conductor), pre-paid tickets (per trip), electronic ticketing and season tickets. The fares may be charged by distance, number of zones, flat fares or time. There may be concessions for selected groups (e.g. local students, resident age pensioners). Some services may not require fares (e.g. the 555 buses in the Sydney CBD (Transport NSW 2014)). This is an area which can be very confusing for people not accustomed to the system (Independent Public Inquiry, Long-Term Public Transport Plan for Sydney 2010, p. 27) and therefore discourage occasional users of the mode (e.g. tourists or visitors).

Some buses run so frequently that a timetable is not considered necessary (e.g. Perth's (WA) CAT buses in the central area (Transperth 2012a)); NSW green shuttle buses in several centres (Transport NSW 2014) but in general it is necessary to know when public transport is scheduled to run and useful to know how close it runs to the timetable (e.g. Transperth 2012b). There are now several different forms of timetable, ranging from traditional paper versions through electronic versions on the Internet. Electronic journey planners (e.g. www.transportnsw.info in Newcastle, the Central Coast, Greater Sydney, Wollongong and adjacent areas) and telephone helplines can provide information, as can the staff of information offices.

Public bus

Bus passengers do not have to navigate, so it is not essential that they know the route, but they do need to know their destination and the bus stops at that location. If they do not recognize the local landmarks, the driver or fellow passengers may be prepared to point them out so that the passenger alights at the appropriate point. Sometimes there is a location name on the bus stop or bus shelter. Alternatively, a local landmark may be used as a stopping place for buses.

When there are request stops, passengers need to be able to indicate to the driver that they wish to board or alight.

A prior knowledge of the best travelling location is not needed for all bus passengers, but may be necessary to obtain the best trip: for example, passengers with pushchairs may find that only one area on the bus is suitable for them.

Rail

Because (heavy) rail stations are fewer in number than bus or tram stops, are larger and less easy to miss, and are often marked on maps, there is less difficulty in ensuring that the start and finish of the rail element of a journey are at the correct places. Hence (heavy) rail can be easier to use than some other forms of public transport.

Trains are often longer than buses and it can be useful to know which carriage to use in order to alight at a station and exit it in minimal time.

When trains are crowded and the dwell time is limited, it is useful to know that positioning oneself close to the doors may make the difference between being able to alight at the desired station in time or missing the stop.

Other competencies

The competencies suggested in this discussion are the basic requirements for travelling by that mode. They could be expanded if necessary. For example, if individual carbon trading or personal carbon reduction targets were introduced (Tight *et al* 2007; Sperling & Gordon

2009; Glover 2011) it would be necessary to include the calculation of the carbon footprint of a journey in the list of planning competencies. It would also be possible to extend competency to include skills such as advanced or fuel efficient driving.

8.5.6 Acquiring travel competence

Because there is a desire on the part of some authorities to decrease the use of PMVs and increase the use of other modes (e.g. NSW DoP 2013; TravelSmart 2009), much work has been, and is being, done to teach people how to use transport, particularly modes other than PMVs. This can vary from the informal (e.g. demonstration, lists of instructions) to organized tuition. Examples of sources of information about the use of modes and training include:

- the would-be traveller's associates;
- beginner and advanced driving courses;
- some language courses include instruction on using transport in the relevant country (e.g. Sidwell & Capoore 1990; Chau 2003; Mérieux & Loiseau 2008);
- TravelSmart programmes (e.g. TravelSmart Australia 2009);
- travel training programmes (e.g. Halcrow 2005; Stevens *et al* 2013);
- driver education programmes (for young people before they are old enough to drive alone) (e.g. The George Institute 2010);
- cycling proficiency courses (e.g. BFA 2006);
- travel training programmes specially designed for people with brain injuries or other disabilities (e.g. Newbiggins & Laskey 1996; Ride Connection 2009);

- community transport may include travel training for people unable, for a variety of reasons, to access either private or public transport (e.g. Battellino & McClain 2011); and
- a survey of motorized mobility scooters and their use in Australia (Johnson & Rose 2013).

However, this assumes that people are prepared to accept the need for training. Government policies could encourage this. They could also promote a culture within organizations over which they have some control (which often includes public transport operators) of creating a system which is easy for travellers to use, rather than emphasizing ease of use for operators. Further work on this topic is beyond the scope of this thesis.

8.5.7 Mutual understanding between users of different modes

In addition to reducing the need for travellers to rely on one mode (which is the PMV in the Australian situation) (Figure 8.2) and enlarging the person's skill set, enhanced travel competence might be assumed to promote better relations between travellers using different modes (and hence enhanced social sustainability). More competent individuals might be expected to be better able to empathize with travellers on a different mode to their own and thus be better able to make allowances for other people's problems in using the transportation system.

For example, during the count on the Epping Road SUP in November 2011, when told that a cycle and pedestrian count was being conducted, the following exchange occurred:

Bus driver: "Did they give you a gun?"

Surveyor: "What for?"

Bus driver: "To shoot the cyclists."

Such an aggressive attitude towards cyclists suggests that there is something badly wrong with the relationship between the two groups, which bodes ill for social sustainability[27].

The bus driver may have disliked cyclists because some used the bus lane instead of the SUP. He may not have appreciated cyclists' problems in using a path into which motorists may suddenly intrude without apparently being aware that a cyclist is coming. Cyclists using the bus lane may not appreciate that they may be causing delay to a bus driver (and therefore, the passengers on the bus) by blocking the bus's passage along the bus lane. Both types of traveller are disadvantaged by other groups who slow them down and interfere with their free passage. Buses can be delayed by private motorists or taxis picking up passengers or dropping them off in bus lanes, or cyclists using bus lanes. Cyclists can be delayed by pedestrians spreading across the whole width of a SUP and by children and animals using the path without thinking of other users (BNA 2008, fobfob). Cyclists may be endangered by motorists driving across the cyclepath – or even along it (which in the case of the Epping Road SUP, may endanger pedestrians too) (BNA 2008, ShanDog).

Several researchers have considered the attitudes of cyclists towards motorists and the attitudes of motorists towards cyclists. Liz Speed worked in the UK in the 1980s. There is a low level of cycling in the UK overall (e.g. in 2010, the UK government figures show that for Great Britain as a whole, 1% of passenger kilometres were by bicycle (unchanged from 1990)) and a high level of car use (e.g. in 2010, 84% of passenger kilometres were by car, van or taxi, from 85% in 1990) (DfT 2011)). Speed found that:

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[27] It must not be assumed that this attitude is universal. One interviewee reported a bus driver letting him travel free because his bicycle had a puncture.

> Drivers tended towards one attitude, cyclists towards another, while those who both drove and cycled lay between the two extremes. This suggests that the type of transport used is associated with the attitudes of an individual, and that to be both a cyclist and driver is associated with a less extreme attitude than that displayed by those who only drive or only use a bicycle. (Speed 1990)

She found that: 'An intrinsic feature of the findings, therefore, was the level of self-interest displayed by respondents.' She noted that:

> The greatest opportunities for success [in improving safety for cyclists] therefore, are *either* through close co-operation with all user groups in an attempt to change attitudes towards an acceptance of cycling and traffic restraint, *or* to build in measures which are virtually impossible to disobey. (*ibid.*) (emphasis as in the original)

Her recommendations included:

4. **Introduce the practice of taking at least one driving lesson on a bicycle,** another as a pedestrian. ...

5. **Ensure that as many children as possible undergo some form of cycling lessons and test** ...

6. Despite the majority of adult cyclists .... also having a driving licence, **an educational programme directed specifically at young adults could be developed.** ...

8. **A fuller use of the retraining, retesting, insurance incentives to study for the advanced drivers test.** ... (*ibid.*) (emphasis as in the original)

Relations between motorists and cyclists were explicitly considered in a study in five different urban areas of England. The report recommendations included:

- education of drivers should focus not on helping them to predict cyclist behaviour but on understanding the circumstances, including driver behaviour, that will influence cyclist behaviour; and
- training to improve awareness of required behaviours at road features and cyclist facilities may be helpful for both drivers and cyclists ... (Basford *et al* 2002, p. 1).

Nevertheless, the authors felt that encouraging more drivers to take up cycling would not improve motorists' attitudes towards cyclists significantly. That was because 'self-categorization theory' (Turner 1987, cited by Basford *et al* 2002) holds that people identify with the group most relevant at any point, so drivers are likely to think of themselves primarily as motorists when in a car, rather than cyclists.

In 2004 the Australian Bicycle Council and Austroads sponsored a general study of the interaction of cyclists and buses (Ker, Yapp & Moore 2004). Most recently, the City of Sydney commissioned a study of the interaction between cyclists and bus drivers (Baumann, Brennan & Zeibots 2012) which explored cyclists' and bus drivers' attitudes towards each other. On the basis of the opinions expressed by both groups, it made recommendations for each which might help them co-exist more amicably.

The attitudes uncovered in this doctoral study concur with the findings of Basford *et al* (2002) with respect to attitudes of motorists, both professional and 'amateur' drivers towards cyclists,. For example:

"Like you don't want to be in anyone's way, ... being a driver and a cyclist I know that the drivers do get annoyed with a bicycle in the way, so I try .... my best to just stay out of their way whenever I can." (IN6)

However, further exploration of this subject is not within the scope of this study.

Although the respondents to this study expressed opinions on the bus lanes and SUP, they did not mention pedestrians or bus passengers.

8.5.8 Travel competence and sustainability

It has been noted (s.8.2.1) that sustainability is a strategy rather than a series of problems to be solved (Brindle 1998). That is, travelling in a sustainable manner is not something that can be undertaken once and then forgotten about. It is necessary that travellers adjust their mindset so that travelling in the most sustainable manner appropriate becomes a normal procedure. In order to do that, it is necessary to know how to use the modes available.

Being travel competent means that the traveller has those skills, that is, they are able to travel in the most sustainable manner for the situation, whether that is using the most environmentally benign mode of transport for the situation or finding a way to achieve the errand with the minimum of physical relocation.

That is, maximum travel competence is essential for a sustainable transport system.

8.6 Travel competence and reducing road capacity

8.6.1 Introduction

As discussed in s.8.4.1, it cannot be assumed that any particular volume of traffic will disappear after an incident of RRC. Nevertheless, it may be possible to enhance the non-

PMV figure by enhancing travellers' travel competence. It follows, therefore, that enhancing travellers' travel competencies would also make an incident of RRC less disruptive and more acceptable – that is, it would make it easier for motorists to accomplish their travel tasks when it is not possible to proceed as they normally would.

This appears to be what happened in the case of disruption to Brisbane's Riverside Expressway (REX) in 2006. The following description is based on a conference paper describing the incident (Marinelli & Watson 2009) and the reports produced after the event, analysing the incident and responses to it (TMR 2009).

8.6.2 Brisbane Riverside Expressway, Queensland

The Riverside Expressway is a stretch of motorway which forms part of the Pacific Motorway and runs (on piles) for almost 2 km parallel to the northern bank of the Brisbane River in Brisbane's central business district (CBD). It connects Coronation Drive in the west with Captain Cook Bridge and the rest of the Pacific Motorway to the south-east (Figure 8.5). A SUP, the Bicentennial Bikeway, runs underneath the expressway for much of its length, with access to both sides of the river for both cyclists and pedestrians. Captain Cook Bridge was one of four road bridges within one kilometre of the General Post Office in 2006. Public transport in the area near the Riverside Expressway includes rail, bus and ferry.

On Tuesday 17th October 2006, a hairline crack was discovered in an on-ramp to the expressway. Queensland Main Roads closed the road and two ramps to motorists, and redirected cyclists and pedestrians from the Bicentennial Bikeway underneath the ramp, while investigations were undertaken. At the outset, it was not known what remedial work would need to be undertaken, nor how long the road closure might be expected to last.

Figure 8.5 Riverside Expressway in Brisbane above Bicentennial Bikeway
(October 2011)

However, the road was reopened three days later, on Friday 20th October 2006, although the two ramps which had been closed were not reopened to most traffic until 10 days later, on the 27th October.

Traffic counts and public transport ticket analysis indicated that the closures had caused little change to traffic north of the Brisbane River. However, there was a significant redistribution of motor traffic within the CBD area, particularly on alternate river crossings. Public transport patronage increased by about 8%. The impact of the closure lessened with distance from the CBD. A household travel survey conducted about four weeks after the closure indicated that overall:

- 51% of respondents had changed route;
- 38% of respondents had changed their time of travel;
- 14% of respondents had changed mode; and
- 7% of respondents had postponed or cancelled their travel.

(This adds up to more than 100% because some respondents changed more than one aspect of their travel.)

An episode of TravelSmart (s.3.2.1) was under way in north Brisbane when the problems with the Riverside Expressway emerged. Questions about the impact of the Riverside Expressway closure were added to the follow-up survey that had been planned for the TravelSmart participants.

The results of this (TravelSmart) survey indicated that only 14% of people involved in that initiative reported being affected by the closure, which was less than half the 29% reported across Greater Brisbane. However, 27% of the people who had been involved in the TravelSmart initiative reported changing mode which was almost twice the proportion who changed mode across the whole of Brisbane.

One possible conclusion from this is that the people who undertook the TravelSmart initiative were better primed to respond to the emergency situation when it arose. In the terms of the discussion in this chapter, their travel competence had been enhanced. However, this conclusion must be treated cautiously, since those people may have originally embarked on TravelSmart because they were already receptive to the TravelSmart message, that is, to the idea of using alternatives to the private motor vehicle. Therefore it may not be possible to generalize the finding to the population at large.

8.7 Summary

Like RRC, sustainability is not a new concept. Nor is sustainability merely a matter of solving a few technical problems. It requires a strategic vision which embraces many areas of life.

None of the commonly used forms of personal transport are absolutely environmentally sustainable. They do not meet a precise definition of sustainable travel, such as that given by the OECD, nor do they meet the more general one derived from the Brundtland statement, that is, in the sense of having no effect on the ability of future generations to meet their own transport needs. Even walking, the most sustainable form of transport, creates problems of greenhouse gas emission if the infrastructure associated with walking or the use of oil to create materials used in walking apparel, such as shoes, is considered.

Thus, it is more realistic to speak of more or less sustainable transport than to attempt to define an absolute standard.

As a general rule, the order of decreasing environmental sustainability for commonly available modes in Australia is:

- walking;
- cycling;
- {bus, rail, ferry}; and
- (other) motor vehicles.

To improve the sustainability of modern car-based societies, it is necessary that a greater number of people should use more of the more sustainable forms of transport or that fewer trips should be made, or both.

The empirical evidence is that people are more likely to use public transport if they have recent experience of it. Assuming that this also holds true for cycling and walking, a way to increase the use of the more sustainable modes, therefore, is to ensure that people have recent experience of them.

There is also empirical evidence that when roads are reduced in capacity, an element of the existing traffic flow disappears. Not all of this flow can be accounted for by migration to other roads, times or modes. Hence, when it is successful, RRC is another tool for transport demand management, and contributes to a sustainable urban future by:

- reducing congestion, air pollution and noise;
- encouraging people to think about modes other than cars;
- reducing the need to build infrastructure to service PMVs; and
- changing the practicable land uses around the area of RRC.

The concepts behind travel competency – that is, of an individual being experienced in all the available modes so that they can use whichever mode is the most appropriate in a given situation, builds on, and brings together, work already being done, including TravelSmart (or the local equivalent, such as TravelWise in the UK), travel training, driver education (both beginners and advanced) and cycling proficiency courses.

CHAPTER 9

Conclusion

This chapter summarizes the study and the findings which were made. It makes suggestions for further work. The contributions to new knowledge are also summarized.

9.1 Summary of work

Reduced road capacity is a phenomenon that is likely to have been of concern as long as roads have been constructed, since disturbances in communication can impinge on all areas of life. Roads can be reduced in capacity both deliberately, by responsible authorities (for example, in order to provide capacity for particular classes of traffic such as turning vehicles, buses and pedestrians, or roadworks) and accidentally (for example, as a result of earthquakes, accidental damage, terrorism or acts of war). Figure 1.1 provides a breakdown of the ways in which capacity can be reduced, both in terms of whether the incident was planned or unplanned, and whether it is likely to have permanent or temporary results. Chapter 1 of this thesis also gives examples, in general terms, of incidents which fall into the category of reducing road capacity.

The effect on traffic of this phenomenon, although studied in individual cases, was not considered systematically until the end of the twentieth century. In 1998, a report on the subject was published in the UK (referred to in this thesis as the HCR report). It discusses the theoretical background for this subject and follows that with 44 case studies from around the world. The precipitating causes include the creation of bus lanes, damage to infrastructure and earthquakes. The report contains a description of the case of reduced road capacity in Australia which was suggested by the author of this doctoral study. Amongst other points, the HCR report notes that the overwhelming evidence is that traffic disappears after an incident of reduced road capacity, but only to the extent that it needs to. However, the report offers no explanation as to how and why this happens. The report also notes that many aspects of the subject remain to be investigated. The HCR report, plus individual case studies before and since its publication, are discussed in Chapter 2.

All the individual cases described in the HCR report were surveyed in a quantitative manner, with little qualitative input. As the author of this thesis has an interest in habitual behaviour it was decided to consider the influence of motorists' existing travel habits on their reactions to reduced road capacity in this doctoral study, using a qualitative approach.

Several authors note that habits can be broken when life events occur to disturb a person's routine. This thesis contains a list of 45 life events, in eight categories, which might affect travel behaviour. The unique nature of reductions in road capacity as life events is also discussed. This is followed by a discussion of habits.

From the analysis of the transcripts (and confirmed by comments from other respondents), it was possible to see that the travel habits of the interviewees included choice of mode, choice of route, manner in which a route was assembled and some aspects of their style of driving.

The physical changes in Epping Road impacted some aspects of several interviewees' style of driving. The traffic congestion, which some interviewees felt was caused by the narrowing of Epping Road, had caused some interviewees to change their route or time of travel. The facilities which were provided for other modes had, in some cases, affected interviewees' choice of mode.

Interviewees described five ways of devising a route for their travel. Some interviewees had the habit of looking for an alternative route when they found the level of traffic on their current route uncomfortable.

It was apparent from their comments that some interviewees had a wider range of transport skills than others. This was most obvious in the use of the available modes. The concept of travel competence describes the varying palette of travel options which travellers possess and which allows for the enhancement of the sustainability of the travel experience. The travel competent traveller who is concerned about sustainability is able to select the most appropriate mode to use for any trip, instead of relying on one (which, in Australia, is usually the car).

9.2 Main findings

Two hypotheses have been proposed which incorporate the route switching habit and suggest reasons for traffic disappearing to the extent that it needs to. The first, the route-switching hypothesis, states that:

> There is a continuum of route-switching behaviour amongst motorists, which varies from none, through occasional, to switching routes whenever the situation exceeds a personal threshold of difficulty.

