Trips and parking related to land use
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Abbreviations

CBD	central business district
EFTS	equivalent full-time student
ex-2001	Indicates earlier data and figures from *Transfund NZ research report 209* published in 2001 which have been retained unchanged in this revised version.
FTE	full-time employed
GFA	gross floor area
GLFA	gross leasable floor area
GP	general practitioner
hh	households
IPENZ	Institute of Professional Engineers, New Zealand
ITA	integrated transport assessment
ITE	Institute of Transportation Engineers (US)
MoT	Ministry of Transport
MUAs	metropolitan urban areas
NZHTS	New Zealand Household Travel Survey
NZTA	New Zealand Transport Agency
NZTPDB	New Zealand Trips and Parking Database Bureau (now the TDB)
OGV	ordinary goods vehicle
PFS	petrol filling station
RAs	rural areas
Report 209	*Transfund NZ research report 209* (2001)
RFA	retail floor area
RTA	Roads and Traffic Authority of New South Wales
SA	site area
SH	state highway
SUAs	secondary urban areas
TDB	Trips Database Bureau
TOD	transit oriented developments
TRICS	Trip Rate Information Computer System (UK)
UK	United Kingdom
veh	vehicle
vpd	vehicle per day
vph	vehicles per hour

Contents

Executive summary

This research project revised, updated and added new material to *Transfund NZ research report 209* 'Trips and parking related to land use' (Douglass and McKenzie 2001).

This report extends the earlier research report and includes a new chapter on travel modes and trip purposes (chapter 3). It extends the chapters on New Zealand trips and parking trends (chapter 7) and survey practices (chapter 9). Recent research on UK and New Zealand travel has broadened the overseas comparisons (chapter 8) and this chapter is further enhanced by tables of trips and parking for New Zealand, Australia, the United Kingdom and the United States. The respective trip and parking databases for each of these countries are also compared (chapter 10).

The purpose of the report remains to contribute to a comprehensive national overview of travel related to land uses at an individual site level. The research covered surveyed trips to and from individual sites by all modes of travel including car drivers, car passengers, walkers, cyclists and bus passengers, and considered observations from car park demand surveys. The research has supported the principle of retaining surveyed information in the Trips Database Bureau (TDB) database on a site-by-site basis so practitioners can compare and contrast a subject site with similar land-use and location characteristics.

The chapters discussing trip generation and parking demand trends show that for most land uses, there have been few significant changes to the rates at individual sites in the period 2000–2010 compared with the 1990s. The exceptions include education and recreation, where there has been strong growth in car trips and parking demand.

The TDB database includes Australian and New Zealand data in a Microsoft Excel spreadsheet and comprises some 1000 sites. To maintain and expand the database requires more survey data of better quality and content. This has become more difficult since local government reduced the resources for these types of surveys. Unless the databases are expanded, there will be limited incentive to make the transition to a web-based version. This step is considered essential to expand the joint Australian and New Zealand facility to something akin to TRICS in the UK.

Overall this report provides a very useful and comprehensive reference for professional engineers, planners and students working in the transportation planning and design field. The widened scope covering mode split and trip purposes, together with additional information on trip generation and parking demand makes the report a very useful resource that complements the work being undertaken to develop integrated transport assessments, multimodal travel surveys and travel plans.

Abstract

The objective of the research detailed in *Transfund NZ research report 209* was to produce a comprehensive national database of information on trips and parking related to land use in New Zealand and to identify historic trends since the 1970s. This research has revised the original report, updating it to 2010 and comparing New Zealand results with those reported in the UK, USA and Australia. It also reviews trip generation surveys and databases from these four countries.

The research indicated a general equivalence and consistency in the travel patterns seen in New Zealand to those reported in UK, USA and Australia.

Drawing on parallel research based on the MoT New Zealand Household Travel Survey, there is a chapter devoted to daily trips by all modes and purposes.

The research considered surveyed seasonal traffic and parking variations and identified the practical parking design demand for a whole year as the 85 percentile satisfaction which is also the 50th highest hour. This is the upper design limit suggested for the site being considered. At selected locations there may be a variety of specific reasons to reduce this design figure. The report also recommends undertaking further multi-modal trip generation and parking demand surveys for more land uses.

1 Introduction

1.1 Research brief

The research brief for this project was to review, revise and update the content of *Transfund NZ research report 209* 'Trips and parking related to land use' (Douglass and McKenzie 2001), referred to in this report as Report 209. The research included reviewing the comprehensive database of trips and parking related to land use, editing relevant information that had appeared since 1990 and identifying any trends between 1970 and 2010. Also, New Zealand results were to be compared with those reported in UK, American and Australian databases.

Most of the earlier surveys, including those referred to in Report 209, focused on car trips and car parking demand without regard to modal split or arrival by alternative modes of transport. This report has, where possible, attempted to update and provide a better perspective on all modes of travel. Goods vehicle movement has not been comprehensively covered in this study.

The revision was completed in four stages:

1. To consider all tables and diagrams in Report 209 and amend and extend accordingly. The tables included in this report are a mixture of those from Report 209 (referenced as 'ex-2001') and more recent data and information from 2009.
2. To increase the land uses covered to include more recreation, event type venues and multiple-use sites from recent surveys.
3. To include more detail on modal split and variations between inner, suburban, small town and rural situations. This will support national and regional strategies which seek greater integration and more sustainable transport.
4. To draw on and analyse comparative data from published information in the UK, Australia and the USA in addition to the overviews originally included in Report 209.

The research for this report drew on information and surveys from many sources, covering a wide range of city and district councils, including the Australian Roads & Traffic Authority guides (1993; 2002) and the results from the Auckland Territorial Local Authorities (1994) *Parking and traffic generation study 1992–94.* In addition, consultants and traffic engineers throughout the country contributed to the revised study.

1.2 Past research and New Zealand references

While there has been a range of reports on the topic at various times, trip generation and parking demand were first reported comprehensively in *Road Research Unit (RRU) bulletin 15* (Douglass 1973) and in Report 209.

RRU bulletin 15 (Douglass 1973) included parking surveys undertaken at 78 shopping centres, 130 industries and 40 hotels, as well as schools and churches. It also included information from the Christchurch 1969 home interview surveys, which covered more than 1300 residences. The surveys of trip generation and travel to work covered 27 city centre shops, office blocks and industries, and 27 suburban shopping centres and industries – about 300 individual establishments in all. *RRU bulletin 52* (Burgess 1981) dealt with the trip generation of vehicle-intensive commercial land uses. This covered liquor stores and fast-food outlets. It was followed by the report *Parking, traffic generation and planning* (Chivers and Lovatt 1982), which summarised the trip generation and parking workshops sponsored by the RRU in 1981 and the district plan provisions of the 1980s.

Throughout the 1980s there was only a small number of published references, mostly relating to major shopping centres. During this period, however, several consultants, including the Traffic Design Group, Transplan Consulting, Gabites Porter and Auckland University published reports on a small number of surveys.

With the advent of the Resource Management Act in 1991 and the need for councils to review their district plans, many councils returned to surveys of specific issues which required determination in the proposed new plans. Between 1992 and 1994 the Auckland TLAs (1994) undertook a traffic and parking generation study for a total of 113 sites. *Transit NZ research report 57* (Gabites Porter Consultants 1996) noted various attempts had been made to pull survey results together, to carry out surveys using standard formats and to make collected information available. However, little real progress in developing an exchange of surveys and a larger database had yet to be achieved.

Report 209 was a major step forward in the collection of New Zealand trip and parking data and the analysis the data revealed. It was also a major step forward with the industry collectively forming a special interest group, the New Zealand Trips and Parking Database Bureau (NZTPDB), which focused on improving data collection and data sharing. A standard survey summary sheet was devised in 2001 and this was provided as a background to Report 209 and used in subsequent surveys. The current survey summary sheet is included in appendix E.

1.3 Comparison of trip generation databases

A review of four trip rate databases from New Zealand, Australia, UK and the USA was undertaken as part of this research. The national database reviewed was from the NZTPDB, now the Trips Database Bureau (TDB)[1]. The international databases reviewed were TRICS (2009) from the UK, Roads & Traffic Authority (RTA) (2002) from Australia and Institute of Transportation Engineers (ITE) Trip Generation from the USA (2008).

The comparison focused on the following features of the databases:

- database style
- database parameters
- multi-modal survey data
- seasonal/daily/hourly variations
- trip types.

A summary of the findings is included in table 1.1. For a detailed discussion of the four databases, see chapter 10.

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[1] The New Zealand Trips & Parking Database (NZTPDB) was renamed the Trips Database Bureau (TDB) in 2008 with its membership widened to include Australian engineers and planners.

Table 1.1 Database features summary

Database feature		TDB (New Zealand)	TRICS (UK)	ITE (USA)	RTA (Australia)
Database style	Spreadsheet format	Yes	No	No	No
	Own software	No	Yes	Yes	No
	Online version	No	Yes	No	No
	Hardcopy	No	No	Yes	Yes
	Site by site level	Yes	Yes	No	No
Database parameters	Frequently used parameters	GFA, site area, employees, residential units, people or occupants, car parks	GFA, parking spaces, site area	GFA, GLFA, no. of seats, employees, dwelling units	GFA, dwelling units, GLFA
Multi-modal survey data	Availability	Yes	Yes	Light and heavy vehicle trip rates only	Yes – now contained in the TDB database
	No. of multi-modal survey data	90 (692 surveys)	600 (3199 surveys)	Nil (4800 surveys)	109 (192 surveys)
	Formal multi-modal survey methodology	No	Yes	No	No
	No. of surveyed modes	7	8	2	7
	No. of surveyed land use activities multi-modal	12	84	Nil	5
Seasonal/daily/hourly information	Hour of day	Yes	Yes	Yes	No
	Day of week	Yes	Yes	Yes	Yes
	Seasonal	Yes	Yes	Yes	Yes
	Relevant activities	Retail	Retail, employment, health, residential, golf	Shopping centres	Shopping centres
Trip types	Primary trips	No	Yes	Yes	Yes
	By-pass trips	No	Yes	Yes	Yes
	Diverted trips	No	Yes	Yes	Yes
	No. of surveyed activities	Nil	Yes	22	4

Note: GFA = gross floor area; GLFA = gross leasable floor area.

1.4 How to use this research

This report includes a review and comments on existing guidelines for use by practitioners when assessing parking demand and trip generation rates for a wide range of land uses and situations. It indicates the probable range of demand rather than recommending the application of a fixed standard or rule.

The results presented here should be seen as a resource to assist professional judgement when advising public authorities and private clients. The report therefore emphasises methodology, and variations between and within land-use activity levels. The report also emphasises the importance of using survey data as a guide when practitioners are undertaking more detailed, site-specific studies to forecast travel changes.

An objective of the research was to discover whether design hour values, seasonal, weekly and daily traffic flows, and parking demands for retail trips were similar in different countries and whether they had altered greatly since the 1990s. While the adoption of seasonal and daily factors enables greater opportunities for surveys throughout the year, it is also important that surveys contain a minimum of information. This includes the dates, times, location and land use as well as the desirably of the site; including the observation of the total number of trips made by people arriving by all modes. A clearer definition of an increased number of parameters, ie additional to gross floor area (GFA) and employment information is proposed. Survey analysis needs to include an assessment of the appropriate daily and seasonal factors to normalise the information to the appropriate design hour.

At some particular locations there may be good reasons to vary the recommended design hour satisfaction figure to reflect parking policies and the balance of parking provided for specific activities and by private and public operators. There may also be constraint policies that are used to control the supply and demand related to total travel. Their advantages and disadvantages are not discussed in this report, the focus of which is based on surveys of existing sites (some with and some without such constraints).

The amount of basic survey work undertaken by city and district councils reduced significantly in the 1990s and 2000s. TLAs tended to rely more on consultants, who complete their immediate task for a particular site but are less compelled to submit their surveys to a cooperative pool of data. Issues of client confidentiality and ownership affect the availability of consultant data for inclusion in a national database. This matter needs to be addressed by the collective profession including TLAs and consultants for the betterment of the industry as a whole.

Gaining surveyed information of uniform quality that embraces the full range of factors is also a difficulty. The includes an increasing need for modal split as well as traditional parking and trip generation information. The scarcity of local government in-house information has meant many district plans have been revised with a ‘roll-over’ of previous parking standards or with those inherited from other district plans. Land uses have also changed in various ways during the last 40 years. The most significant are the spreading of shopping hours and the major increase in both the style and scale of shopping establishments. This has resulted in a spreading of peak parking demand rates and lower peaks for the majority of establishments. Additionally car travel for school pupils has increased significantly with a culture of parents driving children to and from school.

In the CBDs the significance of travel demand management throws up the need for different policies matched to all-day and long-term parking on the one hand and making parking attractive in location and price for short-term casual and shopper parking on the other.

Combined, these changes require more effective ongoing analysis to base good decision making and hence better ongoing data collection and sharing of information. It is therefore the opinion of the authors that the TDB continues to have an important role to play in housing credible data.