The second, the minimal chaos hypothesis, states that:

> Route switching by a percentage of motorists, in combination with other motorists leaving the route or changing their time of travel, results in changes which tend towards the minimum necessary required to avoid on-going disruption.

This latter hypothesis can be represented graphically as:

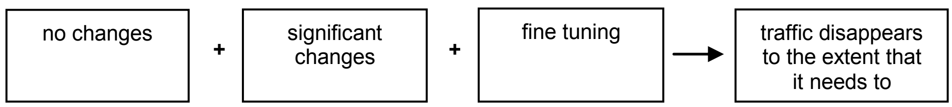


Figure 9.1 Conceptual model of disappearing traffic

9.3 Limitations and level of confidence

This study has been limited by the fact that the sample of motorists was selected on a convenience basis. Although both genders were represented and there was a range of ages, income bands, types of household and employment situations amongst the interviewees, there was no representation from travellers who only passed through Lane Cove and the surrounding area on an occasional basis. The interviewees either lived in Lane Cove or used Epping Road regularly. It is possible that motorists who used Epping Road on a less regular basis (and, therefore, might not know it as well as the interviewees in this survey) would have different responses to those found in this study.

Nevertheless, the responses that were obtained are considered to be accurate statements of interviewees' attitudes and behaviours. All interviewees showed a genuine interest in the study and accepted the option of receiving any reports produced as a result of the work. Interviewees were frank in the descriptions of their driving.

9.4 Innovatory aspects of this study

In the process of this study, a number of concepts were revisited, defined or introduced. These are summarized in Tables 9.1 to 9.4. It is hoped that these concepts will contribute to further research in this area.

Table 9.1 Innovations from this thesis

Innovation	Notes
Use of the phrase ‘reduction in road capacity’ (RRC)	The phrase replaces ‘highway capacity reduction’, which could be misleading in some jurisdictions (including Australia).
Qualitative study of reduced road capacity	The literature review found a predominance of quantitative studies of this subject, and no survey using semi-structured interviews.
The inclusion of opinion from social media in the analysis of reactions to the narrowing of Epping Road	The literature review found no use of social media in transport studies.

Table 9.2 Contributions to knowledge

Contribution to knowledge	Notes
Consideration of the effect of existing habits on motorists’ reactions to reduced road capacity	The literature review found no discussion of habits in conjunction with a reduction in road capacity.
Consideration of style of driving as potentially habitual behaviour	The literature review revealed that the travel habits most often studied are choice of mode or route.
Cycle and pedestrian count of shared use path associated with Epping Road in Lane Cove	The literature review found no current counts of cyclists using Epping Road and no counts of pedestrians from any period.
Presentation of two hypotheses to explain the level of traffic which results after a reduction in road capacity	The hypotheses provide a potential explanation for the empirical evidence that traffic disappears if it need to after a road is reduced in capacity.

Table 9.3 Extensions to existing knowledge

Innovation	Notes
Graphical analysis of categories of reduced road capacity	See Figure 1.1.
Systematic list of possible responses to reduced road capacity	See Table 2.1; enhancement of Figure 5A from HCR report.
Systematic list of life events which might precipitate an alteration in travel behaviour	See Table 3.1; collection and enhancement of lists of life events found during the literature review.
Analysis of RRC's nature as a life event which applies to an entire group of people, simultaneously	Most life events considered in the literature apply to individuals.
Summary of changes in the capacity of the Epping Road corridor after the Lane Cove Tunnel was constructed	This information was not found during the literature review.
Systematic analysis of the factors involved in devising a route	Collection and enhancement of lists of factors found in the literature.

Table 9.4 New definitions

Innovation	Notes
Definition of a 'ripple' effect in choice of route, mode or time of travel	The effect is described but not named or defined in the literature.
Development of the concept of travel competence and travel competencies	The term brings together many disparate activities and consolidates them as one concept.

9.5 Recommendations for further work

Clearly, it is necessary to test the hypotheses that were developed as a result of the study and refine them if necessary. This could be done with the aid of models, followed by statistical surveys of traffic volumes, both before and after a situation of reduced road capacity. As the topology of each network is different and the other events taking place on the network at the same time may interfere with the effect that is produced by the reduction in capacity, it may be advantageous to use a different network for further work in order to ensure that the concepts that have been developed are not unique to the network of which Epping Road is part.

Questions to be considered include whether the small percentage of motorists who do change routes is enough to create the effect that is observed and whether any other factor is involved. It is particularly important to understand why this effect does not occur in 'normal' congested traffic. Further work may be necessary to answer these questions.

A further aspect of habitual behaviour that was not considered explicitly in this thesis relates to motorists' habit of moving around on the road (e.g. overtaking). Some of the motorists interviewed complained that they were unable to drive in the way they normally did because of the reduction in the number of lanes available to them. However, not all motorists interviewed felt disadvantaged enough by this to complain. Further investigation could be done in order to determine the significance of this difference in attitude, in order to maximize the acceptability of further schemes of reduced road capacity. That is, it may be useful to ascertain whether the number of lanes before and after the reduction in capacity is of widespread concern and if so, why.

If the concept of travel competence is to be of use to transport practitioners, it will be necessary to devise a scale which will allow it to be measured and compared. It may be necessary to define several scales, in order to be able to measure the economic impact of the changes that greater travel competence can bring, as well as people's attitudes and willingness to consider the use of alternative modes.

References

'STREET TRAMWAYS.' 1878, *The Sydney Morning Herald (NSW : 1842 - 1954)*, 18 June, viewed 2 January 2013 http://nla.gov.au/nla.news-article28394385

'That Horrible Tram (A Route Resident's Refrain)' 1882, *Sydney Punch*, 23rd September.

'Colonel Crompton on the motor car' 1902, *Sydney Morning Herald*, 1st January, viewed 28/11/2012 http://nla.gov.au/nla.news-article14464937

Report of the Royal Commission for the Improvement of the City of Sydney and its Suburbs 1909, New South Wales Legislative Assembly, Sydney.

'A new parking ban?' 1955, *The Argus*, 5th July, viewed 3/12/12 http://nla.gov.au/nla.news-article71665779

habits 1993, in J. Daintith, E. Martin, F. Alexander & J. Wright (eds), *The Bloomsbury Thesaurus*, no 586, Bloomsbury Publishing Ltd, London, pp. 621-622.

'If new roads generate traffic, what happens when capacity is reduced?' 1997, *Local Transport Today (LTT) (News Extra)*, 8th May, p. 11.

'Delays for drivers on Epping Road' 2007, *Sydney Morning Herald (Drive)*, 28th August.

'First peak-hour test for new Epping Rd' 2008, *Sydney Morning Herald (Drive)*, 10th March, viewed 19/2/2012 http://news.drive.com.au/drive/motor-news/first-peakhour-test-for-new-epping-rd-20080310-143gm.html

Your guide to bus services at Lane Cove Bus Interchange 2008, flyer, Transport for NSW, Sydney, http://web.archive.org/web/20080719084637/http://transport.nsw.gov.au/news/Lane-Cove-Interchange.pdf

'Along the right lines' 2010, *Sydney Morning Herald (pullout)*, 15th February.

'Epping Rd bike path claims another victim' 2011, *Epping Rd bike path claims another victim*, Sydney Cyclist, viewed 8/4/2014 http://www.sydneycyclist.com/forum/topics/epping-rd-bike-path-claims-another-victim?xg_source=activity&id=1321712%3ATopic%3A357808&page=1#comments

'Bike audit by NRMA out of date' 2012, *North Shore Times (News)*, 11th January.

'Bike audit by NRMA out of date' 2012, *Bike audit by NRMA out of date*, Damien M., viewed 4/4/2014 http://www.sydneycyclist.com/forum/topics/bike-audit-by-nrma-out-of-date

'Lost in rail network' 2012, *St George and Sutherland Shire Leader (On the edge)*, 26th April.

"Rusticus" 1879, 'Furious Riding and Driving', *The Sydney Daily Telegraph (Correspondence)*, 18th September.

AAP 2007, 'More lanes to close for Lane Cove Tunnel', *Sydney Morning Herald (Breaking News)*, 7th August, http://www.smh.com.au/news/National/More-lanes-to-close-for-Lane-Cove-Tunnel/2007/08/07/1186252685362.html

Aarts, H. & Dijksterhuis, A. 2000, 'The automatic activation of goal-directed behaviour: the case of travel habit', *Journal of Environmental Psychology*, vol. 20, pp. 75-82.

Aarts, H., Verplanken, B. & van Knippenberg, A. 1997, 'Habit and information use in travel mode choices', *Acta Psychologica*, vol. 96, no. 1, pp. 1-14.

Abdel-aty, M.A., Vaughn, K.M., Kitamura, R., Jovanis, P.P. & Mannering, F.L. 1994, 'Models Of Commuters' Information Use And Route Choice: Initial Results Based On A Southern California Commuter Route Choice Survey', *Transportation Research Record*, no. 1453, pp. 46-55 http://escholarship.org/uc/item/4d84z60v

Abelson, R.F. 1981, 'Psychological status of the script concept', *American Psychologist*, vol. 36, no. 7, pp. 715-729.

Ahmed, F., Rose, G. & Jacob, C. 2010, 'Impact of weather on commuter cyclist behaviour and implications for climate change adaptation', paper presented to the *33rd Australasian Transport Research Forum 2010*, Canberra, 29th September - 1st October http://www.atrf.info/papers/2010/2010_Ahmed_Rose_Jacob.pdf

Ajzen, I. 1991, 'The theory of planned behaviour', *Organizational Behaviour and Human Decision Processes*, vol. 50, pp. 179-211.

Ajzen, I. 2002, 'Perceived behavioral control, self-efficacy, locus of control, and the Theory of Planned Behavior', *Journal of Applied Social Psychology*, vol. 32, no. 4, pp. 665-683.

Ajzen, I. 2005, *Attitudes, Personality and Behavior*, 2nd edn, Open University Press, Maidenhead, Berkshire.

Ajzen, I. & Fishbein, M. 1980, *Understanding attitudes and predicting social behavior* Prentice-Hall, Eaglewood Cliffs, New Jersey.

Ajzen, I. & Fishbein, M. 2000, 'Attitudes and the attitude-behavior relation: Reasoned and automatic processes', in W. Stroebe & M. Hewstone (eds), *European Review of Social Psychology*, John Wiley & Sons, pp. 1-33.

Ampt, E. & Rooney, A. 1998, 'Reducing the impact of the car - a sustainable approach: TravelSmart Adelaide', paper presented to the *22nd Australasian Transport Research Forum*, Sydney, September 1998 http://www.atrf.info/papers/1998/1998_Ampt_Rooney.pdf

Ampt, E., Wundke, J. & Stopher, P. 2006, 'Households on the Move: New Approach to Voluntary Travel Behaviour Change', *Transportation Research Record: Journal of the Transportation Research Board*, no. 1985, pp. 98-105.

Ampt, E.S., Swanson, J. & Pearmain, D. 1995, 'Stated preference: too much deference?', paper presented to the *Transportation Planning Methods Conference*, 11th -15th September.

Anable, J. 2005, "Complacent Car Addicts' or 'Aspiring Environmentalists'? Identifying travel behaviour segments using attitude theory', *Transport Policy*, vol. 12, no. 1, pp. 65-78.

Angus, M. 1975, *The World of Olegas Truchanas*, 6th edn, Australian Conservation Foundation, Melbourne.

Arup 2009a, *Before and After Study*, Report Number RTA/Pub.09/.480, Roads and Traffic Authority, Sydney http://www.northsydney.nsw.gov.au/resources/documents/LCT_trafficevaluation_before_after_study.pdf

Arup 2009b, *Local Street Improvements*, Roads and Traffic Authority (RTA), Sydney http://www.northsydney.nsw.gov.au/resources/documents/LCT_trafficevaluation_local_street_improvements.pdf

Australian Department of Climate Change 2009, *Climate Change Risks to Australia's Coast: A First Pass National Assessment*, Australian Department of Climate Change, Canberra http://www.climatechange.gov.au/publications/coastline/climate-change-risks-to-australias-coasts.aspx

Austroads Incorporated 2009, *Part 3: Traffic Studies and Analysis*, Austroads Incorporated.

Austroads Incorporated 2011, *Assessing Fitness to Drive*, Austroads Incorporated, viewed 1/8/2012 http://www.austroads.com.au/assessing-fitness-to-drive/

Bain, R. 2009, 'Error and optimism bias in toll road traffic forecasts', *Transportation*, vol. 36, no. 5, pp. 469-482 http://www.robbain.com/Bain_Transportation_2009.pdf

Baker, J. 2007a, 'Traffic jams likely as drivers test new tunnel', *Sydney Morning Herald (News)*, 26th July, viewed 14/2/2012 http://www.smh.com.au/news/national/traffic-jams-likely-as-drivers-test-new-tunnel/2007/03/25/1174761283863.html

Baker, J. 2007b, 'Tunnel timing no coincidence, says Opposition', *Sydney Morning Herald (News)*, 24th - 25th February, viewed 19/2/2012 http://www.drive.com.au/Editorial/ArticleDetail.aspx?ArticleID=35798&vf=1&IsPgd=0

Baker, J. 2007c, 'Tunnel ushers in $20 commute', *Sydney Morning Herald (News)*, 26th March, viewed 14/2/2012 http://www.smh.com.au/news/national/sydneysiders-braced-for-20-commute/2007/03/25/1174761283845.html

Bamberg, S., Ajzen, I. & Schmidt, P. 2003a, 'Choice of travel mode in the theory of planned behaviour: the roles of past behaviour, habit and reasoned action', *Basic and Applied Social Psychology*, vol. 25, no. 3, pp. 175-187.

Bamberg, S., Rölle, D. & Weber, C. 2003b, 'Does habitual car use not lead to more resistance to change of travel mode?', *Transportation*, vol. 30, no. 1, pp. 97-108.

Banister, D. 2008, 'The sustainable mobility paradigm', *Transport Policy*, vol. 15, pp. 73-80.

Basford, L., Reid, S., Lester, T., Thomson, J. & Tolmie, A. 2002, *Drivers' perceptions of cyclists*, Report Number TRL549, Department for Transport (DfT).

Battellino, H. & McClain, K. 2011, 'Community Transport in NSW - broadening the horizon', paper presented to the *Australasian Transport Research Forum*, Adelaide, 28th - 30th September http://www.atrf.info/papers/2011/2011_Battellino_McClain.pdf

Bauman, C., Brennan, T. & Zeibots, M. 2012, *Bike Rider and Bus Driver Interaction Study*, Institute for Sustainable Futures (ISF), Sydney http://cfsites1.uts.edu.au/find/isf/publications/Baumannetal2012bikeandbus.pdf

Bayliss, D. 2002, 'Sustainable transport policy - an overview', *Proceedings of the Institution of Civil Engineers: Municipal Engineer*, vol. 151, no. 1, pp. 1-2.

Beder, S. 1996, *The Nature of Sustainable Development*, 2nd edn, Scribe, Newham, Victoria.

Behrens, R. & Del Mistro, R. 2006, 'Methodological problems in the analysis of changing habitual travel behaviour over time', paper presented to the *25th Southern African*

Transport Conference (SATC 2006), Pretoria, South Africa, 10th -13th July http://repository.up.ac.za/upspace/bitstream/2263/6066/1/038.pdf

Behrens, R. & Del Mistro, R. 2010, 'Shocking habits: methodological issues in analyzing changing personal travel behavior over time', *International Journal of Sustainable Transportation*, vol. 4, no. 5, pp. 253-271.

Bell, M.G.H. 1995, 'Solutions to urban traffic problems: towards a new realism', *Traffic Engineering and Control*, vol. 36, no. 2, pp. 78-81.

Besser, L. 2008a, 'If motorways are the answer, we've been asking the wrong question', *Sydney Morning Herald (News)*, 10th December, http://www.smh.com.au/news/national/if-motorways-are-the-answer-weve-been-asking-the-wrong-question/2008/12/09/1228584840247.html

Besser, L. 2008b, 'Test for tunnel as lane closure expected to cause road chaos', *Sydney Morning Herald (News)*, 10th March, viewed 26/10/2012 http://www.smh.com.au/news/national/test-for-tunnel-as-lane-closure-expected-to-cause-road-chaos/2008/03/09/1204998288621.html

Bicycle Federation of Australia (BFA) 2006, *Best-practice in Adult Cycling Proficiency Training*, Department of the Environment and Heritage, Australian Greenhouse Office, Canberra http://www.travelsmart.gov.au/resources/pubs/adult-cycling.pdf

Bicycles Network Australia (BNA) 2008, *Epping Road Bike Path*, Bicycles Network Australia (BNA), viewed 30th March 2014. http://www.bicycles.net.au/forums/viewtopic.php?t=5149

Black, W.R. 2010, *Sustainable Transportation: Problems and Solutions*, The Guildford Press, New York.

Bolman, C., Arwert, T.G. & Völlink, T. 2011, 'Adherence to prophylactic asthma medication: habit strength and cognitions', *Heart and Lung: The Journal of Acute and Critical Care*, vol. 40, no. 1, pp. 63-75.

Bonsall, P. 2008, 'What is so special about surveys designed to investigate the sustainability of travel behaviour?', paper presented to the *8th International Conference on Survey Methods in Transport*, Annecy, France, 25th -31st May.

Bonsall, P., Montgomery, F. & Jones, C. 1984, 'Deriving the constancy of traffic flow composition from vehicle registration data', *Traffic Engineering + Control*, vol. 25, no. 7/8, pp. 386-391.

Booz Allen Hamilton 2006, *International Approaches to Tackling Transport Congestion Paper 10 (Final): Traffic Management – Road Space Reallocation*, Booz Allen Hamilton, http://www.vcec.vic.gov.au/CA256EAF001C7B21/WebObj/InternationalapproachestotacklingtransportcongestionPaper10TrafficManagement-RoadSpaceReallocation13April2006/$File/International%20approaches%20to%20tackling%20transport%20congestion%20Paper%2010%20Traffic%20Management%20-%20Road%20Space%20Reallocation%2013%20April%202006.pdf

Bourne, N., Gillan, W., Notley, S.O., Taylor, N. & Webster, D. 2008, *A Review of Literature on the Nature of the Impact of Roadworks on Traffic Movement and Delay*, Transport Research Laboratory, Wokingham, UK.

Bradley, M.A. & Kroes, E.P. 1992, 'Forecasting issues in stated preference survey research', in E.S. Ampt, A.J. Richardson & A.H. Meyburg (eds), *Selected Readings in Transport Survey Methodology*, Eucalyptus Press, Melbourne, pp. 89-107.

Brindle, R. 1998, "Sustainable Transport' - cause or effect of a sustainable future?', *Road and Transport Research*, vol. 7, no. 3, p. 10.

British Medical Association (BMA) 1992, *Cycling Towards Health & Safety*, Oxford University Press, Oxford.

Bromley, D.W., Feeny, D., McKean, M.A., Peters, P., Gilles, J.L., Oakerson, R.J., Runge, C.F. & Thomson, J.T. 1992, *Making the Commons Work: Theory, Practice and Policy*, Institute for Contemporary Studies Press, San Francisco.

Broomham, R. 1996, *On the Road: the NRMA's first seventy-five years*, Allen & Unwin Pty Ltd, Sydney.

Brown, B.B., Werner, C.M. & Kim, N. 2003, 'Personal and Contextual Factors Supporting the Switch to Transit Use: Evaluating a Natural Transit Intervention', *Analyses of Social Issues and Public Policy*, vol. 3, no. 1, pp. 139-160.

Buchanan, C. 1964, *Traffic in towns: the specially shortened edition of the Buchanan Report*, Penguin Books, London.

Bullard, D.L. 1987, 'Commuter perceptions of traffic congestion during the reconstruction of I-45 North Freeway in Houston', *Transportation Research Record*, no. 1132, pp. 25-33.

Bureau of Infrastructure, Transport and Regional Economics (BITRE) 2009, *Urban passenger transport: how people move about in Australian cities*, Report Number IS31, Bureau of Infrastructure, Transport and Regional Economics, Canberra http://www.bitre.gov.au/publications/05/Files/IS31.pdf

Bureau of Meteorology (BOM) 2014, *Rainfall percentiles*, Commonwealth of Australia, viewed 17/3/2014 http://www.bom.gov.au/jsp/ncc/climate_averages/rainfall-percentiles/index.jsp

Bureau of Resources and Energy Economics (BREE) 2012, *Key Facts: Australia's Energy Sector*, Department of Resources, Energy and Tourism, viewed 20th July 2012 http://www.bree.gov.au/documents/publications/energy/energy-in-australia-fact-card.pdf

Bureau of Transport Statistics (BTS) 2013, *2011/12 Household Travel Survey Summary Report 2013 Release*, Transport for NSW, Sydney.

Burke, D. 1997, *Juggernaut! A Story of Sydney in the Wild Days of the Steam Trams*, Kangaroo Press, Sydney.

Bus Australia 2010, *Epping Road Services - Myzone ticket*, viewed 22nd February 2014 http://www.busaustralia.com/forum/viewtopic.php?f=3&t=50665&start=75

Cairns, S. 1999a, 'The Impact of Reallocating Roadspace on Accident Rates: Some Initial Evidence', paper presented to the *Road Danger Reduction Forum Conference*, Leicester, 16th February.

Cairns, S. 1999b, *Reallocation of roadspace in favour of cyclists*, University College London, London http://www2.cege.ucl.ac.uk/cts/tsu/tpab9910.htm

Cairns, S. 2002, 'Cutting traffic - possibilities and opportunities. (Getting somewhere)', *Town and Country Planning*, vol. 71, no. 2, p. 2.

Cairns, S., Atkins, S. & Goodwin, P. 2002, 'Disappearing traffic? The story so far', *Proceedings of the Institution of Civil Engineers: Municipal Engineer*, vol. 151, no. 1, pp. 13-22 http://www2.cege.ucl.ac.uk/cts/tsu/disapp.pdf

Cairns, S., Hass-Klau, C. & Goodwin, P. 1998, *Traffic Impact of Highway Capacity Reductions: Assessment of the Evidence*, Landor Publishing, London.

Carcopino, J. 1956, *Daily life in ancient Rome*, trans. E.O. Lorimer, Peregrine Books edn, Penguin

Carpenter, R.A. 2010, 'Sacramento's Fix I-5 Project: Impact on Bus Transit Ridership', University of California, Davis, Davis, California.

Catalyst Communications 2007, *Lane Cove Tunnel: Updated summary of contracts Incorporating summaries of all contract changes to 25 March 2007*, Roads and Traffic Authority (RTA), Sydney http://www.wwg.nsw.gov.au/__data/assets/pdf_file/0006/3111/LCT_contracts_summary_2007.pdf

Cervero, R. 2006, 'Freeway Deconstruction and Urban Regeneration in the United States', paper presented to the *International Symposium for the 1st Anniversary of the Cheong Gye Cheon Restoration*, Seoul, Korea, 1st - 2nd October http://www.uctc.net/papers/763.pdf

Cervero, R. 2010, 'Urban reclamation and regeneration in Seoul, South Korea', in W. Ascher & C. Krupp (eds), *Physical Infrastructure Development: Balancing the Growth, Equity, and Environmental Imperatives*, Palgrave Macmillan, New York, pp. xv, 271.

Cervero, R., Kang, J. & Shively, K. 2007, *From Elevated Freeways to Surface Boulevards: Neighborhood, Traffic, and Housing Price Impacts in San Francisco*, B. University of California, Berkeley, CA http://www.uctc.net/papers/836.pdf

Chang, S.E. & Nojima, N. 2001, 'Measuring post-disaster transportation system performance: the 1995 Kobe earthquake in comparative perspective', *Transportation Research A*, vol. 35, pp. 475-494.

Chatterjee, K., Sherwin, H. & Jain, J. 2013, 'Triggers for changes in cycling: the role of life events and modifications to the external environment', *Journal of Transport Geography*, vol. 30, no. 6, pp. 183-193 http://eprints.uwe.ac.uk/21600/

Chau, E. 2003, *English Everywhere Everyday*, NSW Adult Migrant English Service, Sydney.

Chen, C., Gärling, T. & Kitamura, R. 2004, 'Activity rescheduling: reasoned or habitual?', *Transportation Research Part F*, vol. 7, no. 6, pp. 351-371.

Chen, C.-F. & Lai, W.T. 2011, 'The effects of rational and habitual factors on mode choice behaviors in a motorcycle-dependent region: evidence from Taiwan', *Transport Policy*, vol. 18, pp. 711-718.

Chiu, L. & Kriwoken, L. 2003, 'Managing Recreational Mountain Biking in Wellington Park, Tasmania, Australia ', *Annals of Leisure Research*, vol. 6, no. 4, pp. 339-361 http://eprints.utas.edu.au/2948/1/Managing_Recreational_Mountain_Bike.pdf

Choo, S. & Mokhtarian, P.L. 2008, 'How do people respond to congestion mitigation policies? A multivariate probit model of the individual consideration of three travel-related strategy bundles', *Transportation*, vol. 35, pp. 145-163.

Christie, R. 2010, *Preliminary Report: Independent Public Inquiry, Long-term Public Transport Plan for Sydney*, Office of the Independent Public Inquiry, Long-term Public Transport Plan for Sydney, Sydney http://www.transportpublicinquiry.com.au/

Chung, D. 2008, 'Private provision of transport infrastructure - unveiling the inconvenient truth in New South Wales', paper presented to the *31st Australasian Transport Research Forum*, Gold Coast, 30th September - 3rd October http://www.atrf.info/papers/2008/2008_Chung.pdf

Cityrail 2009, *Epping to Chatswood rail link*, Cityrail, viewed 28/4/2011 http://www.cityrail.info/news/projects/ecrl/

Clegg, R. 2005, 'An empirical study of day-to-day variability in driver travel behaviour', paper presented to the *Universities Transport Studies Group*, Bristol, January http://www.richardclegg.org/route/new/publications.html

Clegg, R. 2006, '"It'll be alright by Friday" - traffic response to capacity reduction', paper presented to the *Universities Transport Studies Group*, Dublin, January http://www.richardclegg.org/route/new/publications.html

Clegg, R. 2007, 'Empirical studies on road traffic response to capacity reduction', paper presented to the *17th International Symposium on Transportation and Traffic Theory (ISTT17)*, London, 23rd - 25th July http://www.richardclegg.org/pubs/

Clennell, A. & Baker, J. 2006, 'We won't give up our cars', *Sydney Morning Herald (News)*, 31st July, p. 1 and 4.

Clifton, K.J. & Handy, S.L. 2001, 'Qualitative methods in travel behavior research', paper presented to the *International Conference on Transport Survey Quality and Innovation*, Kruger National Park, South Africa, 15th June http://www.des.ucdavis.edu/faculty/handy/Qualitative_paper.pdf

Connelly, L.B. & Supangan, R. 2006, 'The economic costs of road traffic crashes: Australia, states and territories', *Accident Analysis & Preventation*, vol. 38, no. 6, pp. 1087-1093.

Conner, M. & Armitage, C.J. 1998, 'Extending the theory of planned behaviour: a review and avenues for further research', *Journal of Applied Social Psychology*, vol. 28, no. 15, pp. 1429-1464.

Coombe, D., Bates, J. & Dale, M. 1998, 'Modelling the traffic impacts of highway capacity reductions', *Traffic Engineering + Control*, vol. 39, no. 7, pp. 430-433.

Corpuz, G. 2006, 'Analysis of peak hour travel using the Sydney household travel survey data', paper presented to the *29th Australasian Transport Research Forum*, Gold Coast, 26th -29th September http://www.bts.nsw.gov.au/Publications/Conference-papers/default.aspx?retain=true&PagingModule=313&Pg=2

Crabbe, H. & Elsom, D.M. 1998, 'Air quality effectiveness of traffic management schemes: U.K. and European case studies', *Environmental Monitoring and Assessment*, vol. 52, pp. 173-183.

Crosby, A. 1998, 'Roads of County, Hundred and Township, 1550-1850', in A. Crosby (ed.), *Leading the Way: A History of Lancashire's Roads*, Lancashire County Books, Preston, pp. 53-88.

Cullinane, S. & Cullinane, K. 2003, 'Car dependence in a public transport dominated city: evidence from Hong Kong', *Transportation Research D*, vol. 8, pp. 129-138.

Currie, G. & Delbose, A. 2013, 'Exploring trends in forced car ownership in Melbourne', paper presented to the *36th Australasian Transport Research Forum*, Brisbane, 2nd - 4th October. http://www.atrf.info/papers/2013/2013_currie_delbosc.pdf

Currie, G., Sarvi, M. & Young, W. 2007, 'A new approach to evaluating on-road public transport priority projects: balancing the demand for limited road-space', *Transportation*, vol. 34, pp. 413-428.

Cycling Resource Centre 2011, *Epping Road cycleway proves its worth in new usage study (Sydney)*, Australian Bicycle Council, viewed 17/32014 http://cyclingresourcecentre.org.au/news/epping_road_cycleway_proves_its_worth_in_new_usage_study

Dahlstrand, U. & Biel, A. 1997, 'Pro-Environmental Habits: Propensity Levels in Behavioural Change', *Journal of Applied Social Psychology*, vol. 27, no. 7, pp. 588-601.

Daly, H.E. 1992, *Steady-state Economics*, 2nd edn, Earthscan Publications Ltd, London.

Davis, A.L. 1996, 'Promoting sustainable transport in England: principles and practice', *Journal of Transport Geography*, vol. 4, no. 1, pp. 67-70.

Davis, A.L. 2009, *Essential Evidence on a page - No. 5 Impact of highway traffic capacity reductions*, briefing note, Bristol City Council, Bristol, p. 1, viewed 18/1/13 http://www.bristol.gov.uk/sites/default/files/assets/documents/cd-essential-evidence-no-5-capacity-reductions-cairns.pdf

de Bruijn, G.-J., Kremers, S.P.J., Singh, A., van den Putte, B. & van Mechelen, W. 2009, 'Adult active transportation: adding habit strength to the theory of planned behavior', *American Journal of Preventive Medicine*, vol. 36, no. 3, pp. 189-194 http://www.ajpm-online.net/article/S0749-3797(08)00971-9/abstract

de Hartog, J.J., Boogaard, H., Nijland, H. & Hoek, G. 2010, 'Do the health benefits of cycling outweigh the risks?', *Environmental Health Perspectives*, vol. 118, no. 8, pp. 1109-1116.

de Vries, H. & Mudde, A.N. 1998, 'Predicting stage transitions for smoking cessation applying the attitude social influence efficacy model', *Psychology and Health*, vol. 13, no. 2, pp. 369-385.

Denscombe, M. 1998, *The Good Research Guide: for small-scale social research projects*, Open University Press, Buckingham.

Department for Transport (DfT) 2011, *Passenger transport: by mode, annual from 1952*, U.K. Government, viewed 20/7/2012 http://www.dft.gov.uk/statistics/tables/tsgb0101/

Department of Planning (NSW DoP) 2010, *Sydney Towards 2036*, Government of NSW, Sydney http://www.metrostrategy.nsw.gov.au/LinkClick.aspx?fileticket=K3OvHZ6LP-I%3d&tabid=286&language=en-AU

Department of Planning (NSW DoP) 2013, *Draft Metropolitan Strategy for Sydney*, Government of NSW, Sydney http://strategies.planning.nsw.gov.au/Portals/0/Documents/7_Draft_Metro_Accessibility.pdf

Department of Planning (NSW DoP) 2014, *Major Project Assessments*, Government of NSW, viewed 29/3/2014 http://majorprojects.planning.nsw.gov.au/index.pl?action=search&page_id=&search=150+Epping+Road&authority_id=&search_site_type_id=&reference_table=&status_id=&decider=&from_date=&to_date=&x=0&y=0

Department of Sustainability, Environment, Water, Population and Communities (DoSEWPC), 2012, *Department of Sustainability, Environment, Water, Population and Communities*, Commonwealth Government of Australia, viewed 17/7/2012 http://www.environment.gov.au/

Department of the Environment, Water, Heritage and the Arts (DoEWHA) 2008, *Ecologically Sustainable Development*, Commonwealth Government of Australia, viewed 8/1/2009 http://www.environment.gov.au/esd/

Department of Transport and Main Roads (TMR) 2009, *Riverside Expressway Transport Investigation and Network Analysis (RETINA)*, Government of Queensland, Brisbane.

Devine, S.A., Bucci, J.A. & Berman, D.J. 1992, 'Traffic management during the I-195 Providence River Bridge Repair Project', *Transportation Research Record*, no. 1360, pp. 1-3.

Dia, H. 2002, 'An agent-based approach to modelling driver route choice behaviour under the influence of real-time information', *Transportation Research Part C*, vol. 10, pp. 331-349 http://espace.library.uq.edu.au/eserv/UQ:38812/Dia-_Paper_2.pdf

Director of Public Works Department, Tasmania, (PWD) 1976, *Report for year 1974-75*, Government Printer, Tasmania, Hobart.

Domarchi, C., Tudela, A. & Gonzalez, A. 2008, 'Effect of attitudes, habit and affective appraisal on mode choice: an application to university workers', *Transportation*, vol. 35, no. 5, pp. 585-599 http://www.springerlink.com/content/5572753563475102/fulltext.pdf

Dowling, R. 2000, 'Cultures of mothering and car-use in suburban Sydney: a preliminary investigation', *Geoforum*, vol. 31, no. 3, pp. 345-353.

Dresner, S. 2002, *The Principles of Sustainability*, Earthscan Publications Ltd, London.

Duffy, F. 1981, "People places' in Launceston', *Royal Australian Planning Institute Journal*, vol. 19, no. 2, pp. 55-56.

Eagly, A.H. & Chaiken, S. 1993, *The Psychology of Attitudes*, Harcourt Brace Jovanovich College Publisers, Orlando, FL.

European Commission 2004, *Reclaiming city streets for people: Chaos or quality of life?*, in Directorate-General for the Environment (ed.)Office for Official Publications of the European Communities, Luxembourg, p. 52 http://ec.europa.eu/environment/pubs/pdf/streets_people.pdf

Evans, A. 2008, 'Epping Road will be no nirvana for motorists - or cyclists', *Sydney Morning Herald (Opinion)*, 14th January, http://www.smh.com.au/news/opinion/epping-hell-will-be-no-nirvana-for-motorists--or-cyclists/2008/01/13/1200159272326.html

Ferguson, E. & Bibby, P.A. 2002, 'Predicting Future Blood Donor Returns: Past Behavior, Intentions, and Observer Effects', *Health Psychology*, vol. 21, no. 5, pp. 513-518 http://psycnet.apa.org/index.cfm?fa=fulltext.printArticle&jcode=hea&vol=21&issue=5&format=html&page=513&language=eng

Findlay, F. 2007, 'Forcing drivers to use toll roads', *Northern District Times (Opinion)*, 14th February.

Fleming, T., Turner, S. & Tarjomi, L. 2013, *Reallocation of Road Space*, New Zealand Transport Agency, Wellington http://www.nzta.govt.nz/resources/research/reports/530/docs/RR-530-Reallocation-of-road-space.pdf

Flower, D. & Sanjayan, J. 2007, 'Green House Gas Emissions due to Concrete Manufacture', *International Journal of Life Cycle Assessment*, vol. 12, no. 5, pp. 282-288.

Flyvbjerg, B., Holm, M.K.S. & Buhl, S.L. 2006, 'Inaccuracy in traffic forecasts', *Transport Reviews*, vol. 26, no. 1, pp. 1-24.

Fujii, S. & Gärling, T. 2003, 'Development of a script-based travel mode choice after forced change', *Transportation Research Part F*, vol. 6, pp. 117-124.

Fujii, S. & Gärling, T. 2005, 'Temporary structural change: A strategy to break car-use habit and promote public transport', in G. Underwood (ed.), *Traffic and Transport Psychology: Theory and Application Proceedings of the International Conference of Traffic and Transport Psychology*, Elsevier Ltd, Oxford, pp. 585 - 592.

Fujii, S., Gärling, T. & Kitamura, R. 2001, 'Changes in drivers' perceptions and use of public transport during a freeway closure', *Environment and Behavior*, vol. 33, no. 6, pp. 796-808.

Fujii, S. & Kitamura, R. 2003, 'What does a one-month free bus ticket do to habitual drivers?', *Transportation*, vol. 30, no. 1, pp. 81-95.

Gardner, B. 2009, 'Modelling motivation and habit in stable travel mode contexts', *Transportation Research Part F*, vol. 12, pp. 68-76.

Gardner, B. & Abraham, C. 2007, 'What drives car use? A grounded theory analysis of commuters' reasons for driving', *Transportation Research F*, vol. 10, pp. 187-200.

Gärling, T. & Axhausen, K.W. 2003, 'Introduction: habitual travel choice', *Transportation*, vol. 30, no. 1, pp. 1-11.

Gärling, T., Fujii, S. & Boe, O. 2001, 'Empirical tests of a model of determinants of script-based driving choice', *Transportation Research Part F*, vol. 4, no. 2, pp. 89-102.

Gärling, T., Laitila, T. & Westin, K. (eds) 1998, *Theoretical Foundations of Travel Choice Modeling*, Pergamon, Oxford.

Garvill, J., Marell, A. & Nordlund, A. 2003, 'Effects of increased awareness on choice of travel mode', *Transportation*, vol. 30, no. 1, pp. 63-79.

Gaskell, E. 1971, *The life of Charlotte Brontë*, The Folio Society, London.