1.5 Changing attitudes and practices

Attitudes and community dynamics are changing, and this is reflected in the trips and parking information collected. These changes are also fundamental to current transport reviews, such as those involved in regional land transport studies, and include the following:

- Wider changes in society are being reflected in changing shopping patterns, different business hours, new trends in employment structures, changing social and recreational patterns and the impact of the emerging information society.
- New types of businesses and enterprises are emerging, giving rise to new land uses and quite radical changes in how traditional land uses, such as industries and sales operations, function.
- There is a move from traditional rigid land-use zoning, which encouraged segregation of land uses, to planning for integrated multiple land-use complexes, commercial parks and modest employment uses in residential areas or as mixed developments.
- An appreciation that where car parking is unconstrained, encouraging more sustainable modes of transport is difficult and unconstrained parking can undermine existing transport investment in alternative modes.
- Greater concern is being shown for road safety and accident prevention.
- Shifts in government policy reflect the user-pays principle and the need for interconnection between policies appropriate to a market-led economy.
- Changing travel habits via travel demand management techniques is a different approach to solving travel problems.
- In relation to trips and parking, there is now a need to consider accessibility by all modes of transport and to ensure surveys consider transport as a whole, including all modes and purposes and not just vehicle/driver trips.
- When considering trips and parking generation surveys and forecasts related to individual land uses, the effects external to the site must be assessed as well as those relating to the internal design.
- The groundswell of professional opinion and community prominence given to the principles of ‘sustainable transport’ means that in all their work, transport engineers and planners should be aware of the contribution of:
  - public transport
  - goods vehicles
  - pedestrian and cycle movements
  - car driver and car passenger travel
  - travel demand management

  - interchange stations and mode change facilities
  - those who travel, and in particular those who want to travel but cannot because of a lack of accessibility to various modal options.

The report refers to the 'mobility' and 'diversity' of communities as they become more dispersed and populated by a greater number of people who travel further for both business and pleasure. This leads to greater travel distances in support of developing multi-centred communities with an increasing number of non-home-based trips in major and secondary urban centres.

1.6 Practitioner needs

On 10 September 2009 a trip generation seminar facilitated by the TDB was held in Auckland, New Zealand. The seminar was designed for those involved in data collection, reporting and policy formulation associated with transport. It was particularly relevant to those involved in the interaction of land use and transportation, integrated transport assessments (ITAs) and long-term integrated transportation planning.

The seminar aimed to expand the technical understanding for engineers and planners by describing the trip generation research, databases, transportation assessments and integrated policy work being undertaken in New Zealand and overseas. The participants were given questionnaires related to trip generation and their database needs. A summary of the questions and responses is shown in table 1.2.

Table 1.2 Practitioners' questions and responses

Policy issues	Responses
Issues of the future of TDB, ownership of data, combined New Zealand and Australian accessibility	The future is dependent on joint efforts with Australia and more resources for surveys so enabling access to better quality information. Most clients are happy to pass on the information. A simple pre-signed disclaimer is being prepared.
ITAs and travel plans • Will ITAs be compulsory? • National ITA standards • Can we capture reports? • Collaborative travel plans	ITAs are good practice and best kept as a case of practitioner self regulation. Capturing reports must be done by individual champions in each organisation. Travel plans should be tackled cooperatively on a locality basis.
Database form • Will TDB become web based? • Why use paper survey input? • Parameters for prediction • Modal surveys and modal split	The move to a web-based database is a year or two away. In the meantime parameters will be improved and more modal surveys and modal split analysis will be undertaken in the present database.
Surveys and data • Trip types and trip purposes • Trips on- and off-site • TRICS application to New Zealand of multi-modal travel surveys	Improved and comprehensive surveys are essential including trips on- and off-site and also more on-site interviews. Essence of TRICS is to expand on information for individual sites and multi-modal comparisons.

Note: A more detailed analysis of table 1.2 is attached as appendix D.

1.7 Summary of report content

Chapter 2 deals with seasonality and design hours and describes fluctuations throughout the year. The scale factors for adjusting surveys to the same survey base vary significantly from large metropolitan areas to smaller settlements where the seasonality is greatly affected by a major influx of tourists. The report suggests using the 90% surveyed satisfaction for trip planning (ie 30th highest hour) and 85% surveyed satisfaction for parking demand (ie the 50th highest hour for unconstrained parking) for land uses attracting visitors, eg retail, town centres and recreation activities.

Chapter 3 describes the travel modes and purposes of personal travel based on the Ministry of Transport (MoT) New Zealand Household Travel Survey (NZHTS) 2003–2006. Trips are described in terms of 'trip legs' and 'modes' and are grouped by the characteristics of travel in rural, urban and metropolitan situations. The modes are distributed over all trips as vehicle drivers 54.1%, passengers 25.5%, walk 15.5%, bus 2.4%, bicycle 1.4%, train 0.3%, taxi 0.4% and other 0.5%. This chapter also touches on changes in the use of these modes.

Chapter 4 deals with residential trips and parking and explains how total trips have increased with more residences and higher vehicle ownership. However, trip making has declined slightly from 10.4 vehicle trips per dwelling household per day in the 1990s to 9.5 vehicle trips per household per day in the 2000s. Car ownership has continued to increase significantly. In the 1970s, 26% of households had 2+ cars, whereas this figure increased to 44% in the 2000s. The number of cars per household has increased 29% from 1.4 to 1.8. However, the average number of trips for each car at a household has decreased as car ownership increased.

Chapter 5 covers retail trip and parking surveys. The development of new shopping centres, large format establishments and retail outlets between 1990 and 2010 has meant trip making and parking demands of individual retail establishments have increased at only a moderate rate. The increase in the number of establishments and floor area has risen faster than total retail trip making. There is also increased sharing of parking areas and it has become necessary to consider a group of outlets together. Most modern suburban areas have also been developed on the basis of shared parking. The 85% surveyed satisfaction for trip making has increased from 135 trips per day per 100m^2 gross floor area (GFA) to around 150 trips per day per 100m^2 GFA, an 11% increase. On the other hand, parking to meet the demand at the 50th highest hour, 85% satisfaction, has reduced on average from seven to six carparks per 100m^2 GFA.

Section 5.9 has a brief analysis of central city parking. Eleven cities were studied in 2001, ranging in size from Christchurch to Taupo, and the central city parking demand for retail, commercial, industrial and other activities was found to be relatively constant. In the central business districts (CBDs) recorded in Report 209 the average visitor parking demand was two car parks per 100m^2 of retail commercial GFA, plus one car park for long-term employee parking, yielding an average total of three cars per 100m^2 GFA. The equivalent 30th highest day parking demand is about four cars per 100m^2 GFA. There is, however, some variation from city to city in the off-street parking available for short-term, long-term and commuter parking.

Chapter 6 outlines where selected groups of land uses have changed dramatically since the 1990s. For educational uses, the increased access is reflected in the number of parents delivering and collecting primary school students by car and students driving to secondary schools. Also, the number of students driving to tertiary institutions has increased very significantly. Medical centres, hospitals, rest homes and childcare centres have also witnessed a modest but steady growth in trip generation. Recreational uses and stadiums are being more intensively used. A smaller number of larger service stations have become the highest trip-generating land uses, when measured by their forecourt movements against site size and GFA. These are followed closely by drive-through and fast-food outlets.

Chapter 7 describes the trends in trip generation and parking demand since the 1970s, according to the land uses defined in appendix A. In spite of the 180% increase in the total number of trips being made in New Zealand communities since 1970, the increases in trip generation rates and parking demand at individual sites have been considerably lower at 20% to 50%. These increases have matched demand, and in turn, have led to a wider distribution of traffic throughout the cities and rural areas, adding to ribbon development and the generally dispersed nature of modern New Zealand city living. This has resulted in greater variation in trip rates generated by different sites due to the different traffic environments.

Chapter 8 identifies and discusses many parallels between the New Zealand experience and that of transportation planners in Australia, the UK and the USA.

Chapter 9 discusses survey and projection practice and the level of information required to complete the TDB survey form. A copy of the form is found in appendix E.

A new section 9.2 deals with the need for more multi-modal information at individual sites and localities. This will increase the knowledge on modal choice and possible mode transfer.

Chapter 10 discusses the New Zealand, Australian, UK and US databases and the case for the continuance of the TDB database. This includes the transfer of information to professional practitioners throughout Australasia.

Following the list of significant references there are five appendices providing more detail and comparative background.

2 Seasonal factors and design hours

2.1 Factors affecting trips and parking

The description of the land uses being considered and defined in the database falls within the nine groups of land uses defined in the TDB (2009) *Database user guide*. This is included as appendix A.

In order to determine an appropriate standard, ie design hour or percentage satisfaction, the following sections of chapter 2, plus appendix B 'Seasonal factors and design hours' discuss the broad patterns of variation in trip generation and parking related to localities and activities.

The design of traffic facilities serving a land-use activity involves a wide variety of factors. Those referred to in *NZTA research report 422* (Abley et al 2010) include:

- land-use activity groups and the scale of the activity
- location of site within the road network and the surrounding urban or rural environment
- frontage roads and connections to the road network
- available public transport services
- proximity and relationship to other traffic and parking generating activities
- local authority traffic and parking controls and regulations
- seasonal, daily and hourly variations in travel, trips and parking.

This section of the report deals with the last item of seasonal, daily and hourly trip generation and parking, and requires a decision as to which hour of the day, week or year is seen as the appropriate design hour.

Parking demand and traffic generation are closely linked, with parking demand a function of both the arrival rate of vehicles and the duration of their stay. Other factors also play a part, such as the size of parking reservoir available and the necessary manoeuvre and on-site circulation, as well as any queuing time and associated congestion. Clearly limiting the opportunity to park (constrained parking) will lessen the attractiveness of the site compared with other sites that do not restrict parking. Assuming the site remains competitive, the attractiveness of other travel modes to access the site are likely to increase.

The seasonal, daily and hourly trends presented here are based on actual surveys for a variety of sites some of which may have been constrained in terms of congestion and/or parking restrictions. The trends also provide guidance on the variations in traffic throughout the year on the road network at many other land-use sites.

2.2 Selection of parameters

One of the most important aspects of predicting trip generation and parking demand is the choice of independent or predictive variables, which are called 'parameters'. The available survey information limits the type of parameters that can be used.

The five most common parameters used for this purpose are:

1. Gross floor area (GFA) – the generally accepted definition of GFA is the area within the external walls of a building, excluding any area dedicated for parking of vehicles but including all common areas shared by customers when considering joint retail areas.
2. Gross leasable floor area (GLFA) – for supermarkets and multiple occupations the leasable floor area is frequently used and this is commonly 80% of the GFA.
3. Site area (SA) – the total area of a site associated with the activity surveyed, including areas used for parking and landscaping.
4. Employees – the number of staff employed or engaged at the site. The new trends in employment structures, such as the increasing use of part-time or shift workers creates increased trips and parking demand at shift change-over times. For some employment sites, specialists (eg doctors at a medical centre) can be a useful variable.
5. Activity units – used where the particular activity is best expressed in terms of units related to the function or activity (eg restaurant seats, service station filling positions, number of pupils).

A wide variety of site variables can therefore be used in the prediction of trip generation and parking demand. The onus rests with the practitioner to select the most appropriate variable for a particular land-use, planning and assessment exercise. Unlike the more significant and larger survey samples in the ITE (2003) *Trip generation* manual or the TRICS (2009) database descriptions, the small survey base in Australasia does not yet enable detailed comparisons between the predictive ability of different parameters.

The detailed analysis in *RRU bulletin* 52 (Burgess 1982) for fast-food outlets and liquor stores, considered the establishment's 'employment' and 'gross floor areas', and included 'annual customers', 'population, within 4km (ie catchment)', 'employment, within 2km', 'adjacent retail activities, within 200m' and 'exposure to traffic, vehicles per day (vpd) on the road past the site'. The analysis showed that for annual customers the 'catchment population' and 'passing traffic' were the most significant parameters. For this reason, surveys must confirm and record the location in the urban/rural context and the frontage road type/traffic.

In this report all land uses and activities have had their trip rates and parking demand surveys calculated on the basis of GFA (normally expressed as the rate per $100m^2$). In addition, some sites have the rate expressed in other units, eg employment, number of seats, number of filling positions, number of beds, doctors or students, or per 10 number of audience, etc where that is also appropriate.

In this report, the term 'vph' is vehicles per hour, 'vpd' is vehicles per day and 'hh' is households.

2.3 Selection of seasonal design level

A range of seasonal traffic information was assessed in the course of the 2001 research, including information on vehicle travel, car parking and pedestrian flows for both town centre areas and separate retail centres. In order to investigate a recommended design level, the data was collated and ranked in terms of both weekly and (when available) daily activity levels. Owing to the limited information available covering the full course of a year, the following activity indicators were adopted: 'parking revenue', 'daily' and 'weekly pedestrian arrivals' at major shopping centres, 'daily urban traffic' and 'daily rural traffic' from state highway traffic counts. In some cases the surveyed numbers were indexed to 100 or 1000 to provide ready calculation and also to protect the original surveyed figures, in accordance with the wishes of the original owners of the data.

Figures 2.1a and 2.1b show the weekly pedestrian admission pattern during the course of a full year for a major shopping centre with over 20,000m² GFA located in an inner suburban area. The ranked data shows there is a sharp rise in the weekly activity about the fourth, fifth or sixth busiest week of the year. The pattern shows a significant difference in total pedestrian activity from this point in the graph and, by inference, total parking demand patterns through these busiest five weeks of the year. In keeping with established traffic practice, it is appropriate to select a design level around the 'knee' in this graph. It can be seen the fifth busiest week includes the 30th highest hour of the retail trading year. A detailed review of the data available from on-road counts, shopping centre pedestrian counts and council-operated parking facilities shows the vast majority of these 30 highest hours of traffic and parking activity fall within the five busiest weeks.