Geosciences Australia 2012, *Deserts*, Department of Resources, Energy and Tourism (DRET), viewed 17/7/2012 http://www.ga.gov.au/education/geoscience-basics/landforms/deserts.html

Gilmore, F., Tarbet, A. & Williams, I. 2010, *Benefits of partial road closures: an analysis of the effects on quality of life from the Nørrebrogade road closures*, Worcester Polytechnic Institute, Worcester, MA, USA http://www.wpi.edu/Pubs/E-project/Available/E-project-051010-145425/unrestricted/Agenda21D10_Benefits_of_Partial_Road_Closures.pdf

Giuliano, G. & Golob, J. 1998, 'Impacts of the Northridge earthquake on transit and highway use', *Journal of Transportation and Statistics*, vol. 1, no. 2, pp. 1-20.

Glover, L. 2011, 'Personal carbon budgets for transport', paper presented to the *34th Australasian Transport Research Forum*, Adelaide, 28th - 30th September http://www.atrf.info/papers/2011/2011_Glover_A.pdf

Goldberg, J.L. 2006, 'The fatal flaw in the financing of private road infrastructure in Australia', paper presented to the *29th Australian Transport Research Forum*, Gold Coast, 26th - 29th September http://www.atrf.info/papers/2006/2006_Goldberg.pdf

Gollwitzer, P. 1999, 'Implementation Intentions: Strong Effects of Simple Plans', *American Psychologist*, vol. 54, no. 7, pp. 493-503 http://www.psych.nyu.edu/gollwitzer/99Goll_ImpInt.pdf

González-Guzmán, C.A. & Robusté, F. 2011, 'Road Space Reallocation According to Car Congestion Externality. ', *Journal of Urban Planning and Development*, vol. 137, no. 3, pp. 281-290.

Goodwin, P.B. 1977, 'Habit and hysteresis in mode choice', *Urban Studies*, vol. 14, no. 1, pp. 95-98.

Goodwin, P.B. 1984, 'Market structure, marketing & public transport demand elasticities', paper presented to the *PTRC Summer Meeting*, University of Sussex, Brighton, 10-13 July.

Goodwin, P.B. 1997a, 'Doomsday postponed', *Transport Policy*, vol. 4, no. 1, pp. 1-3.

Goodwin, P.B. 1997b, 'Have panel surveys told us anything new?', in T.F. Golob, R. Kitamura & L. Long (eds), *Panels for Transportation Planning: Methods and Applications*, Kluwer Academic Publishers, Boston, Mass., pp. 79-96.

Goodwin, P.B. 1998, 'ESRC Transport Studies Unit, University College London. Annual Report 1997', *Traffic Engineering + Control*, vol. 99, no. 1, pp. 18-19.

Goodwin, P.B., Cairns, S., Dargay, J., Hanly, M., Parkhurst, G., Stokes, G. & Vythoulkas, P. 2004, *Changing travel behaviour*, ESRC Transport Studies Unit, University College, London, London, pp. 1-48 http://discovery.ucl.ac.uk/1245/1/2004_23.pdf

Goodwin, P.B., Hass-Klau, C. & Cairns, S. 1998, 'Evidence on the effects of road capacity reduction on traffic levels', *Traffic Engineering + Control*, vol. 39, no. 6, pp. 348-354 http://www.worldcarfree.net/resources/freesources/Evide.htm

Gordon, P., Richardson, H.W. & Davis, B. 1998, 'Transport-related impacts of the Northridge earthquake', *Journal of Transportation and Statistics*, vol. 1, no. 2, pp. 21-36.

Goscinny, R. & Uderzo, A. 1974, *Asterix and the Laurel Wreath*, trans. A. Bell & D. Hockridge, Brockhampton Press.

Green Oil UK Ltd 2013, *Green Oil*, Green Oil UK Ltd, viewed 11/10/2013 http://www.green-oil.net/

Grosvenor, T. 2000, 'Workshop on qualitative methods', paper presented to the *Qualitative Research in the Transport Sector*, http://onlinepubs.trb.org/onlinepubs/circulars/ec008/workshop_k.pdf

Grover, P.J. & Richardson, A.J. 1993, 'Traffic Impact of Pedestrianisation', paper presented to the *18th Australasian Transport Research Forum*, Gold Coast, http://www.atrf.info/papers/1993/1993_Grover_Richardson.pdf

Guillen, M.D., Ishida, H. & Okamoto, N. 2010, 'Is the Use of Informal Public Transport modes in Developing Countries Habitual? An Empirical Study in Davao City, Philippines ', paper presented to the *12th World Conference on Transport Research*, Lisbon, Portugal, 11th -15th July http://intranet.imet.gr/Portals/0/UsefulDocuments/documents/02557.pdf .

Hajdu, J.G. 1988, 'Pedestrian malls in West Germany: perceptions of their role and stages in their development', *Journal of the American Planning Association*, vol. 54, no. 3, pp. 325-335.

Halcrow 2005, *Travel training: Good-practice guidance*, Greater Manchester Passenger Transport Executive, Manchester http://www.tfgm.com/upload/library/training_guide.pdf

Hamer, M. 1998, 'Roadblocks ahead', *New Scientist*, 24th January, p. 4.

Han, S.S. 2010, 'Managing motorization in sustainable transport planning: the Singapore experience', *Journal of Transport Geography*, vol. 18, no. 2, pp. 314-321.

Handy, S., Weston, L. & Mokhtarian, P.L. 2005, 'Driving by choice or necessity?', *Transportation Research A*, vol. 39A, no. 2-3, pp. 183-203 http://www.escholarship.org/uc/item/5jm5p89d

Hanson, S. & Huff, J.O. 1988, 'Systematic variability in repetitious travel', *Transportation*, vol. 15, no. 1-2, pp. 111-135.

Hanssen, J.U. 1995, 'Transportation impacts of office relocation: a case study from Oslo', *Journal of Transport Geography*, vol. 3, no. 4, pp. 247-256.

Harms, S. 2003, 'From routine choice to rational decision making between mobility alternatives', paper presented to the *3rd Swiss Transport Research Conference*, Monte Verita/Ascona, 19th -21st March http://www.strc.ch/conferences/2003/harms.pdf

Harris, F.E. 1974, 'The Pedestrianised Town Centre', *7th Australian Road Research Board Conference*, vol. 7, Australian Road Research Board, Adelaide, pp. 20-33.

Hass-Klau, C. 1997, 'Solving traffic problems in city centres: the European experience', *Proceedings of the Institution of Civil Engineers and Municipal Engineers*, vol. 121, pp. 86-96.

Hayden, M. 1976, *The Book of Bridges*, Marshall Cavendish, London.

Hendrickson, C.T., Carrier, R.E., Dubyak, T.J. & Anderson, R.B. 1982, 'Traveler responses to reconstruction of Parkway East (I-376) in Pittsburgh', *Transportation Research Record*, no. 890, pp. 33-39.

Hiscock, R., Macintyre, S., Kearns, A. & Ellaway, A. 2002, 'Means of transport and ontological security: Do cars provide psycho-social benefits to their users?', *Transportation Research D*, vol. 7, pp. 119-135.

Howlett, S. 2012, 'The count is on to save path', *Northern District Times (News)*, 1st November.

Hoye, J., Andreadakis, I. & Vercoe, S. 2011, *Public Attitudes to Mobility and Access: Social Research Report*, Report Number GAR 1102003, National Transport Commission, Melbourne http://www.ntc.gov.au/filemedia/Reports/SmartTransportGAResearchSept11.pdf

Hull, C.L. 1943, *Principles of Behavior*, Appleton-Century-Crofts, New York.

Hunt, J.D. & Abraham, J.E. 2007, 'Influences on bicycle use', *Transportation*, vol. 34, pp. 453-470.

Hunt, J.D., Brownlee, A.T. & Stefan, K.J. 2002, 'Responses to Centre Street Bridge Closure: Where the "Disappearing" Travelers Went', *Transportation Research Record*, no. 1807, pp. 51-58.

Hydro Tasmania 2012, *Sustainability is in our nature*, Hydro Tasmania, viewed 18/7/2012 http://www.hydro.com.au/about-us/sustainability

Hylton, S. 2010, *A History of Manchester*, 2nd edn, Phillimore & Co Ltd, Andover, Hampshire.

Independent Public Inquiry, Long-Term Public Transport Plan for Sydney, 2010, *Independent Public Inquiry into a Long-Term Public Transport Plan for Sydney: Final Report-Themes and Recommendations*, submitted to and published by *The Sydney Morning Herald*, Sydney http://www.catalyst.com.au/Public_files/F1_Public_Transport_Inquiry_Final_Report_Themes_and_Recommendations_26May2010.pdf

Institute for Sustainable Futures (ISF) 2011, *UTS Sustainability Strategy: 2012 - 2015* University of Technology, Sydney, viewed 17/7/2012 http://www.green.uts.edu.au/about/sustainability-strategy/UTS_Sustainability_Strategy_Final_web.pdf

Institute for Transportation and Development Policy (ITDP) 2012, *The Life and Death of Urban Highways*, Institute for Transportation and Development Policy, New York http://www.itdp.org/documents/LifeandDeathofUrbanHighways_031312.pdf

Institution of Engineers, Australia (IEAust) 1999, *Sustainable Transport: Responding to the Challenges*, Report Number ISBN 0 85825 708 4, Institution of Engineers, Australia, Canberra http://www.engineersaustralia.org.au/policy/publications

Jacobs, J. 1962, *The Death and Life of Great American Cities*, Jonathon Cape, London.

James, B. 2002, 'TravelSmart - large scale cost-effective mobility management. Experiences from Perth, Western Australia', *Proceedings of the Institution of Civil Engineers: Municipal Engineer*, vol. 151, no. 1, pp. 39-47.

James, B. & Brög, W. 2003, 'TravelSmart/Individualised Marketing in Perth, Western Australia', in R. Tolley (ed.), *Sustainable Transport: Planning for Walking and Cycling in Urban Environments*, Woodhead Publishing Limited, Cambridge, England, pp. 384-401.

James, W. 1890, *The Principles of Psychology*, vol. 1, Macmillan, London.

Janis, I.L. 1982, *Groupthink: Psychological Studies of Policy Decisions and Fiascoes*, 2nd edn, Houghton Mifflin, Boston.

Jeff Roorda & Associates 2013, *National State of the Assets*, Australian Local Government Association, Canberra http://alga.asn.au/site/misc/alga/downloads/publications/StateoftheAssets2013.pdf

JMP Consultants 2009, *Qualitative Research into Active Travel in Glasgow* Glasgow Centre for Population Health, Glasgow http://www.gcph.co.uk/assets/0000/0431/Active_Travel_in_Glasgow_Final.pdf

Johnson, M. & Rose, G. 2013, 'Motorised mobility scooters - understanding a growing transport mode for older Australians', paper presented to the *36th Australasian Transport Research Forum*, Brisbane, 2nd - 4th October.

Joint Select Committee on the Cross City Tunnel (JSCCCT) 2006, *Third Report: Lane Cove Tunnel*, Parliament of New South Wales, Sydney http://www.parliament.nsw.gov.au/Prod/parlment/committee.nsf/0/162a7e8c1c07f531ca2571d300070643/$FILE/LCT%20Final%20compiled%20report%2017%20August.pdf

Jones, P. & Sloman, L. 2003, 'Encouraging behavioural change through marketing and management: what can be achieved?', paper presented to the *Moving through nets: the physical and social dimensions of travel. 10th International Conference on Travel Behaviour Research*, Lucerne, 10th -15th August http://www.ivt.ethz.ch/news/archive/20030810_IATBR/jones.pdf

Kane, L. & Behrens, R. 2000, 'The Traffic Impacts of Road Capacity Change: A Review of Recent Evidence and Policy Debates', paper presented to the *South African Transport Conference 'Action in Transport for the New Millennium'*, South Africa, 17th - 20th July http://repository.up.ac.za/bitstream/handle/2263/8260/93%20Kane.pdf?sequence=1

Kaspura, A. 2009, *Energy efficiency of transport modes revisited - September 2009*, Institution of Engineers, Australia, viewed 3/2/2010 http://www.engineersaustralia.org.au/da/index/getfile/id/8823

Kay, D. 2011, *Fairness in a Car-dependent Society*, Sustainable Development Commission, London http://www.sd-commission.org.uk/data/files/publications/fairness_car_dependant.pdf

Ker, I., Yapp, S. & Moore, P. 2004, 'David and Goliath - bikes and buses together without throwing stones', paper presented to the *27th Australasian Transport Research Forum*, Adelaide, 29th September - 1st October http://www.atrf.info/papers/2004/2004_Ker_Yapp_Moore.pdf

Kerr, A., Lennon, A. & Watson, B.C. 2010, 'The call of the road: factors predicting students' car travelling intentions and behaviour', *Transportation*, vol. 37, no. 1, pp. 1-13 http://eprints.qut.edu.au/31081/

Khattak, A.J. & de Palma, A. 1997, 'The impact of adverse weather conditions on the propensity to change travel decisions: a survey of Brussels commuters', *Transportation Research Part A*, vol. 31, no. 3, pp. 181-203.

Klöckner, C.A. & Matthies, E. 2004, 'How habits interface with norm-directed behaviour - a normative decision making model for travel mode choice', *Journal of Environmental Psychology*, vol. 24, pp. 319-327.

Knowles, R.D. 1996, 'Transport impacts of Greater Manchester's Metrolink light rail system', *Journal of Transport Geography*, vol. 4, no. 1, pp. 1-14.

Koetse, M.J. & Rietveld, P. 2009, 'The impact of climate change and weather on transport: an overview of empirical findings', *Transportation Research Part D*, vol. 14, pp. 205-221.

Kroon, M. 1998, 'Downsizing power and speed, the safe road to fuel economy, road safety and sustainability', paper presented to the *Second World Congress on Safety of Transportation: Imbalance between Growth and Safety?* , Delft, The Netherlands, http://www.iapsc.org.uk/presentations/0606_Kroon_combined.pdf

Kruse, J. 1998, 'Remove it and they will disappear', paper presented to *The Sixth National Conference on Transportation Planning for Small and Medium-Sized Communities*, Spokane, Washington, 16th - 18th September http://ntl.bts.gov/lib/1000/1100/1180/Trb.pdf

Laird, P., Newman, P., Bachels, M. & Kenworthy, J. 2001, *Back on Track. Rethinking Transport Policy in Australia and New Zealand*, UNSW Press, Sydney.

Lane Cove Tunnel Action Group Inc. (LCTAG) 2002, *Lane Cove Tunnel EIS A response from the Lane Cove Tunnel Action Group Inc*, submission, Lane Cove Council, Sydney, p. 40, viewed 5/4/2014 http://www.lanecove.nsw.gov.au/Your%20Council/Lane%20Coves%20Future/Have%20your%20Say/documents

Lane, M. 2011, 'Assessing population limits: a carrying capacity approach to planning', paper presented to the *4th International Urban Design Conference*, Surfer's Paradise, 21th - 23rd September.

Lanzendorf, M. 2010, 'Key events and their effect on mobility biographies: the case of childbirth', *International Journal of Sustainable Transportation*, vol. 4, no. 5, pp. 272-292.

Lay, M.G. 1993, *Ways of the World, A History of the World's Roads and of the Vehicles That Used Them* Australian edn, Primavera Press, Sydney.

Le Glay, M., Voisin, J.-L., Le Bohec, Y., Cherry, D. & Kyle, D.G. 2005, *A History of Rome*, 3rd edn, Blackwell Publishing.

Lee, S., Lee, S. & Lee, Y.-I. 2006, 'Innovative public transport oriented policies in Seoul', *Transportation*, vol. 33, pp. 189-204.

Lee, T.R. 1978, *The Tasman Bridge Collapse and its Effects on Metropolitan Hobart: Social Disruption and Adjustments*, Report Number 2, University of Tasmania, Hobart.

Lee, T.R. & Wood, L.J. 1978a, *The Tasman Bridge Collapse and its Effects on Metropolitan Hobart: Background and Methodology of a Research Project*, Report Number 1, University of Tasmania, Hobart.

Lee, T.R. & Wood, L.J. 1978b, *Three years of disruption: some effects and consequences of the Tasman Bridge collapse*, University of Tasmania, Hobart.

Lehman, R., Lee, D., Reid, I., Barker, N., Zhong, J., Kim, K., Vaclavek, T. & Garland, R. 2009, *Cycling in New South Wales What the data tells us*, Premier's Council for Active Living, Sydney http://www.pcal.nsw.gov.au/__data/assets/pdf_file/0011/36785/Cycling_in_NSW_-_What_the_Data_Tells_Us.pdf

Levy, J.I., Baxter, L.K. & Clougherty, J.E. 2006, 'The air quality impacts of road closures associated with the 2004 Democratic National Convention in Boston', *Environmental Health: A Global Access Science Source*, vol. 5, no. 16, http://www.ehjournal.net/content/pdf/1476-069X-5-16.pdf

Lewis, C.S. 1951, *Prince Caspian*, Geoffrey Bles, London.

Lex Services 1995, *Lex Report on Motoring: What drives the motorist?*, Lex, London.

Lock, J.B. & Gelling, M.J. 1976, 'Effect on traffic patterns of the collapse of the Tasman Bridge', *ARRB Proceedings*, vol. 8, pp. 42-52.

Loukopoulos, P., Gärling, T., Jakobsson, C., Meland, S. & Fujii, S. 2005, 'Choices of activity- and travel-change options for reduced car use', in H. Timmermans (ed.), *Progress in Activity-Based Analysis*, Elsevier, Amsterdam, pp. 489-501.

Lucas, K. 2009, 'Actual and Perceived Car Dependence: Likely Implications of Enforced Reductions in Car Use for Livelihoods, Lifestyles, and Well-Being', *Transportation Research Record*, vol. 2118, pp. 8-15.

Lyons, G. & Urry, J. 2005, 'Travel time use in the information age', *Transportation Research A*, vol. 39, pp. 257-276.

Macintyre, S., Hiscock, R., Kearns, A. & Ellaway, A. 2001, 'Housing tenure and car access: Further exploration of the nature of their relationships with health in a UK setting', *Journal of Epidemiology and Community Health*, vol. 55, no. 5, pp. 330-331.

Mackett, R.L. 1998, 'Why are travel demand forecasts so often wrong (and does it matter)?', paper presented to the *University Transport Studies Group (UTSG) Annual Conference*, Dublin, January.

Macquarie University 2014, *Bicycles*, Macquarie University, viewed 29/3/2014 http://www.mq.edu.au/about_us/strategy_and_initiatives/sustainability/areas_of_focus/transport/bicycles/

Marinelli, P. & Watson, V. 2009, 'The closure of Brisbane's Riverside Expressway - how people changed their behaviour', paper presented to the *32nd Australasian Transport Research Forum*, Auckland, 29th September - 1st October http://www.atrf.info/papers/2009/2009_Marinelli_Watson.pdf

Martin, E.A. 1994, *A Dictionary of Law*, 3rd edn, Oxford University Press, Oxford.

Maslow, A.H. 1987, *Motivation and Personality*, 3rd edn, Harper & Row, New York.