Figure 2.1a Weekly pedestrian admissions at a major shopping centre [ex-2001]

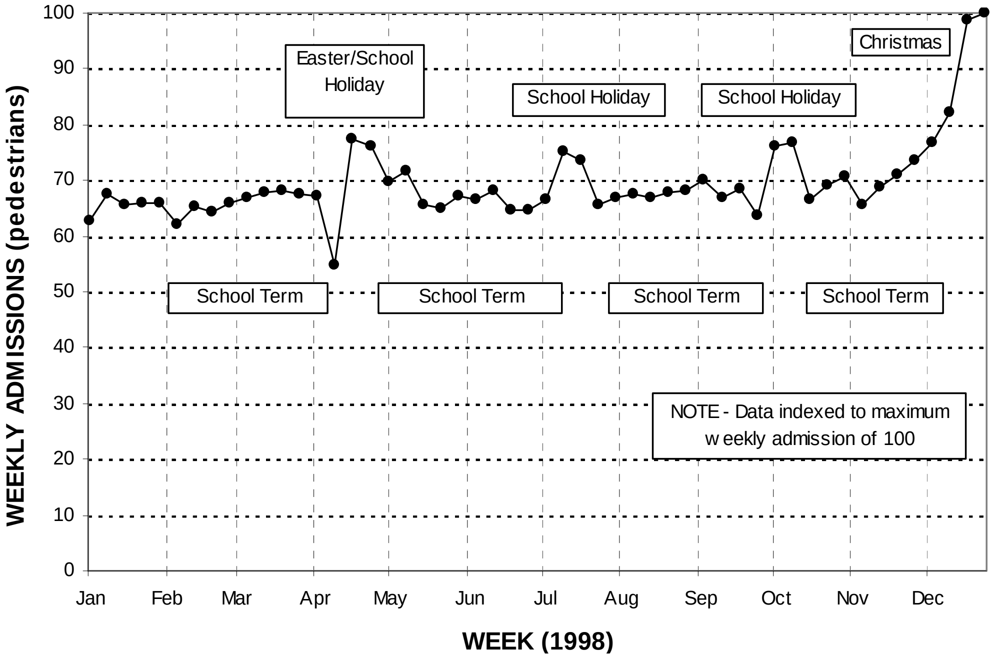
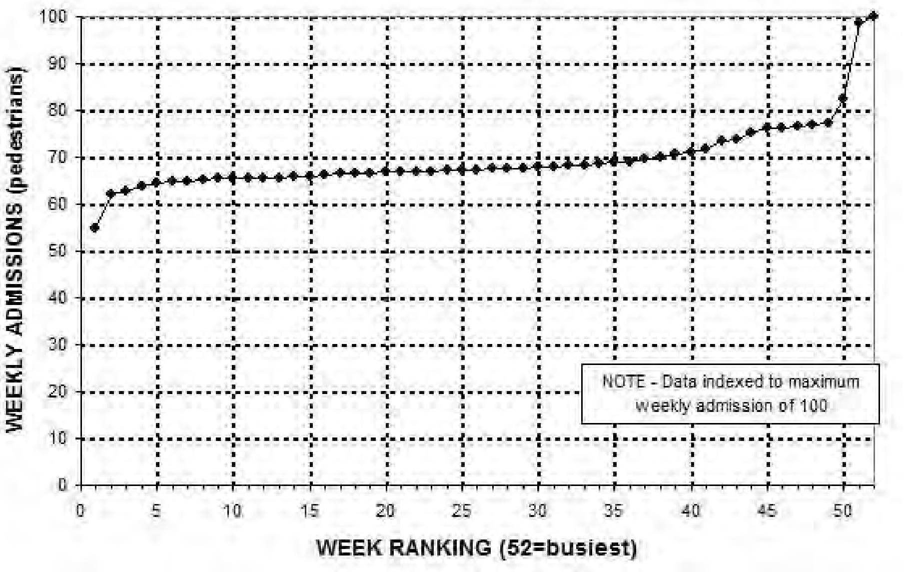


Figure 2.1b Ranked weekly pedestrian admissions [ex-2001]



Figures 2.2a and 2.2b are graphs of the weekly parking revenue data obtained from public parking areas of a major city centre. Parking revenue records were available over a full year. It is recognised parking revenue can only be considered a proxy for parking demand. For the purposes of this exercise such a measure is a useful daily and weekly indicator for a typical provincial town centre. As with the major retail centre pedestrian pattern presented earlier, there is an obvious 'knee' in both graphs which indicates a significant and important intensification of parking activity at this position. In comparison with the shopping centre data, the 'knee' starts in the ranking order at or about the 47th busiest week of the year. This is again about the fifth busiest week of the year.

For parking demand there is now a general acceptance that the 10th highest week may, for many land-use activities, be acceptable. This generally coincides with an 85% satisfaction level of the peak on-site parking demand expected in a year.

Figure 2.2a Weekly parking revenue for major city centre (W) [ex-2001]

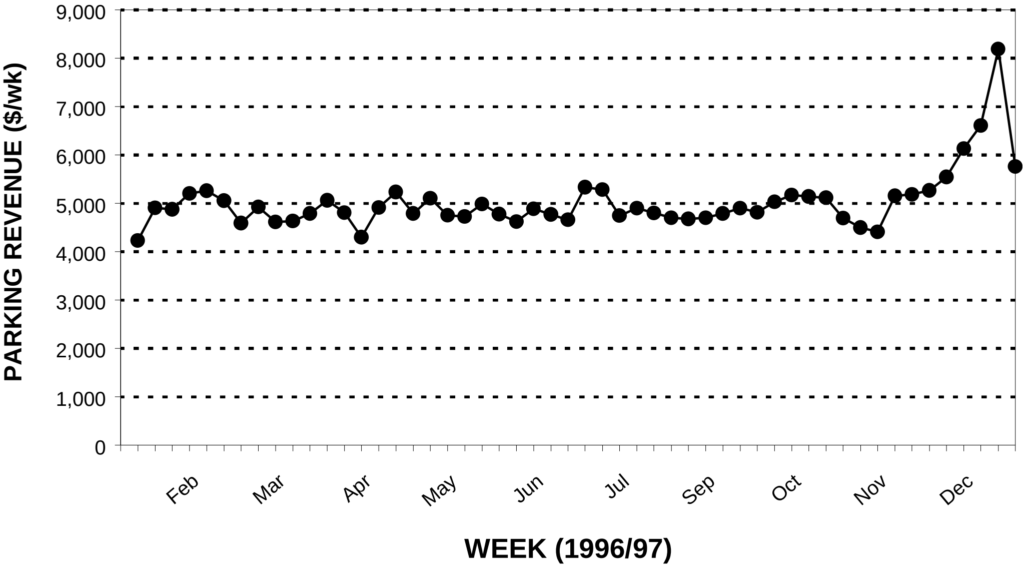
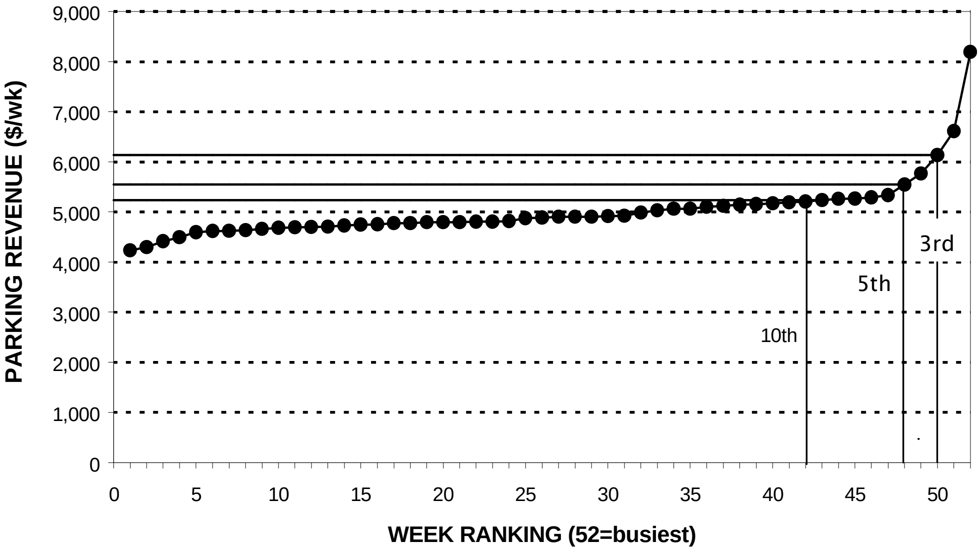


Figure 2.2b Ranked parking revenue [ex-2001]



2.4 Selecting the design hour

The data shows there are significant changes in the parking activity levels associated with all forms of a general retail centre. This starts to point to a recommended parking design level to cater for all but the very busy peak season activity periods. Further detail is set out in appendix B.

The key to the design hour is to select a value at the knee of the curve or just below that value. Generally, the knee rests at the 30th highest hour but for economic and planning reasons the 50th highest hour is generally recommended as being appropriate. The 30th highest hour in the year will be about the 90% trip demand satisfaction level and this occurs at the:

- 5th busiest week
- 15th busiest day
- 30th highest hour, and provides
- 90% satisfaction.

Alternatively, the 85% satisfaction is the most used standard for parking and coincides with the:

- 10th busiest week
- 30th busiest day
- 50th highest hour, and provides
- 85% satisfaction.

The investigations of activity levels at larger retail centres have revealed it is prudent, at locations with particular operational factors (such as limited on-street public parking or low turnover of off-street parking lots), for developers and traffic planners to plan for a slightly higher level of visitor parking.

The range of data available to practitioners on annual trading or activity patterns is often limited, and selecting the 30th or 50th highest hour or any other chosen design level requires some experienced judgement. Whereas for highway traffic flows the 30th highest hour is a common design figure, the more common site trip rate and parking demand satisfaction sought of 85% is widely accepted as being appropriate and this is generally about the 50th highest hour. This would mean the parking supply is sufficient to meet 85% of the peak time demand levels through the course of a year.

While arranging for parking data to be collected, for example, on a busy Thursday evening during the last week in November, would provide close to the recommended 50th highest hour level, such situations and survey timing may be neither available nor convenient. To assist with converting any selected survey period (hour, day or week), appendix B presents recommendations and guidance on the conversion from raw survey information to a design level for the activity. By applying seasonal, daily and hourly design factors to raw survey results, taken at times other than the peak demand, it becomes possible to make a calculated estimate of the likely 85% satisfaction level. This will enable an estimate of the design level for parking (eg 85% or 50th highest hour, 30th busiest day and 10th busiest week) and for traffic flows (eg 90% or 30th highest hour, 15th busiest day and 5th busiest week) to be obtained.

2.5 Hour-of-day factors (H)

The formula to calculate the selected design hour for trips and parking figures from survey data is:

$$\begin{array}{c}\text{Design}\\\text{hour}\end{array} = \begin{array}{c}\text{Survey}\\\text{figure}\end{array} \text{ x } \begin{array}{c}\text{Hour of day}\\\text{factor}\end{array} \text{ x } \begin{array}{c}\text{Day of week}\\\text{factor}\end{array} \text{ x } \begin{array}{c}\text{Week of year}\\\text{factor}\end{array}$$

To establish appropriate guidelines for the design of traffic and parking facilities associated with retail activities, the average weekday patterns of on-road traffic volumes generated by retail centre activity and foot counts at a shopping centre and hourly parking building occupancy counts for two major urban centres were undertaken. Data from several of the NZ Transport Agency’s (NZTA) continuous count stations in larger metropolitan areas throughout typical weekdays averaged over a full year was also analysed, allowing for comparison of on-road traffic, pedestrian activity and parking occupancy patterns.

Figure 2.3 illustrates the general pattern of hourly pedestrian activity recorded at the centres’ doors over a seven-day week. Surveyed hourly activity should then be scaled by an hour-of-day factor in order to obtain the design hourly value for the day of the survey. There are three characteristic groups of days (Mon – Tues – Wed), (Thur – Fri), and (Sat – Sun).

Figure 2.4 shows the recommended scale factor pattern for a typical weekday. The scale factors associated with pedestrian activity are closest to unity (ie when the pedestrian volume is closest to maximum) at the midday to early afternoon period. On-road traffic flows, meanwhile, demonstrate peaks or scale factors closest to unity during the morning and late afternoon commuter peak hours.

In figure 2.4 and table 2.1 the scale factors maintain the design point (ie 1.0) for the hour ending 12 noon with a factor varying between 1.1 and 1.8 for earlier and later hours in the day.

The recommended weekday design factors for retail parking surveys undertaken during ordinary business hours are provided in table 2.1.