Masson Wilson Twiney 2001, *Working Paper Four Traffic and Transport*, Roads and Traffic Authority (RTA), Sydney.

Matthies, E., Kuhn, S. & Klöckner, C.A. 2002, 'Travel mode choice of women: the result of limitation, ecological norm, or weak habit?', *Environment and Behaviour*, vol. 34, no. 2, pp. 163-177.

Matzoros, T., van Vliet, D., Randle, J. & Weston, B. 1987, 'A validation of the SATURN and ME2 models using before-and-after survey data from Manchester', *Traffic Engineering + Control*, vol. 28, no. 11, pp. 641-643.

McShane, W.R. & Roess, R.P. 1990, 'Incidents and Capacity Reductions', in, *Traffic Engineering*, Prentice Hall, New Jersey, pp. 619-623.

Mérieux, R. & Loiseau, Y. 2008, *Latitudes 1*, Les Éditions Didier, Paris.

Meyer, M.D. 1988, 'Reconstructing major transportation facilities: the case of Boston's southeast expressway', *Transportation Research Record*, no. 1021, pp. 1-9.

Mittal, B. 1988, 'Achieving Higher Seat Belt Usage: The Role of Habit in Bridging the Attitude-Behavior Gap', *Journal of Applied Social Psychology*, vol. 18, no. 12, pp. 993-1016.

Mobius Research and Strategy Ltd 2010, *Peninsula Travel Plan - Devonport Peninsula Residents' Baseline and Congestion Attitude Survey*, North Shore City Council, Auckland.

Mogridge, M.J.H. 1990, *Travel in towns: Jam yesterday, jam today and jam tomorrow?*, Macmillan Reference Books, London.

Mokhtarian, P.L., Raney, E.A. & Salomon, I. 1997, 'Behavioural response to congestion: identifying patterns and socio-economic differences in adoption', *Transport Policy*, vol. 4, no. 3, pp. 147-160.

Mokhtarian, P.L., Ye, L. & Yun, M. 2009, 'The effect of gender on commuter impacts and behavior changes in the context of a major freeway reconstruction', paper presented to the *4th International Conference on Women's Issues in Transportation*, Irvine, California, 27th-30th October.

Møller, B. & Thøgerson, J. 2008, 'Car use habits: an obstacle to the use of public transportation?', in C. Jensen-Butler (ed.), *Road Pricing, the Economy, and the Environment*, Springer Verlag, Berlin, pp. 301-313.

Moore, M. 2008, 'Secrets under the hood', *Sydney Morning Herald (Opinion)*, 9th August, viewed 11/1/14 http://www.smh.com.au/news/opinion/secrets-under-the-hood/2008/08/08/1218139074490.html

Morgan, G. & McCrystal, J. 2009, *Poles Apart - Beyond the Shouting, Who's Right About Climate Change?*, Random House New Zealand, Auckland.

MORI 1990, *Green Drivers, Report to RAC Motoring Services*, London.

Moriarty, P. & Honnery, D. 2007, 'Australian car travel: an uncertain future', paper presented to the *30th Australasian Transport Research Forum*, Melbourne, 25th -27th September http://www.atrf.info/papers/2007/2007_Moriarty_Honnery.pdf

Morris, E. 2007, 'From horse power to horsepower', *Access*, no. 30, p. 9 http://www.uctc.net/access/30/Access%2030%20-%2002%20-%20Horse%20Power.pdf

MVA Ltd 1998, *Traffic Impact of Highway Capacity Reduction: Report on Modelling*, Landor Publishing, London.

National Roads and Motorists Association (NRMA) 2008, *Epping Road's cycleway - good, bad or mad?*, National Roads and Motorists' Association, viewed 30/1/2012 http://www.mynrmacommunity.com/motoring/2008/01/18/epping-roads-cycleway-%e2%80%93-good-bad-or-mad/

New York City Parks 2001, *Shirley Hayes and the Preservation of Washington Square Park*, City of New York Parks and Recreation, viewed 9/2/2012 http://www.nycgovparks.org/parks/washingtonsquarepark/highlights/9763

Newbiggins, E.D. & Laskey, J.W. 1996, 'Riding the bus: teaching an adult with a brain injury to use a transit system to travel independently to and from work', *Brain Injury*, vol. 10, no. 7, pp. 543-550.

Nicholson, D. 1998, 'Improving accessibility and reducing the impacts of car traffic in central Fremantle', paper presented to the *Transport 98*, Sydney, 7th -11th December.

North Shore City Council 2009, *Lake Road Upgrade Stage 2: Jutland Road to Napier Avenue*, North Shore City Council, viewed 12/10/2009 http://www.northshorecity.govt.nz/Services/TransportAndRoads/Projects/Pages/Lake

NSW Government 1998, *Action for Transport 2010 An Integrated Transport Plan for Sydney*, Government of NSW, Sydney http://pandora.nla.gov.au/pan/38334/20040302-0000/www.transport.nsw.gov.au/pubs_legal/act2010syd.pdf

NSW Government 2008, *97 Road Access Signs*, NSW Government, viewed 30/3/2014 http://www.legislation.nsw.gov.au/fragview/inforce/subordleg+179+2008+pt.8-div.2-rule.97+0+N?tocnav=y

NSW Government 2010 *New South Wales Bikeplan*, Government of NSW, Sydney http://www.nsw.gov.au/bikeplan

O'Flaherty, C.A. 1986, *Traffic Planning and Engineering*, 3rd edn, vol. 1, Edward Arnold, London.

Ogilvie, D., Egan, M., Hamilton, V. & Petticrew, M. 2004, 'Promoting walking and cycling as an alternative to using cars: systematic review ', *British Medical Journal*, vol. 329, no. 7469, p. 763 ff http://www.bmj.com/cgi/content/full/329/7469/0-a

O'Grady, J. 1971, *Aussie Etiket or Doing Things the Aussie Way*, Ure Smith, Sydney.

Organisation for Economic Cooperation and Development (OECD) 2002, *OECD Guidelines Towards Environmentally Sustainable Transport*, Report Number 52695 2002, Organization for Economic Cooperation and Development (OECD), Paris http://www.oecd-ilibrary.org/environment/oecd-guidelines-towards-environmentally-sustainable-transport_9789264199293-en

Ortúzar, Juan de Dios & Willumsen, L.G. 1990, *Modelling Transport*, 1st edn, John Wiley and Sons, Chicester.

Ory, D.T. & Mokhtarian, P.L. 2005, 'When is getting there half the fun? Modeling the liking for travel', *Transportation Research A*, no. 39, pp. 97-123.

Oullette, J.A. & Wood, W. 1998, 'Habit and intention in everyday life: the multiple processes by which past behavior predicts future behavior', *Psychological Bulletin*, vol. 124, no. 1, pp. 54-74.

Outram, V.E. & Thompson, E. 1977, 'Driver Route Choice', paper presented to the *PTRC Summer Annual Meeting*, University of Warwick, 27th - 30th June.

Oxford University Press (OUP) 2009, *Oxford English Dictionary Online*, Oxford University Press, viewed 7/1/2009.

Papinski, D., Scott, D.M. & Doherty, S.T. 2009, 'Exploring the route choice decision-making process: A comparison of planned and observed routes obtained using person-based GPS', *Transportation Research Part F*, vol. 12, pp. 347-358.

Parkin, J. 2012, 'Introduction', in J. Parkin (ed.), *Cycling and Sustainability*, Emerald Group Publishing Ltd, Bingley, West Yorkshire.

Parramatta City Council 2007, *Church St mall opens to slow traffic*, Parramatta City Council, viewed 23/2/2009 http://www.parracity.nsw.gov.au/home/media/2007/march_2007/church_st_mall_opens_to_slow_traffic

Parsons Brinckerhoff Australia Pty Ltd 2008, *Cycling in New South Wales: What the data tells us*, Premier's Council for Active Living, Sydney.

Parsons Brinckerhoff Australia Pty Ltd 2012, *North Ryde Station Precinct Project Transport Management and Accessibility Plan*, Transport for NSW, Sydney http://www.planning.nsw.gov.au/Portals/0/DevelopmentAssessments/OnExhibition/nthRyde/Appendix_K_TMAP_Part_1.pdf

Pavlov, I.P. 1960, 'Technical methods employed in the objective investigation of the functions of the cerebral hemisphere...', in, *Conditioned Reflexes: An Investigation of the Physiological Activity of the Cerebral Cortex*, Dover Publications, Inc., New York, pp. 16-34.

Pears, A. 2005, 'Sustainability and Roads: Capturing the ESD Opportunity', *Urban Policy and Research*, vol. 23, no. 2, pp. 235-245.

Phibbs, P. 2008, 'Driving alone: Sydney's Cross City Tunnel', *Built Environment*, vol. 33, no. 3, pp. 364-374.

Phillips, G. 2007, 'Analysis of Sydney Public-Private Partnership Road Tunnels', paper presented to the *19th National Conference of the Australian Society for Operations Research (ASOR)*, Melbourne, 3w - 5th December http://www.maths.usyd.edu.au/u/geoffp/melfinrv.pdf

Plowden, S. 1972, *Towns against traffic*, Andre Deutsch Ltd, London.

Pollalis, S., Georgoulias, A., Ramos, S. & Schodek, D. 2012, *Infrastructure sustainability and design*, Routledge, New York.

Polydoropoulou, A. & Ben-Akiva, M. 1994, 'Influence of traffic information on drivers' route choice behavior', *Transportation Research Record*, no. 1453, pp. 56-65.

Pooley, C. & Turnbull, J. 1998, *Migration and Mobility in Britain since the 18th Century*, UCL Press, London.

Poulenez-Donovan, C.J. & Ulberg , C. 1994, 'Seeing the Trees and Missing the Forest: Qualitative Versus Quantitative Research Findings in a Model Transportation Demand Management Program Evaluation', *Transportation Research Record*, no. 1459, pp. 1-6.

Pratchett, T. 1989, *Truckers*, Doubleday, London.

Pratt, J.H. 1991, 'Travel behaviour impact of telecommuting following the San Francisco earthquake: a case study', *Transportation Research Record*, no. 1305, pp. 282-290.

Premier's Council for Active Living (PCAL) 2011, *Active Travel: Optus Relocation*, viewed 1/8/2012 http://www.pcal.nsw.gov.au/case_studies/optus

PriceWaterhouseCoopers & Sinclair Knight Merz 2010, *Evaluation of the costs and benefits to the community of financial investment in the Naremburn to Harbour Bridge Active Transport Corridor (Harbourlink)*, North Sydney Council, Sydney http://www.northsydney.nsw.gov.au/Recreation_Facilities/Walking_Cycling/HarbourLink_Project

Public Transport Users Association Inc. (PTUA) 2010, *Common Urban Myths about Transport*, Public Transport Users Association Inc. (PTUA), viewed 2/8/2012 http://www.ptua.org.au/myths/boyapati.shtml

Redshaw, S. 2008, *In the Company of Cars: Driving as a Social and Cultural Practice*, Ashgate Publishing Limited, Aldershot, England.

Rees, J. & Williams, T. 1998, 'Degeneration: Hammersmith Bridge closure', *European Transport Conference 1998*, PTRC, pp. 29-39, viewed 18/9/09 http://www.etcproceedings.org/paper/degeneration-hammersmith-bridge-closure-1

Reeson, A. & Dunstall, S. 2009, *Behavioural Economics and Complex Decision-Making*, Report Number 09/110, CSIRO Mathematical and Information Sciences, Melbourne http://taxreview.treasury.gov.au/Content/html/commissioned_work/downloads/CSIRO_AFTS_Behavioural_economics_paper.pdf

Regan, L. 2004, 'Sustainable transport in the Lower Hunter Region', paper presented to the *AITPM National Conference*, Adelaide, 4th - 6th August.

Richardson, B.C. 1999, 'Toward a policy on a sustainable transportation system', *Transportation Research Record*, no. 1670, pp. 27-34.

Ride Connection Inc. 2009, *A Guide to Travel Training*, Ride Connection Inc., Portland, Oregon http://www.rideconnection.org/ride/LinkClick.aspx?fileticket=dwrbjbCP7_o%3D&tabid=69

Roads and Maritime Services (RMS) 2011a, *Time of day tolling*, Roads and Maritime Services (RMS), viewed 21/2/2012 http://www.rta.nsw.gov.au/usingroads/motorwaysandtolling/tod_tolling/index.html

Roads and Maritime Services (RMS) 2011b, *Tunnel safety*, Roads and Maritime Services (RMS), viewed 11/1/2014 http://sydneymotorways.com/tunnelsafety.html#6

Roads and Maritime Services (RMS) 2013a, *Paying tolls*, Roads and Maritime Services (RMS), viewed 20/12/2013 http://www.rms.nsw.gov.au/usingroads/motorwaysandtolling/tolling_tolling.html

Roads and Maritime Services (RMS) 2013b, *Road number and name changes in Sydney*, Roads and Maritime Services, viewed 6/4/2014 http://www.rms.nsw.gov.au/roadprojects/projects/alpha_numeric/documents/factsheets/generic_nsw.pdf

Roads and Maritime Services (RMS) 2013c, *Using bus lanes*, Roads and Maritime Services (RMS), viewed 20/12/2013 http://www.rms.nsw.gov.au/usingroads/buses/buslanes/

Roads and Traffic Authority (RTA) 2006, *Lane Cove Tunnel Surface traffic modifications environmental assessment report*, Roads and Traffic Authority (RTA), Sydney. http://www.planning.nsw.gov.au/asp/pdf/06_0268_lct_surface_traffic_changes_report_december_2006.pdf

Roads and Traffic Authority (RTA) 2007, *Welcome to Sydney Motorways*, Roads and Transport Authority, viewed 16/2/2012 http://sydneymotorways.com/

Roads and Traffic Authority (RTA) 2008, *Annual Report*, Roads and Traffic Authority, Sydney http://www.rta.nsw.gov.au/publicationsstatisticsforms/downloads/2008_annual_report_dl1.html

Roads and Traffic Authority (RTA) 2009a, *2008 New South Wales Driver and Vehicle Statistics*, Roads and Traffic Authority (RTA), viewed 10/6/2009 http://www.rta.nsw.gov.au/publicationsstatisticsforms/downloads/statiregis_dl6.html

Roads and Traffic Authority (RTA) 2009b, *Annual Report 2008-09*, Roads and Traffic Authority (RTA), Sydney http://www.rta.nsw.gov.au/publicationsstatisticsforms/downloads/rta_annualreport_2009_complete.pdf

Roads and Traffic Authority (RTA) 2010a, *Building Sydney Motorways*, Roads and Traffic Authority (RTA), viewed 31/1/2011 http://buildingsydneymotorways.com.au/

Roads and Traffic Authority (RTA) 2010b, *Post Implementation Review: M7 Motorway, Cross City Tunnel and Lane Cove Tunnel*, Roads and Traffic Authority (RTA), Sydney http://www.treasury.nsw.gov.au/__data/assets/pdf_file/0016/20662/m7_motorway_cct_lct_post_implementation_review_report_dnd.pdf

Ronis, D.L., Yates, J.F. & Kirscht, J.P. 1989, 'Attitudes, decisions and habits as determinants of repeated behavior', in A.R. Pratkanis, S.J. Breckler & A.G. Greenwald (eds), *Attitude Structure and Function*, Erlbaum, Hillsdale, N.J., pp. 213-239.

Root, A., Schintler, L. & Button, K. 2000, 'Women, travel and the idea of 'sustainable transport'', *Transport Reviews*, vol. 20, no. 3, pp. 369-383.

Rose, G. & Marfurt, H. 2007, 'Travel behaviour change impacts of a major ride to work day', *Transportation Research Part A*, vol. 41, pp. 351-364.

Ross, J. 2012, *Cycle path working: researcher*, News Limited, viewed 6/1/2012.

Rowling, J.K. 2005, *Harry Potter and the Half-Blood Prince*, Bloomsbury, London.

SACTRA 1994, *Trunk Roads and the Generation of Traffic*, HMSO, London.

Saulwick, J. 2011, 'Trams to return to George Street under plan for light rail expansion', *Sydney Morning Herald (New South Wales)*, 8th December, viewed 3/12/12 http://www.smh.com.au/nsw/trams-to-return-to-george-street-under-plan-for-light-rail-expansion-20111207-1ojah.html

Saulwick, J. 2013, 'Motorists to pay up to $4 a trip on wider M4', *Sydney Morning Herald*, 19th September, viewed 21/9/13 http://smh.drive.com.au/roads-and-traffic/motorists-to-pay-up-to-4-a-trip-on-wider-m4-20130919-2u181.html

Schönfelder, S. & Axhausen, K.W. 2009, 'Travel as a function of (life) projects', paper presented to the *European Transport Conference 2009*, http://www.etcproceedings.orxcg/paper/travel-as-a-function-of-life-projects

Scott, P. 1978, 'Tasman Bridge collapse: its influence on the transport and social behaviour of a population', in R.B. Potts (ed.), *Transport in Australia, papers delivered at a meeting of the Science and Industry Forum of the Australian Academy of Science on 11 February 1978*, Australian Academy of Science, Canberra, pp. 108-121.

Scott, S. 2004, *Think Global, Act Local: Actions for a Sustainable Lane Cove*, Lane Cove Council, Sydney http://ecouncil.lanecove.nsw.gov.au/newtrim/documents/718977583/TRIM_Sustainability%20Action%20Plan%202005%20-%20Think%20Global%20%20Act%20Local%20Actions%20for%20a%20Sustainable%20Lane%20Cove_405680.PDF

Sharples, R. 1997, 'Cycle flows by time of day', *Traffic Engineering + Control*, vol. 38, no. 11, pp. 607-609.

Sharples, R. 2009, 'Are public transport, cycling and walking the answer to the anticipated growth in motorized traffic?', paper presented to the *32nd Australasian Transport Research Forum*, Auckland, 29th September - 1st October http://www.atrf.info/papers/2009/2009_Sharples_A.pdf

Sharples, R. 2013, *There is more to it than public transport*, poster, NCCARF, Sydney.

Shin, J.-H. & Lee, I.-K. 2006, 'Cheong Gye Cheon restoration in Seoul, Korea', *Proceedings of the Institution of Civil Engineers: Civil Engineering*, vol. 159, no. 14775, pp. 162-170 http://www.icevirtuallibrary.com/content/article/10.1680/cien.2006.159.4.162

Sidwell, D. & Capoore, P. 1990, *Deutsch Heute Teil 1*, 2nd edn, Thomas Nelson and Sons Ltd, Cheltenham.

Siegel, C. 2007, *From Induced Demand to Reduced Demand*, Preservation Institute.

Silverman, D. 2006, *Interpreting qualitative data : methods for analyzing talk, text and interaction*, 3rd edn, Sage, Thousand Oaks.

Sinclair Knight Merz (SKM) 2001, *Lane Cove Tunnel and Associated Road Improvements: Environmental Impact Statement*, Roads and Traffic Authority (RTA), Sydney.