Table 2.1 Parking hourly design factors (H) [ex-2001]

Hour of survey (hour ending)	Scale factor		
	Weekday (non-late night)	Weekday late lights	Weekend
9am	1.83		
10am	1.36		1.82
11am	1.16		1.28
12 noon	1.00		1.09
1pm	1.01		1.05
2pm	1.10		1.00
3pm	1.14		1.08
4pm	1.10		1.29
5pm	1.20	1.15	
6pm	1.50	1.36	
7pm		1.38	
8pm		1.56	

☐ denotes design hour

Figure 2.3 Pedestrian hourly patterns by day of week (retail) [ex-2001]

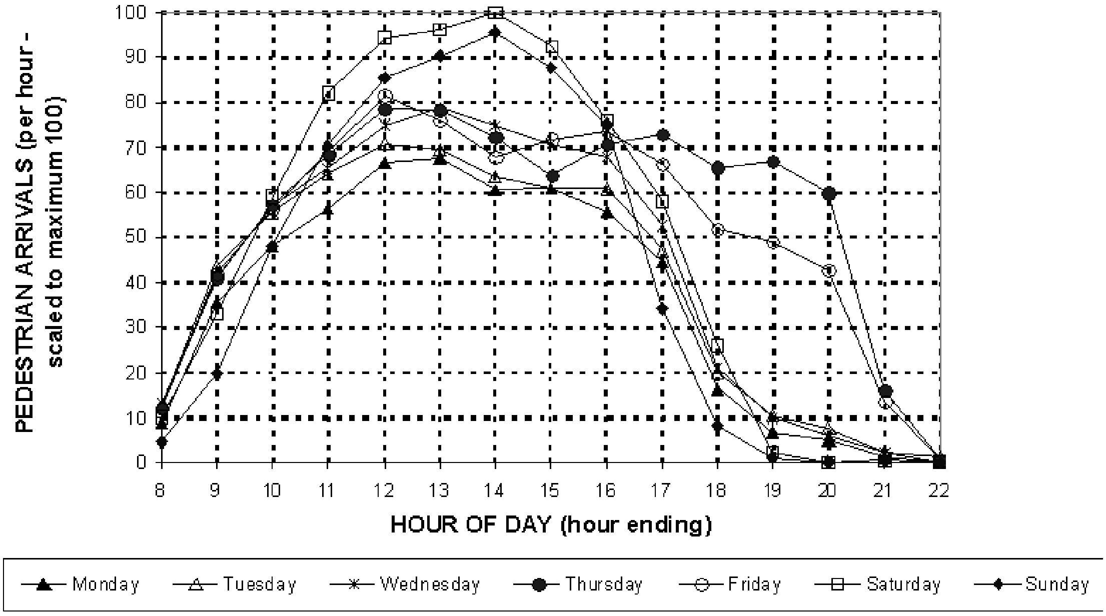
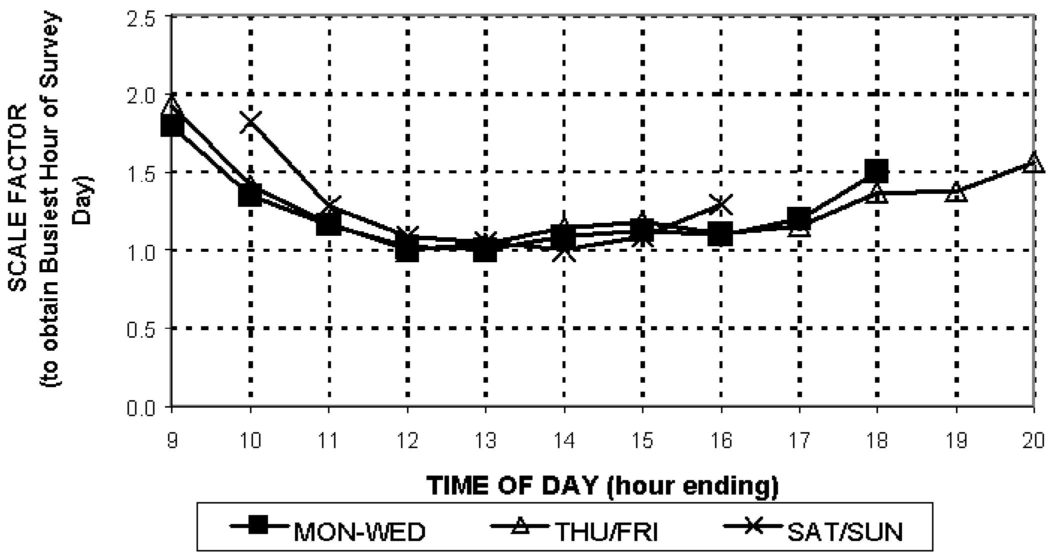


Figure 2.4 **Pedestrian design hour factors (retail) [ex-2001]**



2.6 Day-of-week factors (W)

Over the past 30 years, retail activity trip making patterns in particular, and other land uses in general, have changed significantly with a general spreading of visitor parking activity throughout the week. A move away from the traditional activity patterns of employment and shopping during weekdays and recreation and entertainment during the weekend has caused spreading into both Saturdays and Sundays, which have become the highest trip generating days. Increased car ownership, with consequent total mobility, has resulted in a lengthening of peak duration and greater numbers of peaks throughout the week. This in turn has spread the peak period rather than lifting the highest demand at a particular time.

Figure 2.5 illustrates the pattern of total daily pedestrian activity recorded at a major suburban shopping centre (>20,000m^2 GFA) over a seven-day trading week. The combined effects of both school holidays and the busy pre-Christmas period are also shown. Overall, school holidays are between 5% and 10% busier in terms of the total weekly pedestrian activity (and also the vehicle counts) compared with the equivalent non-holiday times.

Figure 2.5 **Daily pedestrian arrivals at a major shopping centre [ex-2001]**

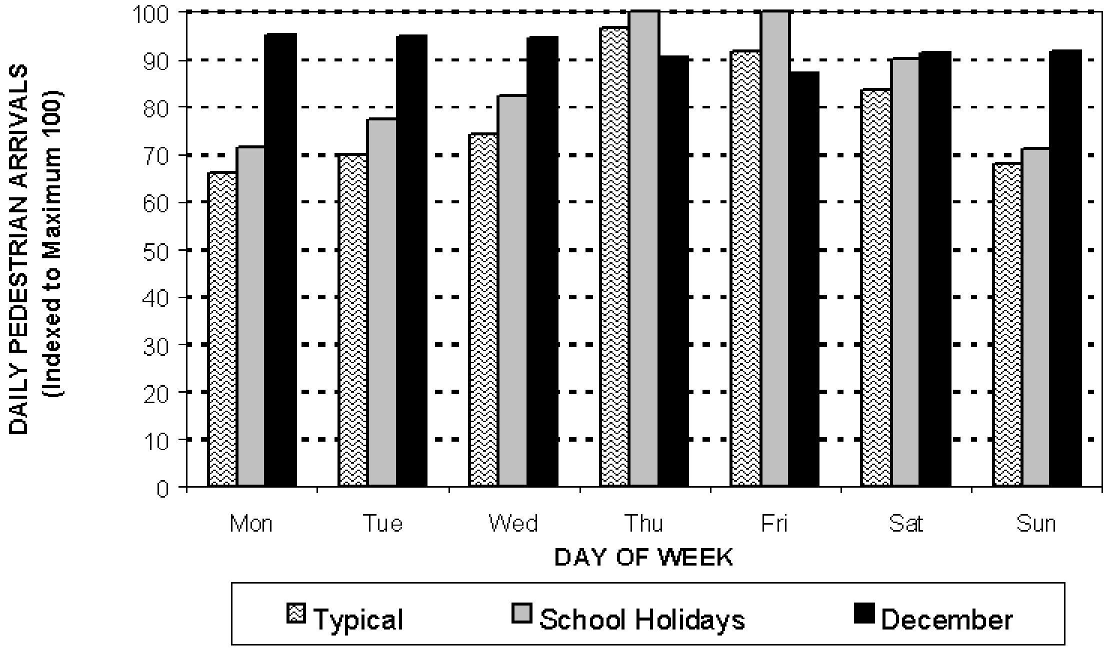


Table 2.2 **Total daily counts by day of week design factors (W) (shopping centres) [ex-2001]**

Day of survey	Scale factor	
	Typical	Holiday
Monday	1.46	1.40
Tuesday	1.38	1.29
Wednesday	1.30	1.21
Thursday	1.00	1.00
Friday	1.06	1.00
Saturday	1.16	1.11
Sunday	1.42	1.41

☐ denotes design day

The above factors are recommended for an initial guidance in the absence of more specific information. In all situations it is advisable to have surveys of comparable existing sites.

Local variations in trading patterns are to be expected. If data more appropriate to a particular location or activity is available, then this should be used at the discretion and judgement of the practitioner.

2.7 Seasonal or yearly factors (Y)

Typically the only comprehensive and continuous traffic counts throughout the year are state highway (SH) road traffic volumes. These have been collated to indicate the pattern and scale of general traffic activity levels within the major road network of major urban and other centres.

Continuous count stations at 16 locations were analysed for the calendar year 1998 to determine a set of scale factors for extrapolating individual survey results in terms of the seasonal or weekly design level. This surrogate measure provided by on-road traffic volume compared with on-site parking and traffic activity is considered to provide an appropriate basis for considering the seasonal travel variations over time. The most contrasting situation is illustrated by figure 2.6 showing the seasonality of small centres and locations subject to significant holiday variations. The equivalent graphs for provincial and metropolitan cities are illustrated in figures 2.7 and 2.8.

The practitioner should select the group, ie 1, 2 or 3, which matches the situation being investigated and also choose the appropriate week for design, ie 3rd, 5th or 10th.

Figure 2.6 Weekly factors (group 3) [ex-2001]

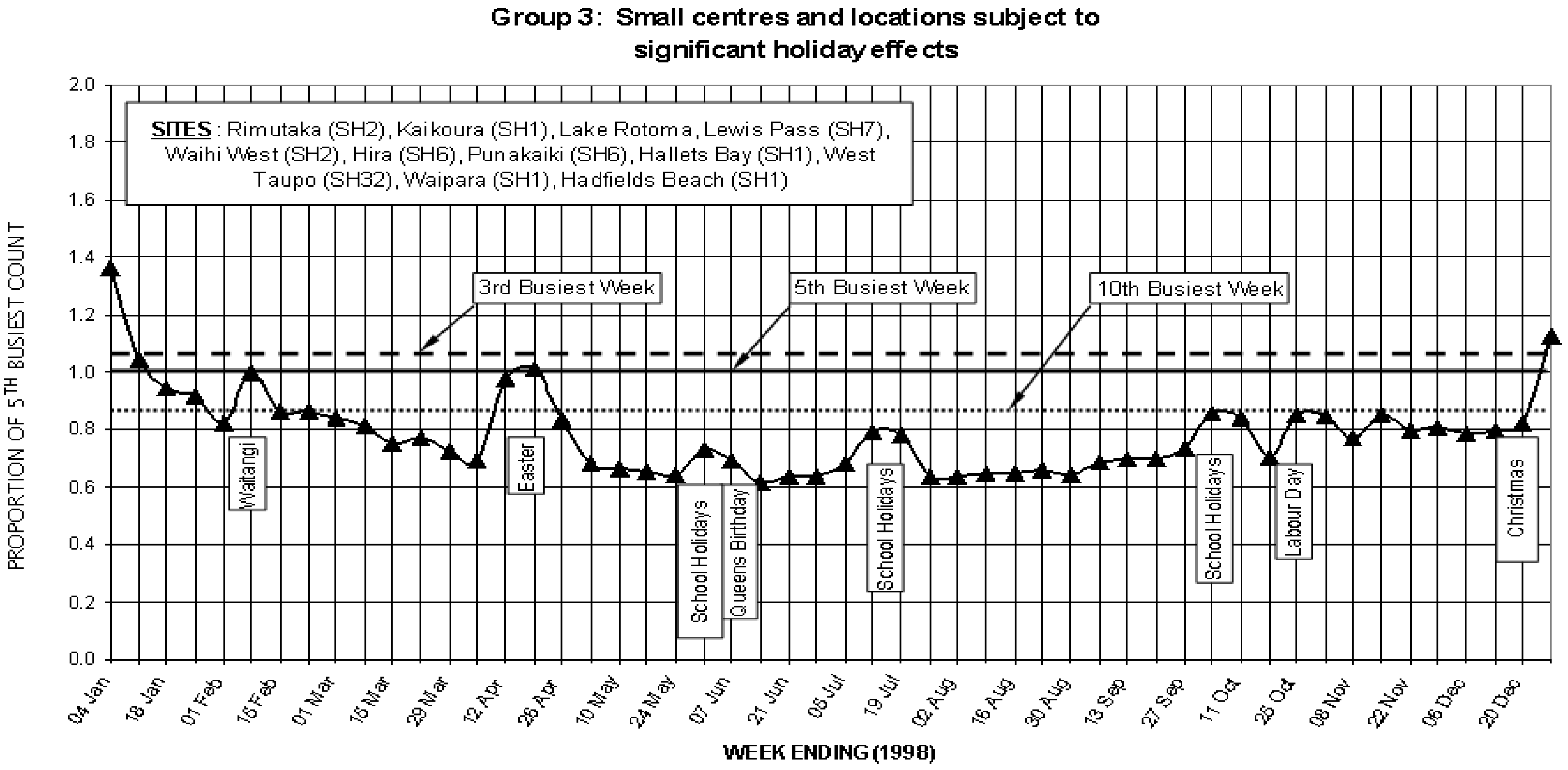


Figure 2.7 Weekly factors (group 2) [ex-2001]

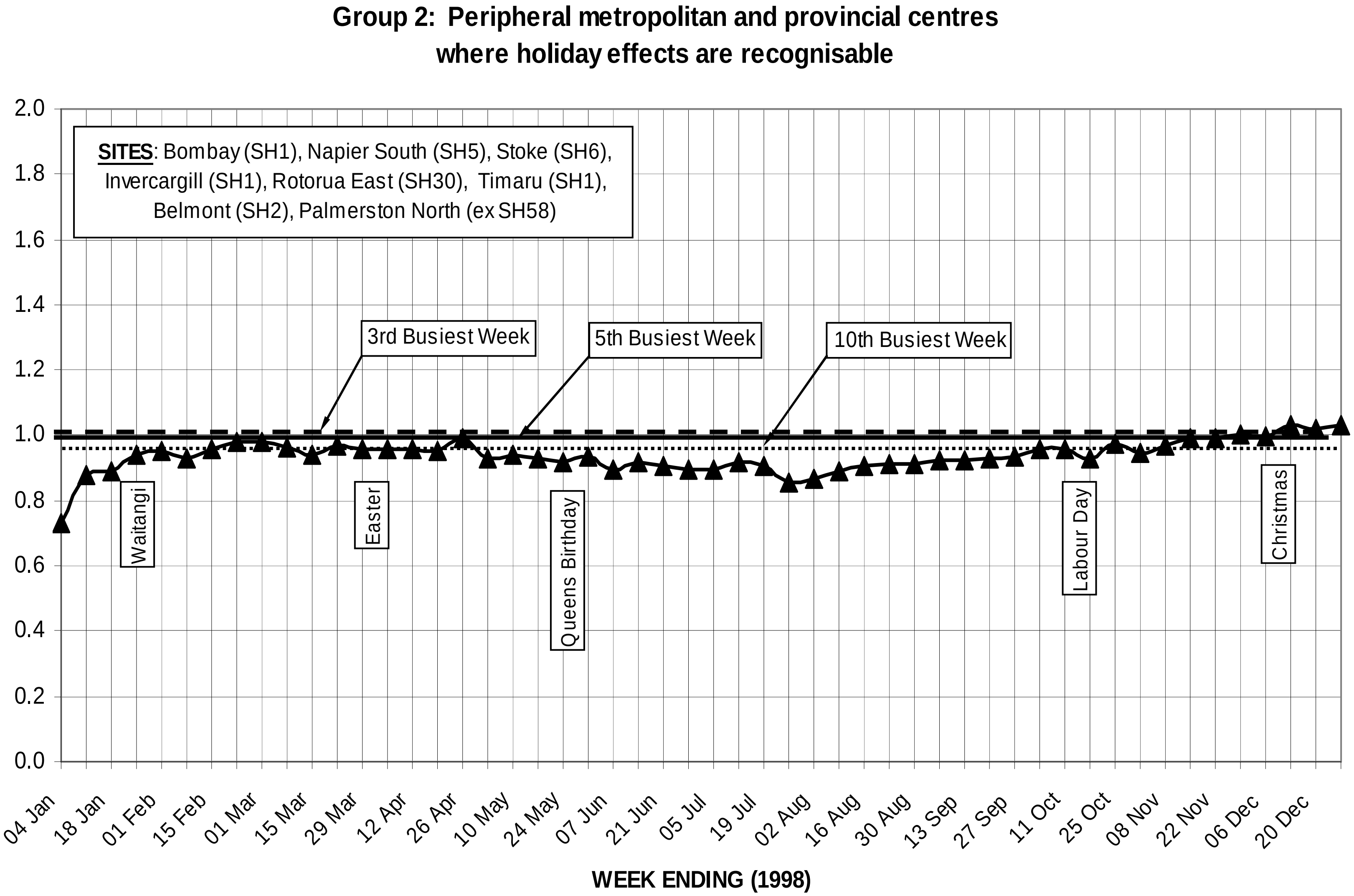
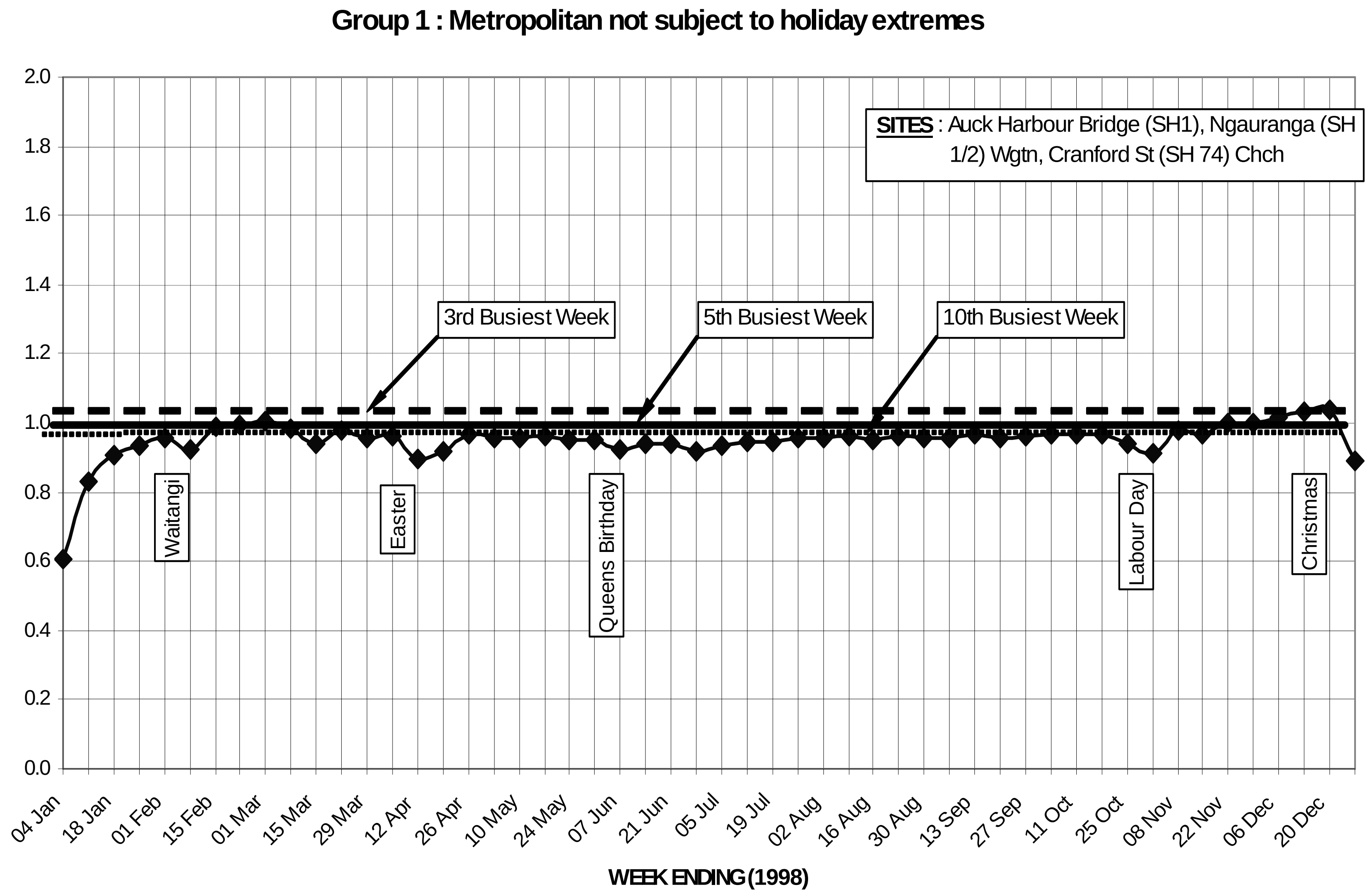


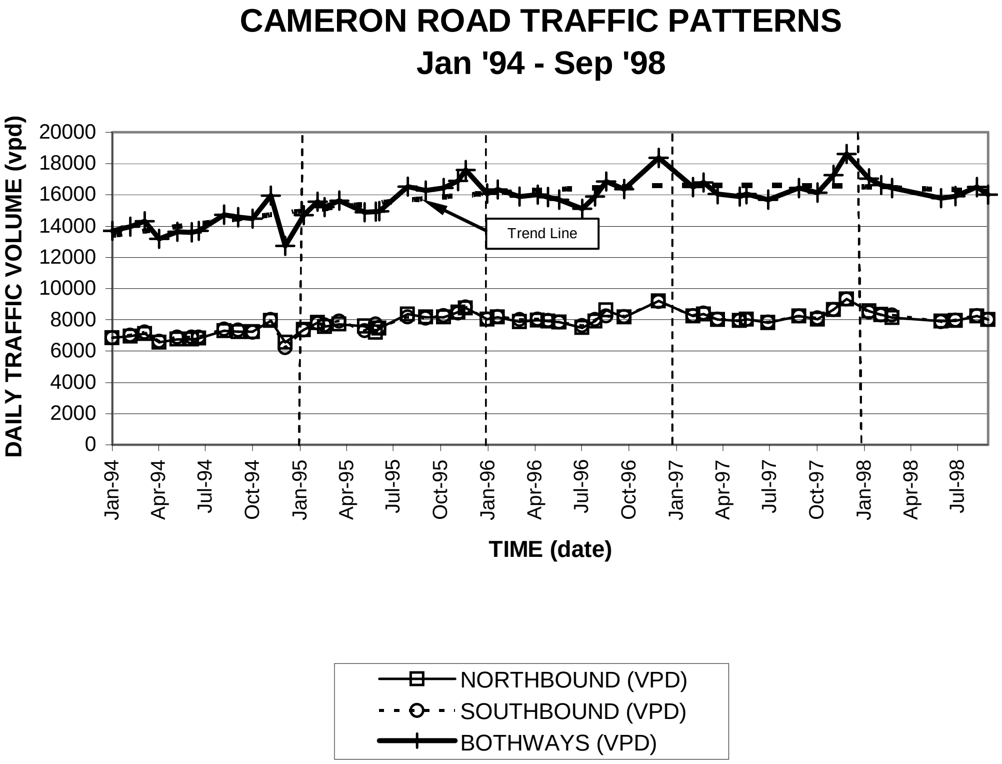
Figure 2.8 Weekly factors (group 1) [ex-2001]



2.8 Longer time – for future year assessments

Figure 2.9 shows data collected by the Tauranga District Council from its regular on-road traffic count station in Cameron Road, adjacent to the CBD, showing daily traffic volumes from January 1994 to August 1998. The data related to a weekly two-way traffic count undertaken for one week of each month over the five-year period.

Figure 2.9 Longer time-scale traffic patterns



The graph shows the pattern of monthly variation with the significant peaks in activity in the December/ Christmas period of each year. It also shows there was a significant seasonal variation in Tauranga and a steady trend growth-line from 1994 to 1998.

The key benefit of the data comes in reviewing the underlying long-term trend line. The average two-way traffic volume in Cameron Road over those five years showed a steady increase over the first two to three years, then a tailing off from about 1996. The explanation for such trends comes from a combination of reasons, including but not limited to:

- Network capacity – the two-way daily volume of up to 18,000 vehicles along this two-lane, undivided section of Cameron Road represents a level of traffic activity that would cause some drivers to choose alternative routes to and from the city centre.

- Economic and development patterns – with increasing dispersal of retail and service activities around the greater Tauranga area, it is likely the city centre was experiencing a slight but noticeable slowing in its increased rate of activity.
- Infrastructure improvements – several major roading projects in the greater Tauranga area resulted in an incremental transfer of traffic activity away from the Cameron Road spine through Tauranga city centre.

Changes in network performance can potentially alter travel times through a network for either private car or public transport modes, while major roading changes can also create impediments for non-motorised modes. Such factors must be recognised when assessing accessibility, trip generation and parking demands for new or redeveloped land uses.

Where comprehensive metropolitan or regional transportation studies have been undertaken, and there are future vehicle traffic assignment forecasts available, these should also be taken into account. Such regional studies should give greater confidence as the medium-term (20 year) and longer-term (40 year) land-use distribution and forecast network traffic flows. Even with the inevitable delays in programmed transport improvements, such longer-term changes should be understood and taken into account in ITAs.

2.9 Application of scale factors

As discussed in section 2.4, the derivation of these weekly, daily and hourly scale factors has been based on the data available throughout the course of a year for pedestrian activity at a shopping centre in a major suburban centre, plus car parking turnover and data from a series of SH continuous count sites. For trip generation and parking design at the individual site or shopping centre, a level of the 50th highest hour and the 10th highest day or 85% satisfaction is suggested for sites that supply their own parking and where this is generally unconstrained.

Table B.3 in appendix B is a worksheet showing how all those scale factors contribute to determining a suitable design hour.

Practitioners should also be aware of the local network operation and the wider influences on the accessibility and convenience of travel to and from particular sites and land uses over the next five or 10 years at least. If a region-wide network and an assignment model are available for longer-term forecasts of future traffic of possibly 20 years may also be considered.

The trip making and parking demand variations described in this section must be considered when undertaking ITAs. These matters are referred to in Abley et al (2010).

3 Daily trips, modes and purposes

3.1 Source of information and definitions

Report 209 did not discuss the whole community's balance of trip making between modes. Some 10 years hence multi-modal trip making is now of greater importance and is included in this report to give some background on daily travel by mode and purpose in New Zealand.

This section relies on the reporting of the New Zealand Household Travel Survey (NZHTS) (MoT 2008a). It is derived from questionnaires put to more than 12,000 people from 5650 households between 2003 and 2006. The national analysis of travel mode choices is reported by the MoT (2009). The information on daily travel in different regions included here is derived from *NZTA research report 353* 'National travel profiles part A: description of daily travel patterns' (Abley et al 2008). The following definitions are used in the NZHTS (MoT 2008a).

Participants All household members, including babies, were eligible for inclusion in the survey.