Smeed, R. & Wardrop, J. 1964, 'An explanatory comparison of the advantages of cars and buses for travel in urban areas', *Journal of the Institute of Transport*, vol. 30, no. 9, pp. 301-315.

Smith, A. 2008, 'Money wasted on cyclists: NRMA', *Sydney Morning Herald (National)*, 10th January, viewed 24/1/2012 http://www.smh.com.au/news/national/money-wasted-on-cyclists-nrma/2008/01/09/1199554742667.html

Sohn 2011, 'Multi-objective optimization of a road diet network design', *Transportation Research Part A*, vol. 45, pp. 499-511.

Spearritt, P. 1978, *Sydney since the twenties*, Hale and Iremonger, Sydney.

Speed, E. 1990, 'It's all a question of attitudes', *Cycle Touring & Campaigning*, October/November, pp. 16-17.

Sperling, D. & Gordon, D. 2009, *Two Billion Cars*, Oxford University Press, New York.

St George Bank 2013, *Sustainability and Community*, St George Bank, viewed 21/10/2013 http://www.stgeorge.com.au/about-stgeorge/sustainability-and-community

Stanbridge, K., Lyons, G. & Farthing, S. 2004, 'Travel behaviour change and residential relocation', paper presented to the *Third International Conference on Traffic and Transport Psychology*, Nottingham, 5th - 9th September 2003 http://www.psychology.nottingham.ac.uk/IAAPdiv13/ICTTP2004papers2/Travel%20Choice/Stanbridge.pdf

Stern, P.C. 2000, 'Towards a coherent theory of environmentally significant behaviour', *Journal of Social Issues*, vol. 56, no. 3, pp. 407-424.

Stevens, N., Battellino, H. & Pedler, K. 2013, 'Evaluating travel training in northern Sydney: methodological and practical issues', paper presented to the *36th Australasian Transport Research Forum*, Brisbane, 2nd - 4th October http://www.atrf.info/papers/2013/2013_stevens_battellino_pedler.pdf

Stradling, S.G. 2002, 'Transport user needs and marketing public transport', *Proceedings of the Institution of Civil Engineers: Municipal Engineer*, vol. 151, no. 1, pp. 23-28.

Suler, J. 2004, 'The online disinhibition effect', *CyberPsychology & Behaviour*, vol. 7, no. 3, pp. 321-326.

Sydney Morning Herald (SMH) 2006, *Lane Cove Tunnel*, Fairfax Media Ltd, viewed 21/2/2014 http://blogs.smh.com.au/newsblog/archives/your_say/005640.html?page=fullpage

Sydney Morning Herald (SMH) 2007, *Lane Cove Tunnel*, Fairfax Media Ltd, viewed 21/2/2014 http://blogs.smh.com.au/newsblog/archives/your_say/010535.html

Sydney Morning Herald (SMH) 2011, *Sydney*, Fairfax Media Ltd, 2011 http://weather.smh.com.au/local.jsp

Tatnell, P. 2010, 'Lane Cove Tunnel sold for $630m', *Sydney Morning Herald*, 10th May, http://www.smh.com.au/nsw/lane-cove-tunnel-sold-for-630m-20100510-umn3.html

Tertoolen, G., van Kreveld, D. & Verstraten, B. 1998, 'Psychological resistance against attempts to reduce private car use', *Transportation Research A*, vol. 32, no. 3, pp. 171-181.

The George Institute 2010, *Driver Education*, The George Institute, viewed 25/5/2010 http://www.youngdriverfactbase.com/the-issues/driver-education/

Thøgerson, J. 2006, 'Understanding repetitive travel mode choices in a stable context: a panel study approach', *Transportation Research Part A*, vol. 40, pp. 621-638.

Tight, M.R., Bristow, A.L., Pridmore, A. & May, A.D. 2005, 'What is a sustainable level of CO2 emissions from transport activity in the UK in 2050?', *Transport Policy*, vol. 12, pp. 235-244.

Tight, M.R., Timms, P., Banister, D., Bowmaker, J., Copas, J., Day, A., Drinkwater, D., Givoni, M., Gühnemann, A., Lawler, M., Macmillen, J., Miles, A., Moore, N., Newton, R., Ngoduy, D., Ormerod, M., O'Sullivan, M. & Watling, D. 2011, 'Visions for a walking and cycling focussed urban transport system', *Journal of Transport Geography*, vol. 19, pp. 1580-1589.

Tight, M.R., Vicat, A., Bristow, A.L., Pridmore, A. & May, A.D. 2007, 'An exploration of household response to personal travel carbon-reduction targets', *International Journal of Sustainable Transportation*, vol. 1, no. 3, pp. 143-159.

Tinslay, C. 1979, 'Road closures and other limitations', paper presented to the *Control of Traffic on Residential Streets Symposium*, Sydney, 12th June.

Tipping, M.J. nd, *Hoddle, Robert (1794–1881)*, *Australian Dictionary of Biography*, National Centre of Biography, Australian National University, Canberra, viewed 22/12/2012 http://adb.anu.edu.au/biography/hoddle-robert-2190/text2823

Toleman, R. & Rose, G. 2007, 'A pathway to sustainable transport', paper presented to the *30th Australasian Transport Research Forum*, Melbourne, 25th - 27th September. http://www.atrf.info/papers/2007/2007_Toleman_Rose.pdf

Toleman, R. & Rose, G. 2009, 'Towards a moving target: delivering outcomes for sustainable transport', paper presented to the *32nd Australasian Transport Research Forum*, Auckland, 29th September - 1st October. http://www.atrf.info/papers/2009/2009_Toleman_Rose.pdf

Towler, G. & Shepherd, R. 1991, 'Modification of Fishbein and Ajzen's Theory of Reasoned Action to predict chip consumption', *Food Quality and Preference*, vol. 3, no. 1991/92, pp. 37-45.

Transperth 2012, *Perth CAT Live Times*, Public Transport Authority, viewed 1/8/2012 http://www.transperth.wa.gov.au/TimetablesMaps/PerthCATLiveTimes.aspx

Transperth 2012, *Transperth bus system punctuality*, Public Transport Authority of WA, viewed 1/8/1 2012 http://www.transperth.wa.gov.au/AboutUs/Surveysandstatistics.aspx

Transport Data Centre (TDC) 2010, *2008/09 Household Travel Survey Summary Report 2010 Release*, Government of New South Wales, Sydney http://www.transport.nsw.gov.au/sites/default/file/tdc/documents/R2010-01-2008-09-HTS-Summary-Report.pdf

Transport NSW 2014, *Free shuttle buses*, Transport for NSW, viewed 8/4/2014 http://www.transportnsw.info/en/tickets/free-shuttles.page?

Transportation Research Board (TRB) 2000, *Highway Capacity Manual*, 2000 edn, National Academy of Sciences, Washington D.C.

Transurban Ltd 2012, *Transurban*, Transurban Ltd, viewed 16/2/2012 http://www.transurban.com.au/

Transurban Ltd 2014, *Results for half year ended 31 December 2013*, Transurban Ltd, viewed 7/4/2014 http://www.transurban.com/1302372.pdf

TravelSmart Australia 2009, *TravelSmart Australia a better way to go*, Department of the Environment, Water, Heritage and the Arts, viewed 17/3/2009 http://www.travelsmart.gov.au/

Triandis, H.C. 1977, *Interpersonal Behaviour*, Brooks/Cole, Monterey.

Triandis, H.C. 1980, *Values, Attitudes and Interpersonal Behavior*, University of Nebraska Press, Lincoln.

Turner, J.C., Hogg, M.A., Oakes, P.J., Reicher, S.D. & Wetherell, M.S. 1987, *Rediscovering the social group:a self-categorisation theory*, Blackwell, Oxford.

Twiney, P. & Rudd, J. 2005, 'Transport planning for congestion in Sydney', paper presented to the *AITPM*, Sydney.

University of Technology, Sydney (UTS), 2012, *HREC Policy for Undergraduate and Postgraduate Students*, University of Technology, Sydney, viewed 19/10/2012 http://www.gsu.uts.edu.au/policies/hrecpolicy.html

van der Waerden, P., Timmermans, H. & Borgers, A. 2003, 'The influence of key events and critical incidents on transport mode choice switching behaviour: a descriptive analysis', paper presented to the *Moving through nets: The physical and social dimensions of travel -10th International Conference on Travel Behaviour Research*, Lucerne, Switzerland, 10th -15th August http://www.ivt.ethz.ch/news/archive/20030810_IATBR/waerden.pdf

van Exel, N.J.A. & Rietveld, P. 2009, 'Could you also have made this trip by another mode? An investigation of perceived travel possibilities of car and train travellers on the main travel corridors to the city of Amsterdam, The Netherlands', *Transportation Research Part A*, vol. 43, pp. 374-385.

Vandenbulcke, G., Dujardin, C., Thomas, I., de Geus, B., Degraeuwe, B., Meeusen, R. & Panis, L.I. 2011, 'Cycle commuting in Belgium: spatial determinants and 're-cycling' strategies', *Transportation Research Part A*, vol. 45, pp. 118-137.

Veitch, T., Alaimo, A. & Walker, L. 2013, 'Demand forecasting for toll roads: an approach to more accurately forecasting traffic volumes', paper presented to the *36th Australasian Transport Research Forum*, Brisbane, 2nd - 4th October.

Verhoeven, M., Arentze , T.A., Timmermans , H.J.P. & Van der Waerden, P. 2008, 'Retrospective Surveys: Some Experiences in the Context of Measuring Lifecycle Events', paper presented to the *87th Annual Meeting of the Transportation Research Board, Washington, DC to ABJ40-Committee on Travel Survey Methods.*, Washington D.C., 13th -17th January.

Verplanken, B. & Aarts, H. 1999, 'Habit, attitude, and planned behaviour: is habit an empty construct or an interesting case of goal-directed automaticity?', in W. Stroebe & W. Hewstone (eds), *European Review of Social Psychology*, vol. 10, John Wiley and Sons, pp. 101-134.

Verplanken, B., Aarts, H. & van Knippenberg, A. 1997, 'Habit, information acquisition, and process of making travel mode choices', *European Journal of Social Psychology*, vol. 27, pp. 539-560.

Verplanken, B., Aarts, H., van Knippenberg, A. & Moonen, A. 1998, 'Habit versus planned behaviour: a field experiment', *British Journal of Social Psychology*, vol. 37, no. 1, pp. 111-128.

Verplanken, B., Aarts, H., van Knippenberg, A. & van Knippenberg, C. 1994, 'Attitude versus general habit: antecedents of travel mode choice', *Journal of Applied Social Psychology*, vol. 24, no. 4, pp. 285-300.

Verplanken, B., Myrbakk, V. & Rudi, E. 2005, 'The measurement of habit', in T. Betsch & S. Haberstroh (eds), *The routines of decision making*, Lawrence Erlbaum, Mahwah, New Jersey, pp. 231-247.

Verplanken, B. & Orbell, S. 2003, 'Reflections on past behaviour: a self-report index of habit strength', *Journal of Applied Social Psychology*, vol. 33, no. 6, pp. 1313-1330.

Verplanken, B., Walker, I., Davis, A. & Jurasek, M. 2008, 'Context change and travel mode choice: combining the habit discontinuity and self-activation hypotheses', *Journal of Environmental Psychology*, vol. 28, no. 2, pp. 121-127.

Verplanken, B. & Wood, W. 2006, 'Interventions to break and create consumer habits', *Journal of Public Policy & Marketing*, vol. 25, no. 1, pp. 90-103.

VicRoads nd, *Swanston Street Walk Resource Kit*, VicRoads, Melbourne.

Victoria Transport Policy Institute (VTPI) 2013, *Sustainable Transportation and TDM Planning that Balances Economic, Social and Ecological Objectives*, Victoria Transport Policy Institute (VTPI), viewed 21/10/2013 http://www.vtpi.org/tdm/tdm67.htm

Wall, G.T., Davies, D.G. & Crabtree, M. 2003, *Capacity Implications of Advanced Stop Lines for Cycling*, Report Number TRL 585, Transport Research Laboratory.

Wallace, P. 1999, *The Psychology of the Internet*, Cambridge University Press, Cambridge.

Walsh, B. 2006, 'Saving Seoul', *Time*, 15th May, pp. 30-36, viewed 26/4/2012 http://www.time.com/time/magazine/article/0,9171,1191882,00.html

Weinstein, A. 2006, 'Congestion as a cultural construct: The 'congestion evil' in Boston in the 1890s and 1920s', *Journal of Transport History*, vol. 27, no. 2, pp. 97-115.

Weiss, M. 2011, 'Rewinding a public infrastructure', in J. Busquets (ed.), *Deconstruction/construction: the Cheonggyecheon restoration project in Seoul*, Harvard University Graduate School of Design, Cambridge MA, pp. 47-60.

Wells, L.G. & Strickland, T.L. 1993, *Summary Report*, Vic Roads, Melbourne.

Whelan, J., Seaton, E. & Cunningham Dax, E. 1976, *Aftermath: the Tasman Bridge Collapse*, Australian Institute of Criminology, Canberra.

Whitelegg, J. 1993, *Transport for a Sustainable Future*, Belhaven Press, London.

Wilder, T. 1941, *The Bridge of San Luis Rey*, Penguin Books.

Wind, M., Kremers, S., Thijs, C. & Brug, J. 2005, 'Toothbrushing at school: Effects on toothbrushing behaviour, cognitions and habit strength', *Health Education*, vol. 105, no. 1, pp. 53-61 http://ejournals.ebsco.com/direct.asp?ArticleID=40388283C347E6E07A0B

Wittenbraker, J., Gibbs, B.L. & Kahle, L.R. 1983, 'Seat Belt Attitudes, Habits, and Behaviors: An Adaptive Amendment to the Fishbein Model', *Journal of Applied Social Psychology*, vol. 13, no. 5, pp. 406-421.

Wood, W. & Neal, D.T. 2007, 'A new look at habits and the habit-goal interface', *Psychological Review*, vol. 114, no. 4, pp. 843-863.

Wood, W., Quinn, J.M. & Kashy, D.A. 2002, 'Habits in Everyday Life: Thought, Emotion, and Action', *Journal of Personality and Social Psychology*, vol. 83, no. 6, pp. 1281-1297.

Wood, W., Tam, L. & Guerrero Witt, M. 2005, 'Changing circumstances, disrupting habits', *Journal of Personality and Social Psychology*, vol. 88, no. 6, pp. 918-933.

World Commission on Environment and Development (WCED) 1987, *Our Common Future*, Oxford University Press, Oxford.

Yang, X., Gao, Z., Zhao, X. & Si, B. 2009, 'Road capacity at bus stops with mixed traffic flow in China', *Transportation Research Record*, no. 2111, pp. 18-23.

Ye, L., Mokhtarian, P.L. & Circella, G. 2010, 'Commuter impacts and behavior changes during a temporary freeway closure: the Fix I-5 Project in Sacramento, California', paper presented to the *89th Annual Meeting of the Transportation Research Board* Washington D.C., 10th - 14th January.

Youn, H., Jeong, H. & Gastner, M.T. 2008, 'The price of anarchy in transportation networks: efficiency and optimality control', *arXiv.org*, vol. 0712, http://arxiv.org/abs/0712.1598

Yun, M., van Herick, D. & Mokhtarian, P.L. 2011, 'Nonwork Travel Behaviour Changes During Temporary Freeway Closure', *Transportation Research Record*, vol. 2231, pp. 1-9.

Zapata, Z. 2008, *Citizens Against Road Ripoffs (CARR)*, Zapata, Ziggy, viewed 21/2/2012 www.carr.org.au

APPENDIX A

Cyclist and Pedestrian Counts on Epping Road

A.1 Introduction

A route for cyclists and pedestrians was constructed on the southern side of Epping Road in Lane Cove as part of the Lane Cove Tunnel scheme. The route is a combination of cycle lane, footpath and shared use path (SUP), and has been described in s.4.4.6. The bus lanes on Epping Road in Lane Cove were also available for use by cyclists, as described in s.4.4.5. Cyclists, and these two facilities, were mentioned by several respondents. Therefore, it was felt desirable to obtain figures for cycle flows, both pre- and post-tunnel, in order to obtain an objective indication of the use of the cycle route. As a result, a count of cyclists was undertaken in 2011. Although not mentioned by respondents, the opportunity was also taken to undertake a count of pedestrians (near the junction with Mowbray Road West) for completeness.

A.2 Background

Promoting alternative modes to private motor vehicles (PMV), including cycling and walking, was state government policy at the time of construction of the Lane Cove Tunnel, and the cycling and walking facilities were provided in response to that (SKM 2001, s.1, p. 1-3). The facilities were built primarily on land resumed when Epping Road was narrowed, although at several points (e.g. just west of the junction with Sam Johnson Way) the SUP is cantilevered over the slope and therefore does not use land that might otherwise might be available to provide road space for motor traffic.

A SUP continues eastwards from Lane Cove beside the Gore Hill Freeway as far as Naremburn. In the westerly direction, a SUP continues beside Epping Road into North Ryde as far as Wicks Road. Since the count was undertaken, it has been extended to Macquarie University (Macquarie University 2014). The SUP and cycle lanes are part of the Metro Sydney Bike Network (NSW Government 2010, pp. 10-11). The following video provides an incomplete, but useful, view of the extended path and adjacent carriageway, from a cyclist's point of view: http://www.sydneycyclist.com/video/epping-road-cycleway-east

Although, as in the video, the route is sometimes described as a cycleway (e.g. NRMA 2008; Evans 2008), for most of the length between the Gore Hill Freeway and Wicks Road it is a shared facility, for use by pedestrians as well as cyclists. As well as making specific provision for cyclists, it provides a continuous route along Epping Road in Lane Cove for pedestrians that did not exist prior to the tunnel (SKM 2001, s.8.4.2, pp.8-12 – 8-14 & s.8.6.11, pp. 8-29 – 8-30).

Anecdotal evidence suggests that the cycle facilities have collected cyclists from other routes in the area: e.g. cyclists formerly using Mowbray Road West now use the SUP and cycle lanes to traverse Lane Cove (see Figure 4.2).

A.3 Existing Counts

A.3.1 Cyclists

Upon investigation, only two published counts of cyclists along Epping Road in Lane Cove in recent years were found:

1. a count of cyclists heading east in the transit lane on Epping Road near Elizabeth Parade in 2000 (i.e. 11 years before the count undertaken for this study), commissioned for the Lane Cove Tunnel Environmental Impact Statement (EIS), found an average of six in the a.m. peak (SKM 2001, p.8-7 Table 8.7); and
2. an all day survey commissioned by the National Roads and Motorists Association (NRMA) and published on the 10th January 2008 found an average of 25 cycle trips on the SUP (Smith 2008; NRMA 2008; Evans 2008).

The NRMA did not respond to an e-mail requesting further information about this count. However, assuming that the count was published soon after it was completed (but see Moore (2008)), it may be noted that there are several factors which may have contributed to the low number of cyclists found:

- the survey would have been undertaken during the Christmas/New Year holiday break, when the two most likely sources of cyclists (that is, students from Macquarie University and commuters) were not undertaking routine travel;
- the SUP was incomplete and not yet open.

A.3.2 Pedestrians

No counts of pedestrians on Epping Road in Lane Cove were published in the EIS.

A.4 Post-SUP count

A.4.1 Introduction

Enquiries to the Lane Cove Council (t. Sullivan, pers. comm. 2011), Roads and Traffic Authority (RTA - now Roads and Maritime Services (RMS)) (S. Soelistio, pers. comm. 2011) and local cycling groups (C. New, pers. comm. 2011) elicited no knowledge of any survey of cyclists in Epping Road in Lane Cove since the SUP opened in 2008. Although the RTA installed loop detectors at three locations on the Epping Road SUP (including one near the junction with Mowbray Road West) they have not all produced satisfactory counts. Only the counters on the Artarmon branch of the overall Ryde – Naremburn SUP function usefully (S. Soelistio, pers. comm. 2011).

Therefore, it was decided to undertake a count of cyclists on the SUP. The new survey was carried out on Wednesday 16th November 2011 with the help of volunteers from local cycling groups Bike Macquarie and Bike North. A second count of cyclists was undertaken on Monday 28th November 2011 by the researcher, to confirm the validity of the first count.

A.4.2 Locations

Counts were undertaken at two locations:

1. a 12 hour count of both cyclists and pedestrians was undertaken on the southern side of Epping Road in Lane Cove in the vicinity of the junction with Mowbray Road West (see Figure A.2); and
2. two hour counts of cyclists only were undertaken on the southern side of Epping Road in Lane Cove at a position near Elizabeth Parade (i.e. west of Centennial Avenue (see Figure A.3)).

These general locations were chosen:

- for comparison with the EIS counts (Elizabeth Parade); and
- to be in the vicinity of one counting site for motor vehicles (Mowbray Road West).

The count site near Elizabeth Parade was also included to test the hypothesis that cyclists were using an extended stretch of the SUP rather than short stretches. Clearly, a count which is similar at both locations will not prove this as cyclists may join and leave the path in numbers and at locations which mimic cyclists making a longer ride. However, an intercept survey by which this question could be definitively answered, was not within the resources of this study, nor was it necessary for this study.

The precise locations were chosen bearing in mind potential needs of the surveyors: seating; shelter from rain or sun; access to toilets and food; and security for surveyors' bicycles.

As the count near the junction with Mowbray Road West was intended to capture pedestrian numbers as well as cyclists, the bus stop was selected as the enumeration point (see s.4.9.5). The stretch of Epping Road near the junction with Mowbray Road West is adjacent to industrial and commercial areas. However, there is pedestrian access near the junction to a residential area, which overlooks Epping Road from the north but for which vehicular access is provided further east at Centennial Avenue.

Figure A.1 Residential development overlooking the junction of Mowbray Road West and Epping Road
(looking east from Mowbray Road West; 10/8/2013)

Figure A.2 Epping Road SUP sloping down to the junction with Mowbray Road West
The Lane Cove Tunnel's western portal is visible in the centre back, framed by the traffic signals. The cycle detectors can be seen in the foreground (looking west).

Figure A.3 Epping Road SUP viewed from surveying position in Turrumbarra Park
Elizabeth Parade is to the right of the white van. There is no bus lane at this point on either side of Epping Road (looking west).

Elizabeth Parade, on the northern side of Epping Road, is in a residential area with established provision for pedestrians (see Figure A.3). There is no location (e.g. business park) from which cyclists are expected to emerge (i.e. they are all expected to traverse the full length of Turrumbarra Park, which is on the corner of Epping Road and Centennial Avenue (see Figure 4.1)).

A.4.3 Timing

Choice of survey day

Although cycling is known to be affected by the weather (e.g. Sharples 1997; Ahmed *et al* 2010) the cycle counters installed around the Greater Sydney area (Lehman *et al* 2008) do not give a clear picture of cycling seasonality, owing to data which is missing for appreciable periods. However, it was felt that counting in bad weather (e.g. winter) would not give a fair indication of the use that the SUP can command. Nevertheless, professional experience suggests that the principal weekday users would be commuting cyclists. Therefore, it was thought preferable to avoid holiday periods – in particular January and the Christmas/New Year break. Because of the SUP's proximity to a university, it was felt that it would be desirable to count during semester, in order to capture students and academic staff who might not come in during holiday periods.

The climate in Sydney is such that it is not possible to name a date and assume that the weather will be dry (BOM 2014). However, a decision about the day on which the count was to be undertaken had to be made in advance because people apart from the researcher were involved in the count. Therefore, a long range forecast from the local newspaper the *Sydney Morning Herald* (SMH 2011) was consulted in order to choose a day that might offer the best chance of being free of rain and therefore maximize the observed flow.

> *I ride home on it every day, rain or shine, and it's amazing how much weather affects the numbers. (EM2)*

Choice of survey period

Based on professional experience and anecdotal evidence, the expectation was that the majority of cyclists who used the SUP would be commuting either to work or Macquarie University. Therefore, it was decided to conduct the count on a weekday. There is no study, to the author's knowledge, which has analysed cycle use by day of week in the Australian context. However, an earlier survey of cyclists in Sydney (the Harbourlink survey) had conducted counts on a Tuesday, Wednesday and Thursday in October 2009 (PriceWaterhouseCoopers & Sinclair Knight Merz 2010). Using the results of this count as a guide, and the long range forecast, it was decided to count on the 16th November. Unfortunately, this took the count into the Macquarie University exam period. Cycle use by university staff and students has been observed to drop at this time (A. Sharp, pers. comm.. 2011).

The 12 hour period 7 a.m. – 7 p.m. was chosen to encompass both morning and evening peak periods as well as the interpeak. The Harbourlink survey began at 6 a.m. (PriceWaterhouseCoopers & Sinclair Knight Merz 2010). Given the substantial pre-a.m. peak flow (see s.4.6) and with the benefit of hindsight, it would have been useful to also start this count at 6 a.m., to obtain the most accurate picture of SUP use by cyclists.

The two hour counts near Elizabeth Parade were conducted between 7 a.m. and 9 a.m. This period was chosen to capture commuting cyclists and to allow comparison with the EIS a.m. peak cycle counts. The comments about starting the count at 6 a.m. apply equally to this location.

A.4.4 Weather

The sky was overcast all day on the 16th November 2011. The temperature was mild in the morning until about 10.30, when it became cooler. Light rain started to fall and developed into steady rain, albeit not heavy, after lunch. There was no appreciable wind.

The weather for the second count on the 28th November 2011 was fine and sunny. No rain was forecast for the day.

A.4.5 Method

Data gathered

All cyclists and pedestrians on the SUP and on the road (bus lane) were counted travelling in both directions :

- east/Lane Cove/city bound; and

- west/North Ryde/Macquarie Park/Macquarie University bound.

When the same person went past and later returned, they were counted as two trips.

Counts were conducted over different periods at different locations:

- near the junction with Mowbray Road West, counts were conducted during the 12 hours between 7 a.m. and 7 p.m.;
- at the location west of Elizabeth Parade, cycle counts were conducted during the two hours of the morning peak period between 7 a.m. and 9 a.m. (but see note below).

Pedestrians were counted for the full 12 hours at Mowbray Road West, but not counted at all west of Elizabeth Parade (see s.4.9.5).

Survey team

The survey team consisted of four people – the researcher and three volunteers from local cycling groups. There was only one surveyor in position at each location at any time. Three individuals shared the task of counting cyclists and pedestrians near the junction of Epping Road and Mowbray Road West. One person was dedicated to the cycle count near Elizabeth Parade.

Counting method

Counts were taken by tallying individual cyclists and pedestrians; using pen and paper, during 15 minute time slots. All cyclists were counted equally (that is, children were given the same weight as adults). Passers-by were not approached at any point. Noteworthy manoeuvres were also collected: e.g. cyclists moving between the road (bus lane) and the SUP, or cyclists pushing their bikes rather than riding.

Errors

Potential errors in this type of survey include undercounting and overcounting. This may happen if, for example, a large group of cyclists or pedestrians passes and the surveyor is unable to count them accurately. Limitations on resources precluded the use of two surveyors operating simultaneously to check each other's results. However, it was felt that such errors were likely to be minimal and, in fact, no large groups of cyclists or pedestrians were seen.

Figure A.4 Surveyor at the count site near the junction with Mowbray Road West
(Looking west; 16/11/2011)

Enumeration points

For the 12-hour count, surveyors were stationed at the bus stop on the southern side of Epping Road, near its junction with Mowbray Road West (see Figure A.4). Cyclists were counted as they passed the stop. A majority of the pedestrians who were seen alighted from buses at this stop. They were assigned a direction depending on the direction they took after alighting from the bus. For the two hour counts near Elizabeth Parade, surveyors were stationed inside Turrumbarra Park at a position which gave a view of the SUP in either direction.

A.4.6 Results

The results of the counts on both days and at both locations are summarized in Table A.1. A summary of the results of the cycle count near the junction of Epping Road with Mowbray Road West is presented graphically in Figure A.5.

Table A.1 Total cyclists and pedestrians counted during November 2011

Date	**Mowbray Road West**		**Elizabeth Parade**
	cyclists (a.m. peak)	pedestrians	(a.m. peak: cyclists only)
16th (Wednesday)	271 (133)	164	136
28th (Monday)	-		143

Note: a 12 hour count was undertaken at Mowbray Road West; a 2 hour count was undertaken at Elizabeth Parade

The similarity in numbers between counts amassed on two different days in two different weeks suggests that a figure of approximately 140 cyclists per day is a typical flow.

From Figure A.5, it can be seen that, in contrast to the counts from the EIS and NRMA, many cyclists are using the SUP during the peak hour, although not in the middle of the day.

Extended counts

It should be noted that, if the count period is extended from 6.40 a.m. to 9.14 on the 28th November, the total cycle count is 180 (around 25% more than the 7-9 a.m. count). Of those extra 37 cyclists, 31 (i.e. most) passed in the twenty minutes before 7 a.m. If this result is typical, it can be seen that the total count would be substantially increased by starting at (for example) 6 a.m. No extra pedestrians were observed before 7 a.m.

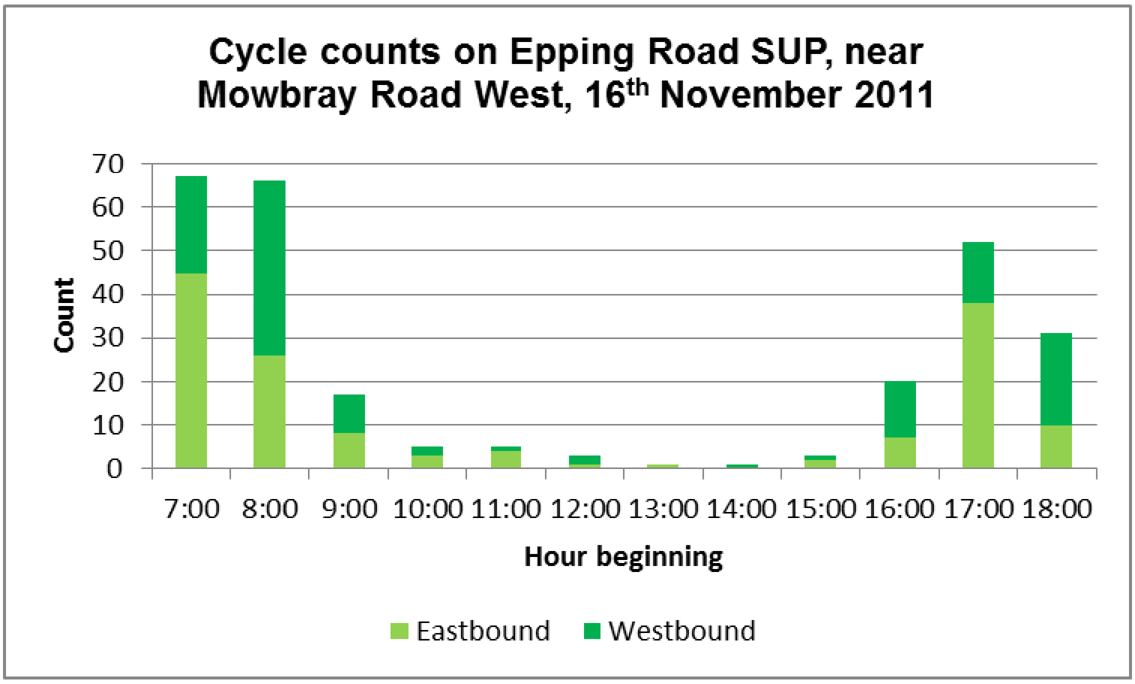


Figure A.5 Number of cyclists for each hour on Epping Road, 16/11/2011

Cyclists' use of bus lanes

Four cyclists were counted on each day using the bus lane in the westbound direction at Elizabeth Parade. No cyclists were counted on the eastbound bus lanes. Social media postings ('Epping Road bike path claims another victim' 2011) suggest that at certain points, there have been problems because motorists sometimes cross the SUP without paying sufficient attention to approaching cyclists. It is not known whether the cyclists observed using the bus lanes were doing so in order to circumvent this problem.

A.4.7 Analysis

The figures in Table A.1 show that the number of cyclists on the SUP passing Elizabeth Parade is similar to the number passing the junction with Mowbray Road West. This suggests that most cyclists are travelling the full length of the path between these two points. An intercept survey would be necessary to confirm this.

Figure A.6 Access to Riverview business park from Epping Road
Motorists must cross the Epping Road SUP (looking west).

As may be seen from the graph in Figure A.5, the weekday snapshot of the SUP cycle use captured in this count showed, in general terms:

- a substantially greater number of cycle trips than found in previous counts;
- the heaviest flows in the morning peak;
- the a.m. peak for westbound cyclists slightly later than the peak for eastbound cyclists;
- little use by cyclists in the middle of the day.

It was not possible to undertake an intercept survey to ascertain cyclists' origins and destinations. Anecdotal evidence suggests that the morning flow represents the journey to work (or university) and the evening flow represents the journey home.

If this supposition is correct, the second count near Elizabeth Parade (Table A.1) suggests that this overall pattern is valid for any weekday. However, as cycling represents a recreational activity as well as a utility mode of transport, the pattern may be different at the weekend or on public holidays. Nevertheless, this result follows a similar pattern to the counts of cyclists crossing the Sydney Harbour Bridge on weekdays in 2009 (PriceWaterhouseCoopers & Sinclair Knight Merz 2010) and counts taken at other locations around Sydney (Parsons Brinckerhoff 2008).

It should be noted that anecdotal evidence suggests that the number of cyclists counted would be greater on a fine day during the Macquarie University term time.

A.4.8 Further publicity

A press release with results of the cycle count was issued by the UTS media office (Figure A.7). This was taken up by two local newspapers (*Northern District Times* (Howlett 2012) and *North Shore Times* ('Bike audit out of date' 2012)) and the website of one national daily (*The Australian* (Ross 2012)). It was also added to the Cycling Resource Centre (2011) web site and discussed on a 'Sydney Cyclist' forum ('Bike audit by NRMA out of date' 2012).

It should be noted that this press release was issued after most interviews were undertaken. Therefore, it is unlikely to have influenced the interviewees' attitudes and opinions.

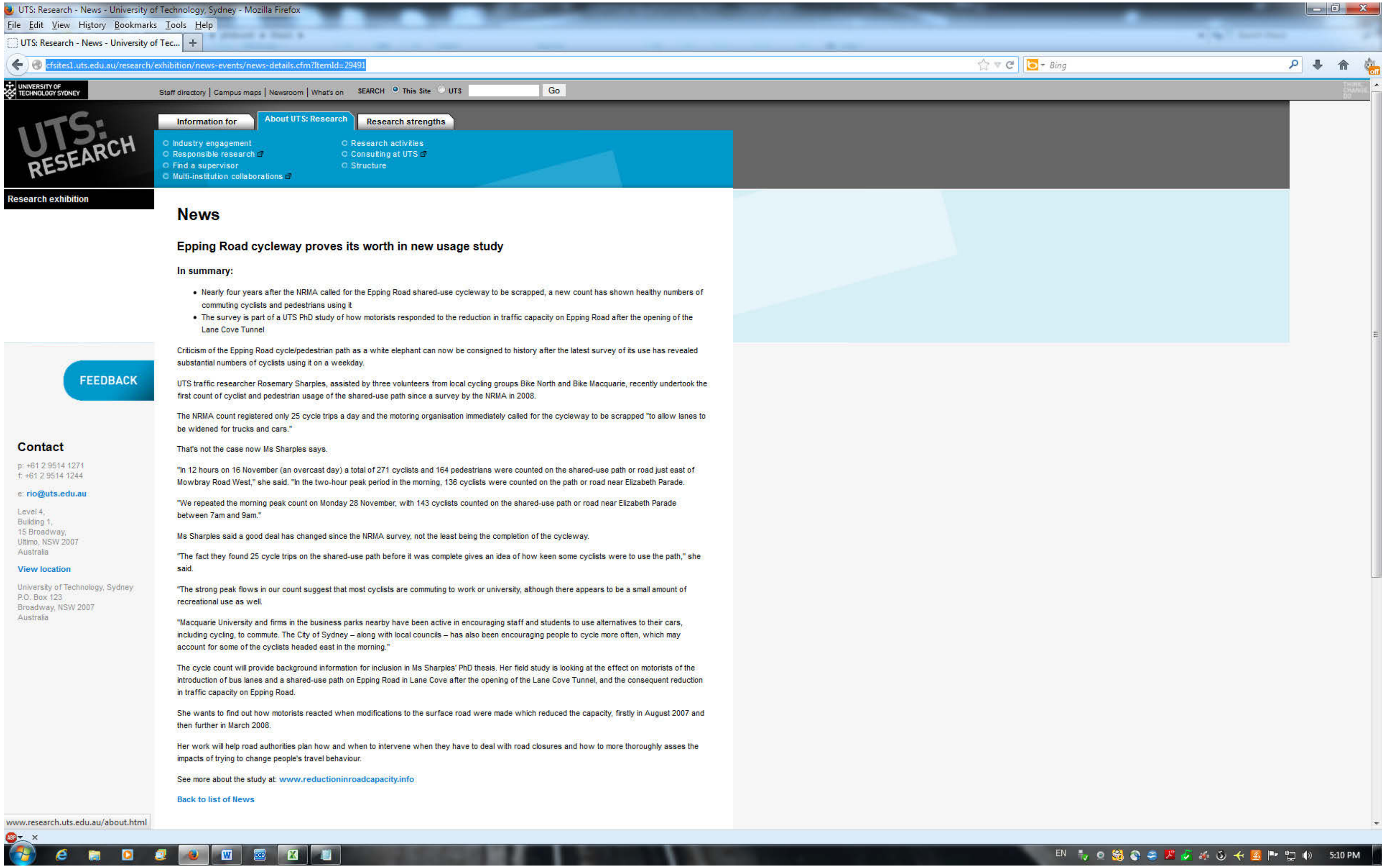
A.4.9 Conclusion

The counts of cyclists and pedestrians that were undertaken on the Epping Road shared use path in November 2011 suggests that the path is well used on weekdays, particularly during commuting periods. A comparison of the 2011 cycle counts and previous cycle counts indicate a substantial rise in use of the shared use path since construction began in 2007.