Stratification The sample strata and substrata were geographically based using Statistics NZ definitions for the 1996 Census of Population and Dwellings. The strata were from 14 local government districts grouped as follows:

- metropolitan urban areas (MUAs), which have a population of at least 30,000
- secondary urban areas (SUAs), which have a population between 10,000 and 30,000
- rural areas (RAs), which include minor urban areas with populations less than 10,000 and all other rural areas.

The sample sizes per local government district were generally proportional to 2001 Census populations.

Usage The definitions of 'trip legs', 'modes' and 'trip purposes' often vary between countries. The perception of these terms may also vary from one research document to another. For example, the *Travel survey report 1997/1998* (Land Transport Safety (LTSA) 2000) used 'trip legs' to understand New Zealanders' travel behaviour and O'Fallon and Sullivan (2005) used 'trip chains' to understand how New Zealanders linked their trip legs into journeys. Parallel with these works several comprehensive multi-modal regional studies were undertaken in which modes and purposes were defined in a slightly different manner.

Trip legs are defined by the MoT (2009) as follows:

> *Trip leg: a single leg of a journey, with no stops or changes in travel mode. For example, driving from home to work with a stop at a shop, is two trip legs; one ending at the shop and one ending at work.*

Trip leg departures consider the start time of a trip leg for a given purpose. Trip leg arrivals consider when the trip leg ends. 'Home-based' departures and arrivals are made to and from home, while a 'home-based arrival' is any trip leg that ends at home irrespective of the time of day. Trip legs begin on leaving any property. A walk trip is more than 100m.

Trip leg purpose. Each trip leg has a trip leg purpose, which is related to activities generally at the arrival end of the trip. These are set out in detail in Abley et al (2008) and on the MoT website (MoT 2009). More detail on trip purposes is included in sections 3.6 to 3.10.

Modes. The following definitions were used when defining modes:

- Trip legs made by walking included skateboards, scooters, prams, tricycles and children carried in backpacks.
- Trip legs made by motorbike (either as driver or passenger) were classified as 'vehicle driver' or 'vehicle passenger'
- Trips legs made by professional taxi and bus drivers as part of their work were classified as 'vehicle driver'.
- Emergency vehicles (eg ambulances, police cars) were classified as vehicles with professional drivers and passengers.
- Public mode includes passenger travel on train, bus, ferry, plane and taxi.
- Private mode includes vehicle driver, vehicle passenger, motorcycle, bicycle and walking.

To give some overall perspective of total trip legs by all modes and all purposes, the average trip leg distances and the average trip leg times for the three sample regions are compared in figures 3.1 and 3.2. The average trip length distances are greatest for RAs (13km) and least for MUAs (8.5km). The mean trip leg times do not vary greatly, ranging between 13 and 16 minutes in all regions.

Figure 3.1 Average trip leg distance, categorised by area

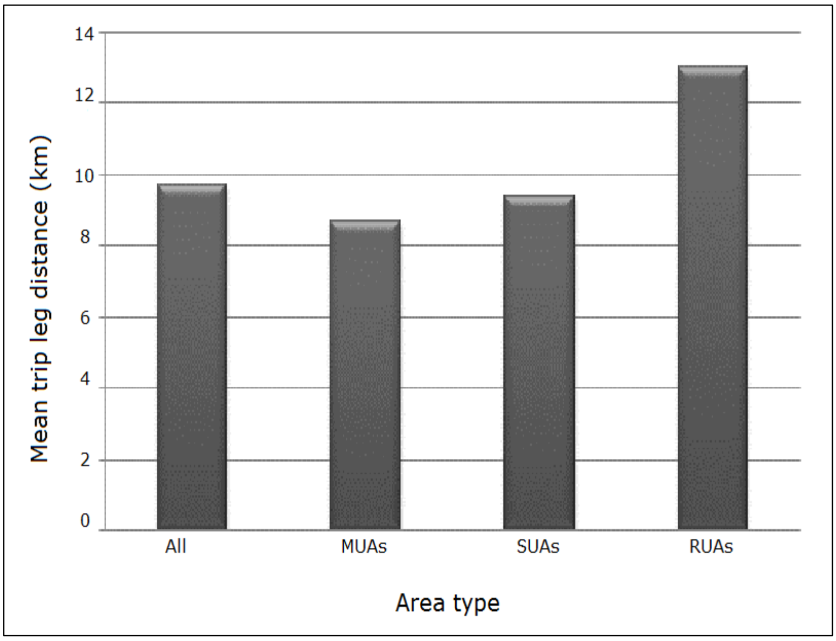
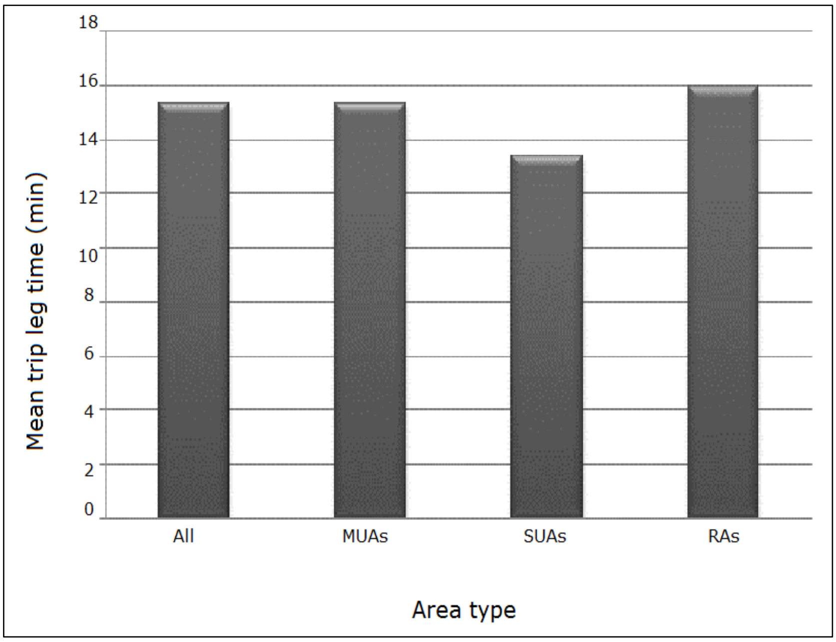


Figure 3.2 Average trip leg time, categorised by area



MUAs = metropolitan urban areas

SUAs = secondary urban areas

RAs = rural areas

3.2 Trip legs by private and public modes

The proportions of trip legs made by different modes and categorised by area are presented in table 3.1. The proportion of trip legs taken by selected private and public transport modes are illustrated in figures 3.3 and 3.4, respectively. These show the selected mode as a proportion of total trip legs by all modes.

The analysis of the proportions of trip legs taken by selected private and public transport modes shows:

- Travel mode as a 'vehicle driver' had the highest trip leg proportion, accounting for over 50% of all trip legs taken from 2003 to 2006 in all three areas.
- The proportion of walking trip legs varied between 11% and 16% in all three areas.
- In terms of public travel modes, the proportion of trip legs made by bus in RAs was 2.9%, compared with 2.4% and 0.8% in MUAs and SUAs, respectively. In SUAs and RAs, bus trip legs reflected the high proportion of rural school children taking the bus to school.

Table 3.1 The proportions of trip legs made by modes, categorised by area

Mode description	**Trip leg proportion**			
	All areas	**MUAs**	**SUAs**	**RAs**
Walk	15.5%	16.5%	11.3%	13.7%
Vehicle driver	54.1%	53.0%	58.5%	56.1%
Vehicle passenger	25.5%	25.5%	26.9%	24.9%
Bicycle	1.4%	1.2%	1.9%	1.8%
Bus	2.4%	2.4%	0.8%	2.9%
Train	0.3%	0.3%	0.1%	0.1%
Taxi	0.4%	0.5%	0.4%	0.2%
Other*	0.5%	0.6%	0.3%	0.4%
Total	100%	100%	100%	100%
Unweighted trip legs (all modes)	108,482	67,589	10,775	30,097

* The 'other' category includes trips by train, ferry, plane and mobility scooter, as well as trips which were classified as 'other' on the survey forms (these may include travel by boat, horse, electric wheelchairs etc).

Figure 3.3 The proportions of trip legs made by private transport modes, categorised by area

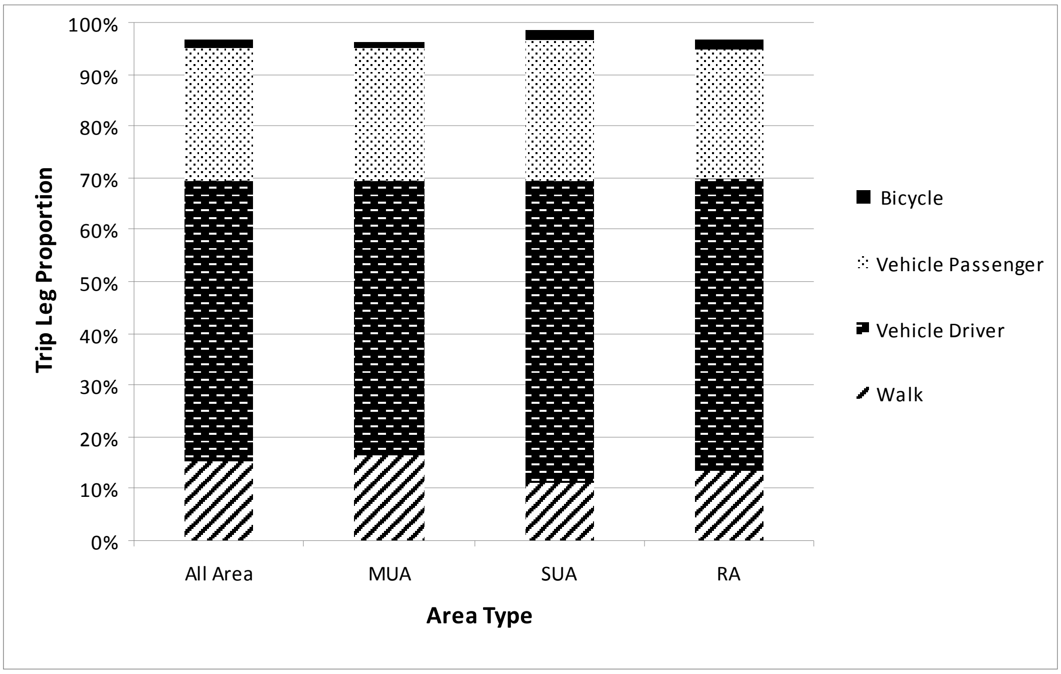
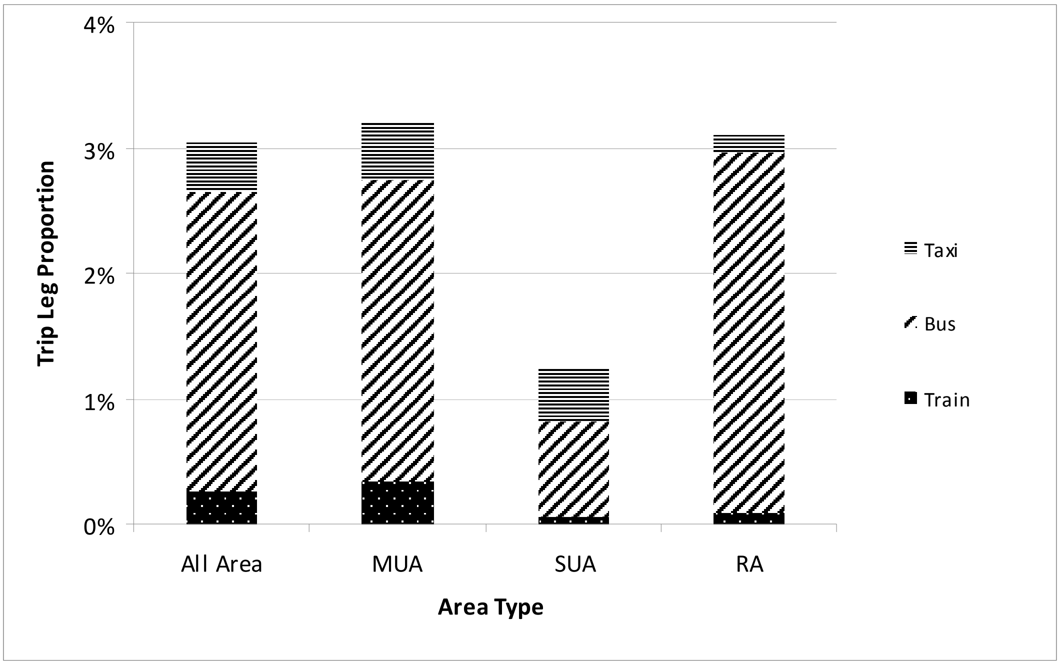


Figure 3.4 The proportions of trip legs made by public transport modes, categorised by area



3.3 Trips and modes in different regions

Travel in the three different types of regions or areas of New Zealand, as defined for these surveys (MUA, SUA, RA), does not vary greatly:

- Overall, the mean number of trip legs per person per day for all areas is around 4.4.
- Travel mode as a 'vehicle driver' has the highest trip leg proportion, accounting for over 50% of all trip legs taken on a national basis.

The modes of trips, their length, their destination and the total time spent per day according to mode in the MUA, SUA and RA regions are illustrated in figures 3.5 and 3.6.