Further investigation outside the standard 12 hour counting period (before 7 a.m. and after 7 p.m.) and at the weekends is necessary to give a more complete picture. Furthermore, the count described here was undertaken during the Macquarie University exam period. Anecdotal evidence suggests that the flow would have been greater if the count had been undertaken during the university semester.

These results suggest that motorists travelling in either direction along Epping Road in Lane Cove during peak periods could be expected to see a steady, albeit not large, flow of cyclists. If they had been travelling on the road since the tunnel was opened, they may also have noticed an increase in the number of cyclists on the shared use path over the years.

If the use of bus lanes by cyclists noted near Elizabeth Parade is typical, then it can be assumed that cyclists' use of bus lanes is uncommon but not unknown.



News

Epping Road cycleway proves its worth in new usage study

In summary:

- Nearly four years after the NRMA called for the Epping Road shared-use cycleway to be scrapped, a new count has shown healthy numbers of commuting cyclists and pedestrians using it
- The survey is part of a UTS PhD study of how motorists responded to the reduction in traffic capacity on Epping Road after the opening of the Lane Cove Tunnel

Criticism of the Epping Road cycle/pedestrian path as a white elephant can now be consigned to history after the latest survey of its use has revealed substantial numbers of cyclists using it on a weekday.

UTS traffic researcher Rosemary Sharples, assisted by three volunteers from local cycling groups Bike North and Bike Macquarie, recently undertook the first count of cyclist and pedestrian usage of the shared-use path since a survey by the NRMA in 2008.

The NRMA count registered only 25 cycle trips a day and the motoring organisation immediately called for the cycleway to be scrapped "to allow lanes to be widened for trucks and cars."

That's not the case now Ms Sharples says.

"In 12 hours on 16 November (an overcast day) a total of 271 cyclists and 164 pedestrians were counted on the shared-use path or road just east of Mowbray Road West," she said. "In the two-hour peak period in the morning, 136 cyclists were counted on the path or road near Elizabeth Parade.

"We repeated the morning peak count on Monday 28 November, with 143 cyclists counted on the shared-use path or road near Elizabeth Parade between 7am and 9am."

Ms Sharples said a good deal has changed since the NRMA survey, not the least being the completion of the cycleway.

"The fact they found 25 cycle trips on the shared-use path before it was complete gives an idea of how keen some cyclists were to use the path," she said.

"The strong peak flows in our count suggest that most cyclists are commuting to work or university, although there appears to be a small amount of recreational use as well.

"Macquarie University and firms in the business parks nearby have been active in encouraging staff and students to use alternatives to their cars, including cycling, to commute. The City of Sydney – along with local councils – has also been encouraging people to cycle more often, which may account for some of the cyclists headed east in the morning."

The cycle count will provide background information for inclusion in Ms Sharples' PhD thesis. Her field study is looking at the effect on motorists of the introduction of bus lanes and a shared-use path on Epping Road in Lane Cove after the opening of the Lane Cove Tunnel, and the consequent reduction in traffic capacity on Epping Road.

She wants to find out how motorists reacted when modifications to the surface road were made which reduced the capacity, firstly in August 2007 and then further in March 2008.

Her work will help road authorities plan how and when to intervene when they have to deal with road closures and how to more thoroughly asses the impacts of trying to change people's travel behaviour.

See more about the study at: www.reductioninroadcapacity.info

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Figure A.7 UTS press release for the Epping Road cycle and pedestrian count

APPENDIX B

Survey Documents

Appendix B-1

Template letter of introduction

< date > 2011

<name>
<address>
<address>
<suburb> NSW <postcode>

Dear <name>

My name is Rosemary Sharples and I am a doctoral student in the Faculty of Engineering and Information Technology at the University of Technology, Sydney, under the supervision of Dr Jim Underwood. My subject is the effect on traffic of a reduction in road capacity.

I am particularly interested in how motorists' strength of driving habit affects the way they react to road closures. Therefore, I want to interview motorists affected by the closure of lane closures on Epping Road to find out how they reacted and their reasons for doing what they did.

<reason for inviting to interview>

If you agree to be interviewed, I would like to arrange a time to interview you about your reaction to the lane closures on Epping Road. I expect this to take about an hour. The interview will be semi-structured; that is, I will have subject headings I wish to discuss but I expect the conversation to range over a variety of topics within those general areas.

During the interview I will be making notes. With your agreement, I would also like to record the interviews electronically. This will ensure that your views are not distorted by my need to summarize them. Any recordings that I make will be transcribed. Copies of the transcription will be sent back to the individuals concerned for checking and for comments. Any interview quotes that I include in my final thesis will be anonymous unless those involved agree otherwise.

I would be pleased to offer a copy of a summary report to any survey participant who is interested in the findings of this study.

If this is satisfactory to you, and you wish to participate, please sign and return the attached consent form. The return address is given on the enclosed information sheet.

If you have further questions, I can be contacted on (02) 9514 2417. My e-mail address is rosemary.a.sharples@student.uts.edu.au. Dr Underwood can be contacted on (02) 9514 1831; e-mail jim.underwood@uts.edu.au.

Yours faithfully,

Rosemary Sharples

NOTE:
This study has been approved by the University of Technology, Sydney Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the researcher, you may contact the Ethics Committee through the Research Ethics Officer (ph: +61 2 9514 9772) and quote the UTS HREC reference number. Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

Appendix B-2

Template consent form

CONSENT FORM – Reduction in Road Capacity PhD

I, <name>, agree to participate in the research project *The Effects on Traffic Caused by a Reduction in Road Capacity* (UTS HREC No 2010-463A) being conducted by Rosemary Sharples, from the Faculty of Engineering and Information Technology at the University of Technology, Sydney for the PhD.

I understand that the purpose of this study is to enquire into how motorists react when the capacity of a road is reduced, particularly in light of the motorists' strength of driving habit.

I understand that my participation in this research will involve taking part in a face to face interview. The interview will be semi-structured and will concern my responses to lane closures on Epping Road. The interview will take about an hour of my time. There is potential for these questions to make me uncomfortable. I understand that I am free to not answer any question that I am uncomfortable with. There is no obligation for me to answer all the questions or to continue with the interview.

I consent/do not consent *(delete as applicable)* to Rosemary Sharples making an audio recording of this interview.

I understand that all data collected about me and provided by me will be stored in a secure facility which is password protected and accessed only by Rosemary Sharples. Rosemary Sharples will share her data with her supervisor, Dr Jim Underwood, where necessary. The data will be archived for a five (5) year period before being destroyed. All interviews will be coded to ensure anonymity of participants. Any quotes will not be identifiable in publications or other material, unless I agree to be identified.

I am aware that I can contact Rosemary Sharples or her supervisor, Dr Jim Underwood, if I have any concerns about the research. Contact details are as follows:

	Researcher: Rosemary Sharples	**Supervisor:** Dr Jim Underwood
Phone:	02 9514 2417	02 9514 1831
E-mail:	rosemary.a.sharples@student.uts.edu.au	jim.underwood@uts.edu.au
Address:	PO Box 123, Broadway, NSW 2007	PO Box 123, Broadway, NSW 2007

I also understand that I am free to withdraw my participation from this research project at any time I wish, without consequences, and without giving a reason.

I agree that Rosemary Sharples has answered all my questions fully and clearly.

I agree that the research data gathered from this project may be published in a form that does not identify me in any way.

____ ____/____/____

Signature (participant)

____ ____/____/____

Signature (researcher)

NOTE:
This study has been approved by the University of Technology, Sydney Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the researcher, you may contact the Ethics Committee through the Research Ethics Officer (ph: +61 2 9514 9772) and quote the UTS HREC reference number. Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

Appendix B-3

Description of the research

THE EFFECT ON TRAFFIC OF A REDUCTION IN ROAD CAPACITY *(HREC REF NO 2010-463A)*

WHO IS DOING THE RESEARCH?
My name is Rosemary Sharples; I am a student at the University of Technology, Sydney, undertaking a PhD. My supervisor Is Jim Underwood.

WHAT IS THIS RESEARCH ABOUT?
This research is to find out about how motorists react when the capacity of a road is reduced; in particular how their reaction relates to their strength of driving habit.

IF I SAY YES, WHAT WILL IT INVOLVE?
I will ask you to participate in an interview. I will start by taking some standard details including age and income range, summary of people and cars in your household, and brief details of your commute and employment. Then I will ask you about the changes (if any) that you made to your travel when the lane closures on Epping Road occurred. I will make an audio recording of the interview and transcribe it. I will send you a copy of the transcription and notes that I took during the interview and ask you to review them. If I have not received any comment from you by a fortnight from when you received the copy of the transcript, I will assume that you are happy for it to be used as it is.

ARE THERE ANY RISKS?
There are very few if any risks because the research has been carefully designed. However, it is possible that you may feel uncomfortable discussing some particular trips.

WHY HAVE I BEEN ASKED?
You <were suggested to me by …> as a person whose unique experiences would help me explore the breadth of motorists' responses to an incident of reduced road capacity.

DO I HAVE TO SAY YES?
You don't have to say yes.

WHAT WILL HAPPEN IF I SAY NO?
Nothing. I will thank you for your time so far and won't contact you about this research again.

IF I SAY YES, CAN I CHANGE MY MIND LATER?
You can change your mind at any time and you don't have to say why. I will thank you for your time so far and won't contact you about this research again.

WHAT IF I HAVE CONCERNS OR A COMPLAINT?
If you have concerns about the research that you think I (or my supervisor) can help you with, please contact us:

	Researcher: Rosemary Sharples	**Supervisor:** Dr Jim Underwood
Phone:	02 9514 2417	02 9514 1831
E-mail:	rosemary.a.sharples@student.uts.edu.au	jim.underwood@uts.edu.au
Address:	PO Box 123, Broadway, NSW 2007	PO Box 123, Broadway, NSW 2007

If you would like to talk to someone who is not connected with the research, you may contact the Research Ethics Officer on 02 9514 9772, and quote this number: 2010-463A.

WHAT HAPPENS NEXT?
If you are agreeable to taking part in this study, please fill in and sign the consent form attached and return it to me at:

PhD Reduction in Road Capacity
Faculty of Engineering and Information Technology
University of Technology, Sydney
P.O. Box 123, Broadway, NSW 2007

I will then contact you to arrange a time and place for an interview.

Appendix B-4

Demographic details of interviewees

<name> ***<date > 2011***

Address: Phone:

e-mail:

Demographic questions	**Purpose of questions**
We need to ask for some more information about yourself:	
What age group are you in? • under 25 • 26-35 • 36-45 • 46-55 • 56-65 • 0ver 65	Propensity to travel varies with age
What sort of employment do you have outside home? • paid work/voluntary work/study • fulltime/part time (and number of part time jobs)	Need to travel
How long is your commute? • distance: • time:	Details of regular travel
This helps us to determine whether there are any connections between income and the amount of travel people do. Which one do you fall in?	
• <$20,800 per year [<$400pw for most wage earners in the home] • $20,800 - $52,000 per year [anywhere between $400 to $1000pw for the majority of the wage earners] • $52,000 - $104,000 per year [between $1000 and $2000 per week for most of the household's earners; • >$104,000 per year [> $2000 per week]	
We are interested in how the number of people in a household, and whether the connections between those people, influence the household travel. So…	
How many people live in your home?	Household occupancy rate data
How many cars are there in your household?	Car ownership
Is your household made up of: • just yourself; • a family; • a shared household?	Household structure data

Report: Y/N

Appendix B-5

Thank you letter to interviewees

<FEIT/UTS heading>

<date>
<addressee>

Dear *<so and so>*

In *<date>* you kindly took part in a survey regarding the reactions of motorists to *<instance of RRC>*.

You indicated at the time that you would be interested in seeing some of the results. I have pleasure in enclosing a short summary of the results and the conclusions that I have derived from them.

Should you wish to comment on any aspect of the summary, please feel free to contact me at the University of Technology, Sydney. You may contact me by post at the address above; my telephone number is (02) 9514 2417 and my e-mail address is rosemary.a.sharples@student.uts.edu.au

Once again, I would like to thank you for your co-operation and participation in my study.

Yours faithfully,

Rosemary Sharples

Appendix B-6

Interview questions

Interview questions

Travel behaviour questions

Initial thoughts

Was the reallocation of general traffic lanes to bus lanes or foot/cyclepath on Epping Road significant to you, and if so, why?

Travel behaviour before capacity was reduced:

1) Before the change in capacity, what (types of) trips did you make regularly that were affected by, or involved, the part of Epping Road that was later reduced in capacity?
2) Why did you choose that route (as opposed to any other)?
3) How often did you make that/those trip/s?
4) Were there any other ways you could have made that/those trip/s?
5) Did you have recent experience of any other modes?
6) Could you/how would you explain how to use <*mode*> to an <*(e.g.) interstate*> visitor?

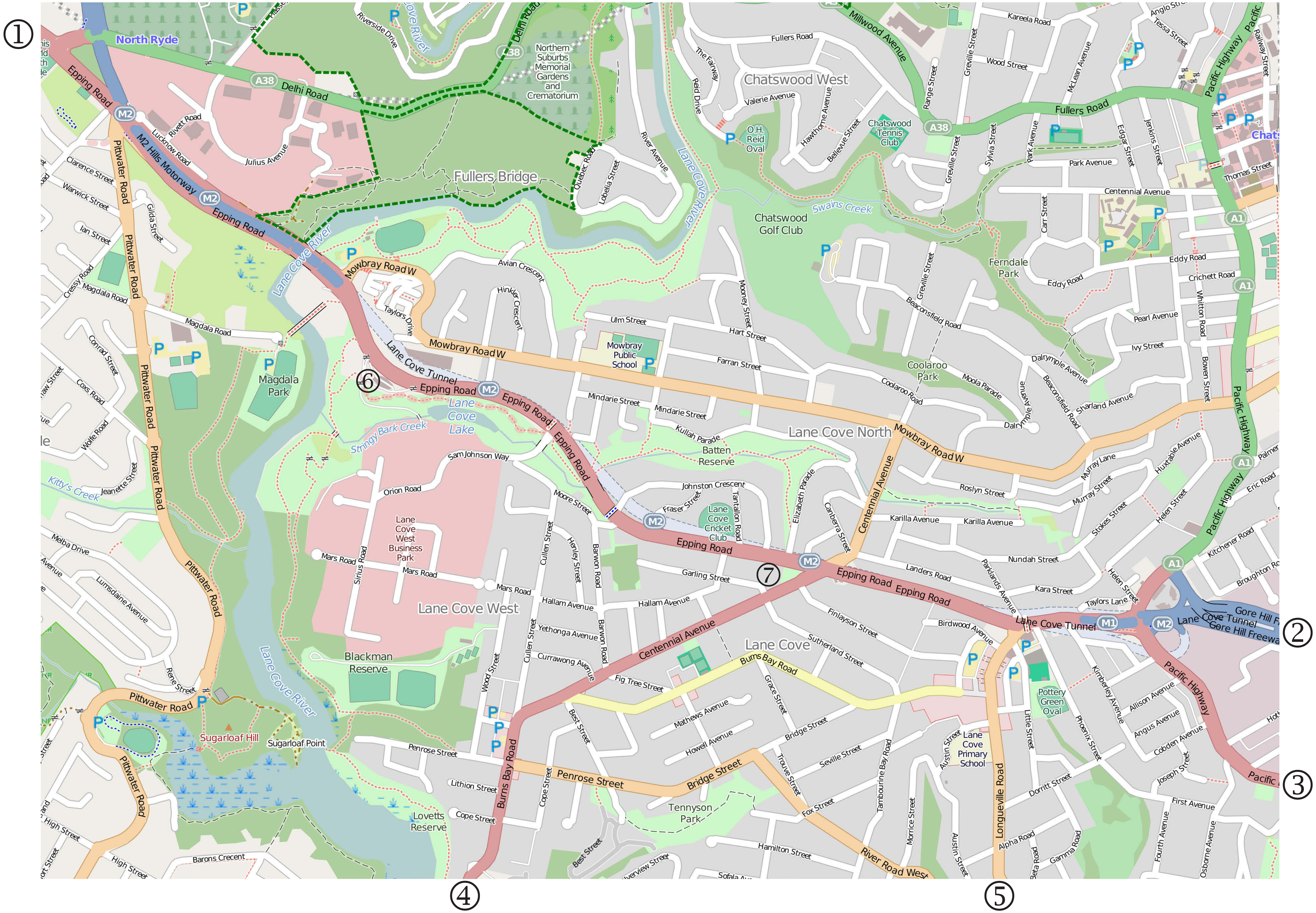
Changes to travel behaviour because of a reduction in road capacity (RRC):

for each (type of) trip affected

1) Did you make any changes because of the reallocation of general traffic lanes to bus lanes or foot/cyclepath on Epping Road?
2) Why?
3) What changes?
4) Could you have made the trip any other way – how flexible could you have been?
5) Why did you choose one way rather than the other?
6) How did you find out about this option?
7) How did you design your route?
8) Were there any other influences that affected your decision?
9) Did you consider any alternatives before you chose to <*do what ever you did*>?
10) Did any change vary from day to day or week to week?
11) Have you settled on a new routine for travel? How long did it take to settle? Why so <*quickly/slowly*>?
12) How sure are you of your answers?

Further thoughts:

1) How would you recommend other people circumvent the blockage?
2) Would you do that yourself?
3) Is there anything else the RTA or council could have done to help you during the period of change?
4) Do you use technology to help you get around the blockage – e.g. navigation systems?
5) Would you behave differently if the blockage was short term (e.g. roadworks) to a permanent change?
6) If relevant – where did you see a mention of this study?
7) Can you suggest anyone else who might be prepared to talk to me about their trip?



1. To the Hills District, Epping, Beecroft, North Ryde, Macquarie Park, Macquarie University, Macquarie Centre, Wicks Rd
2. To Manly, Gore Hill, Naremburn, Artarmon, Warringah Freeway, North Sydney
3. To Sydney City, Neutral Bay, Milsons Point, Double Bay, the Cross City Tunnel, Sydney Airport
4. To Gladesville, Eastwood, Silverwater, Hunter's Hill
5. To Northwood
6. Site of the former Shell service station
7. Turrumbarra Park

Figure 4.1 Epping Road corridor, Lane Cove and adjacent roads