Figure 3.5 shows the trip legs per person. These must be summed to generate the trips made by a household. Thus, the average vehicle driver trips for a household of possibly four people could be 4 x 2 = 8 vehicle driver trips per day of which three or four could be to or from home. This could result in an average of six home-based resident driver trips per day. This aspect of generating trips by households is also being undertaken in current research for the NZTA (NZTA research report 'National travel profiles part B: Trips, trends and travel predictions' is soon to be published).

Figure 3.5 The mean number of trip legs/person/day, categorised by mode of travel and area

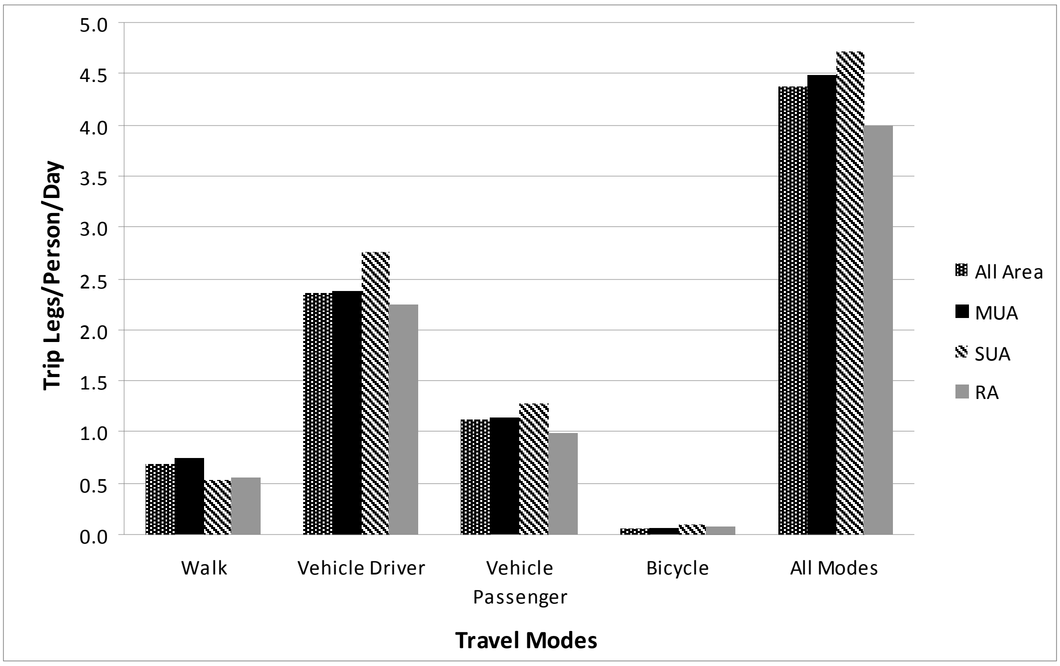
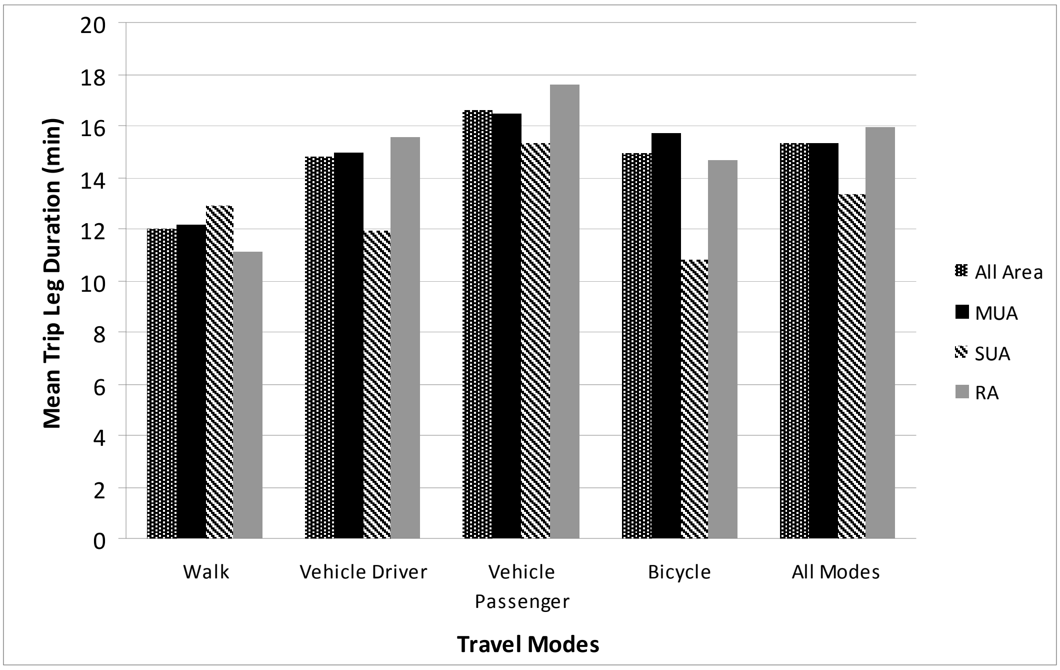


Figure 3.6 The mean trip leg duration, categorised by mode of travel and area



3.4 Variation in travel by household car availability

Table 3.2 and figure 3.7 show how travel patterns differ according to household car availability. Trip legs, distance and time per household per day are indexed to show the relative difference of variations in household car availability. For this index, a reading of 100 is used to indicate the average rate per household. This is equivalent to 15 trips per household, 121km travelled per household and 227 minutes of travel time per household.

Analysing the variations in travel categorised by household car availability shows:

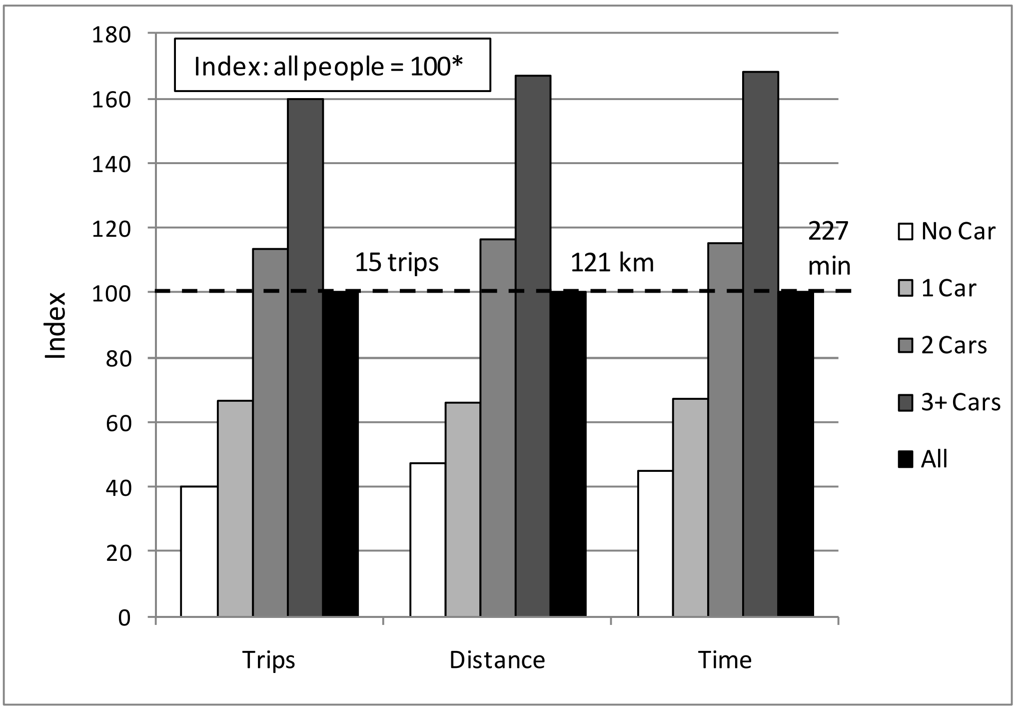
- Households with three or more cars generated proportionally more trip legs than households with fewer than three cars.
- Households with more than three cars also travelled correspondingly greater distances and spent significantly more time travelling.

Table 3.2 Variations in total travel for all modes by household car availability

Number of cars in household	Unweighted sample size (households)	Total trips/ household/ day	Distance/ household/ day (km)	Travel time/ household/ day (min)
No car	360	6	57	102
1 car	1818	10	80	153
2 cars	1783	17	141	262
3+ cars	848	24	202	382
Totals and means	4809	15*	121*	227*

* These values were used to calculate the 100 index shown in figure 3.7.

Figure 3.7 Mean variations in travel by all modes categorised by household car availability



*100 = 15 trip legs/household
= 121km/household
= 227 minutes/household

3.5 Variation in travel by household size

Variation in travel behaviour by all modes, categorised by number of people in a household, is shown in table 3.3. Trip legs, distance and time travelled per household per day are illustrated in figures 3.8, 3.9 and 3.10, respectively. The table and figures show:

- Trip legs, time spent travelling and distances travelled increased linearly with the number of people in a household, up to four persons.
- The average number of trip legs (six), the travel distance (50km) and travel time (90 minutes) per person per day in a household was fairly constant until the household size reached 5+ people.
- Households with five people travelled the greatest distance: 244km per day.

The surveys and subsequent reports only considered the effect of individual variables on trips, distances and time. Numerous variables might all affect trips, distances and time but the relative magnitude of the effects of these variables in combination was not determined in this investigation.

Table 3.3 Variations in travel by number of people in a household

No. of people in household	Unweighted sample size (households)	Trip legs/ household/ day	Distance/ household/day (km)	Travel time/ household/day (min)
1	1169	6	47	91
2	1809	12	99	188
3	749	18	147	282
4	687	25	200	376
5	272	28	244	421
6+	124	29	230	426
All	**4810**	**15**	**121**	**227**

Figure 3.8 Trip legs per household per day, categorised by number of people in the household

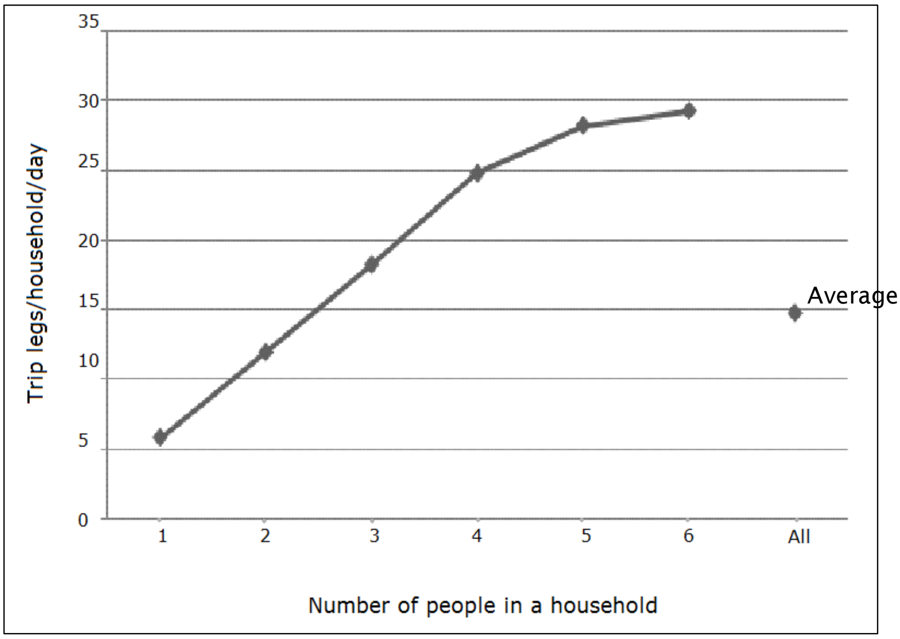


Figure 3.9 Distance per household per day, categorised by number of people in the household

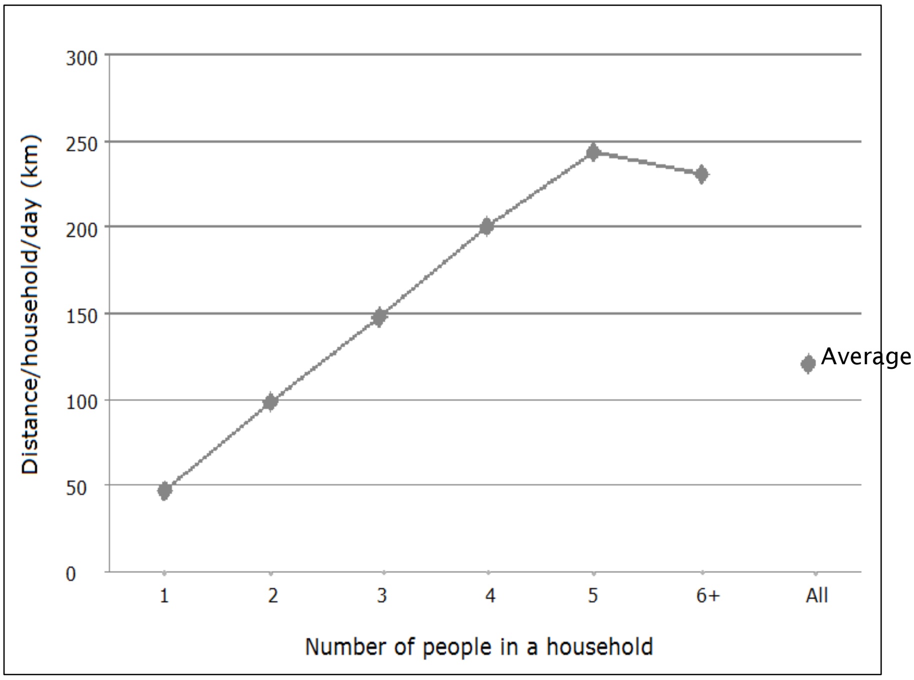
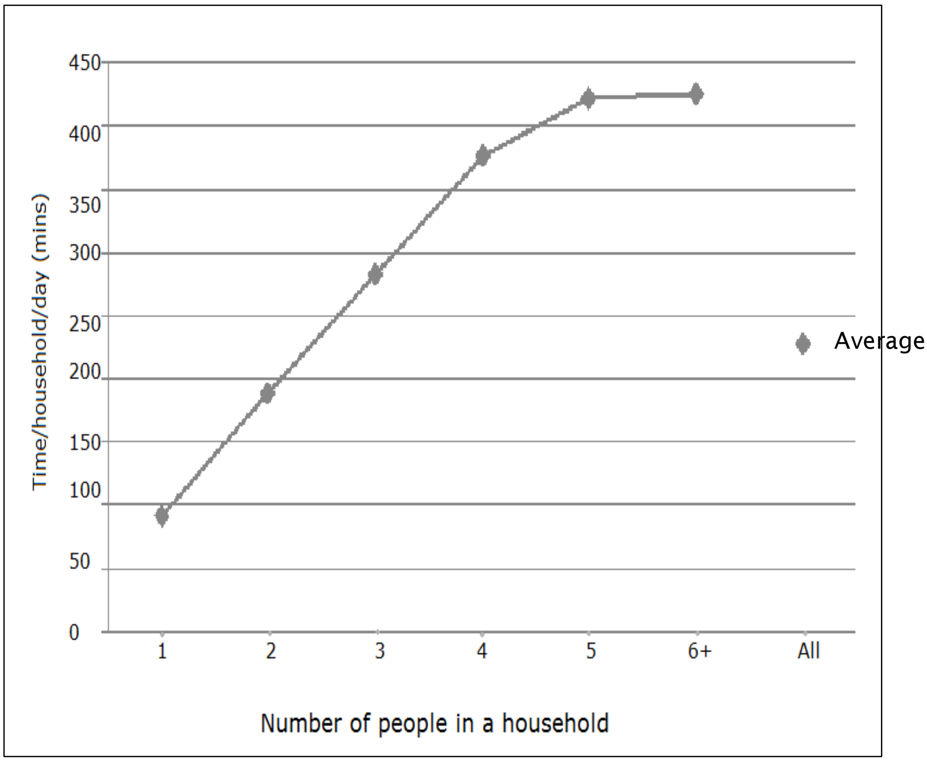


Figure 3.10 Travel time per household per day, categorised by number of people in a household



3.6 Walking duration by purpose in metropolitan urban areas

The 85th percentile, 15th percentile and mean walking duration by purpose in MUAs for all trip leg arrivals and for home-based trip leg arrivals are illustrated in figure 3.11. Walking trip legs from all trip leg arrivals include trip legs that may not be home based, such as arrivals from 'work – main job', 'social/recreation' or 'hospital/medical'. Home-based walking trip leg durations are calculated using the first trip leg an individual makes at the start of the day when they leave home. Those trip legs made by people who returned home at some point and then went out again have not been included in this analysis.

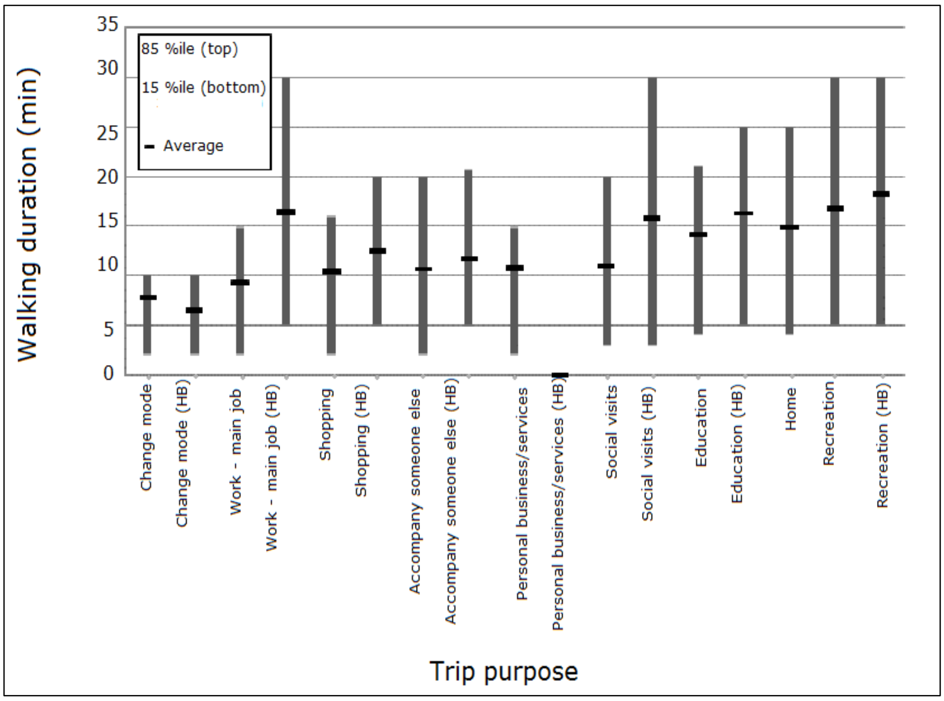
Respondents were also prompted to include all walking trip legs of 100m or more along a public road or footpath, or where a road was crossed. In practice, it is likely very short trip legs might tend to be under-reported. Trip legs from a car park to work were eligible for the survey if they met these criteria. Interviewers were trained to probe for this information.

The analysis of walking trip leg durations, categorised by purpose for home-based arrivals in MUAs, shows:

- Recreational trip legs have the highest mean walking duration. On average, an individual will walk 17 minutes for all recreational trip leg arrivals and 18 minutes for home-based recreational arrivals.
- Trip legs made to 'change mode' have the lowest mean walking duration (eight minutes).

- The ‘work (home-based)’ has a higher walking trip leg duration (16 minutes) compared with trip leg purpose by ‘work’. This is because trip leg purpose by ‘work’ includes other short walking distance trip legs such as walking from the bus stop to work or short walk trips for business purposes during the day.

Figure 3.11 Walking trip leg duration by purpose in MUAs*



* Estimates for ‘personal business and services (HB)’ cannot be made because the number of trip legs sampled was less than 120.

3.7 Cycling duration by purpose in MUAs

The 85th percentile, 15th percentile and mean cycling duration by purpose in MUAs for ‘home’ and ‘work’ trip leg arrivals are presented in table 3.5. Estimates of cycling duration by other trip leg purposes apart from ‘home’ and ‘work’ cannot be made because of the low sample rate of surveyed returns.

Table 3.5 shows on average a person takes about 14 minutes to cycle to work in MUAs. The mean cycling time arriving home from all origins is about 16 minutes.

Table 3.5 Cycling trip leg duration by purpose in MUAs

Trip leg purpose	Unweighted sample size (trip legs)	Duration (min)		
		15th %ile	Mean	85th %ile
Home	386	5	16	25
Work*	263	4	14	23

* ‘work’ includes trip legs for ‘work – main job’, ‘work – other job’ and ‘work – employer’s business’.

3.8 Mean distance and time by purpose

The mean trip leg distance and trip leg time, categorised by trip leg purpose, are shown in table 3.6 and illustrated in figures 3.12 and 3.13.

The analysis of the mean trip leg distance and trip leg time, categorised by trip leg purpose, shows that:

- 'Work – employer's business' has the highest trip leg distance (10.7 km), followed by 'recreation' (10.5 km) and 'social visits' (9.8 km).
- Recreational trip legs have the highest mean trip leg time (19.9 minutes), followed by 'work – employer's business' (19.2 minutes) and 'social visits' (16.4 minutes).

Figure 3.12 Mean trip leg distance, categorised by trip leg purpose

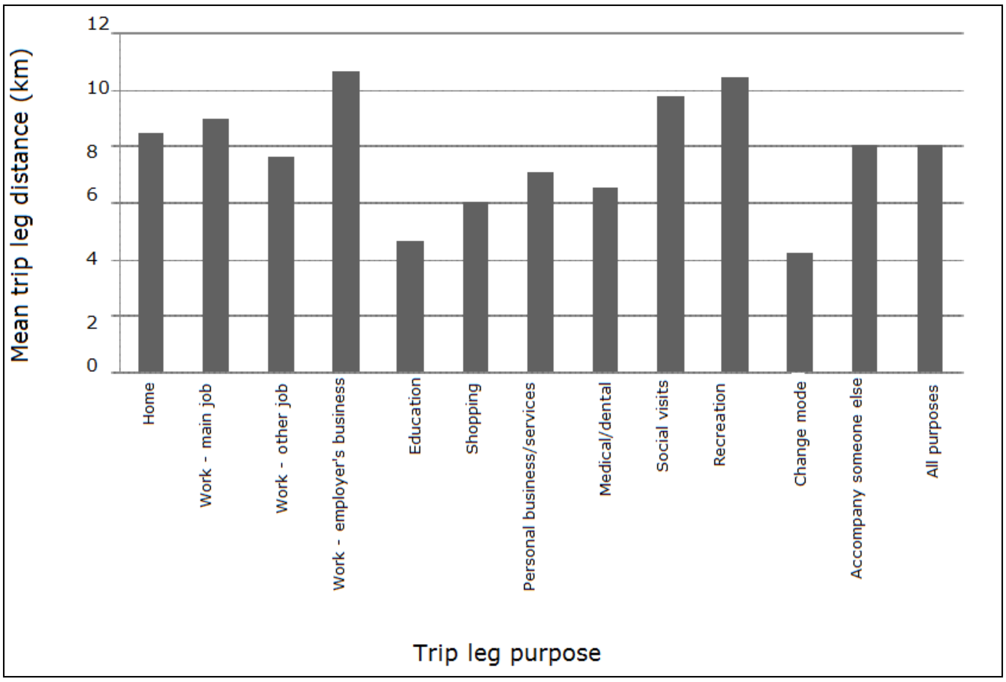
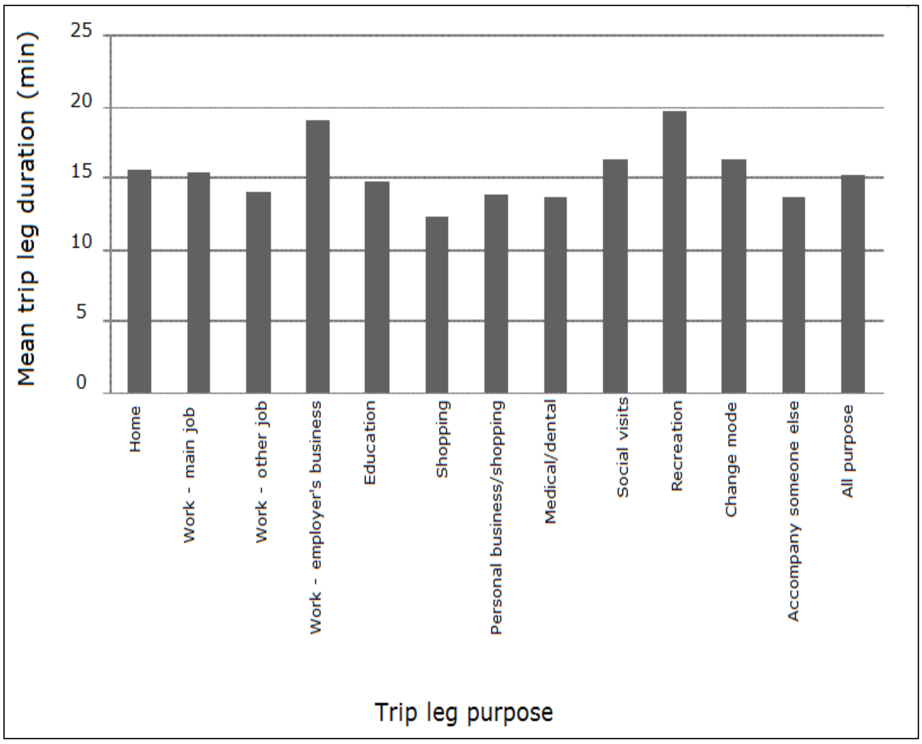


Figure 3.13 Mean trip leg duration, categorised by trip leg purpose



3.9 Trip leg by purpose and mode

Trip leg proportions, categorised by trip leg purpose and mode of transport for the whole of New Zealand, are presented in table 3.7 and illustrated in figure 3.14.

Looking at the figure and the table shows that:

- Trip legs made as a 'vehicle driver' comprise the highest proportion of trip legs travelled for working purposes. Shopping, personal business/services, social visit and medical dental trip purposes show a similar pattern.
- Trip legs made as a 'vehicle passenger' comprise the highest proportion of trip legs made for 'education' and to 'accompany someone else', with proportions of 39% and 54%, respectively.
- Walking was the dominant mode of transport for trip legs made to 'change mode' (42% of all 'change mode' trip legs).
- Buses were the most frequently used mode of public transport, being the fourth highest mode for education and the second highest for 'change mode' trip legs.

Figure 3.14 Trip leg proportions, categorised by trip leg purpose and mode of transport

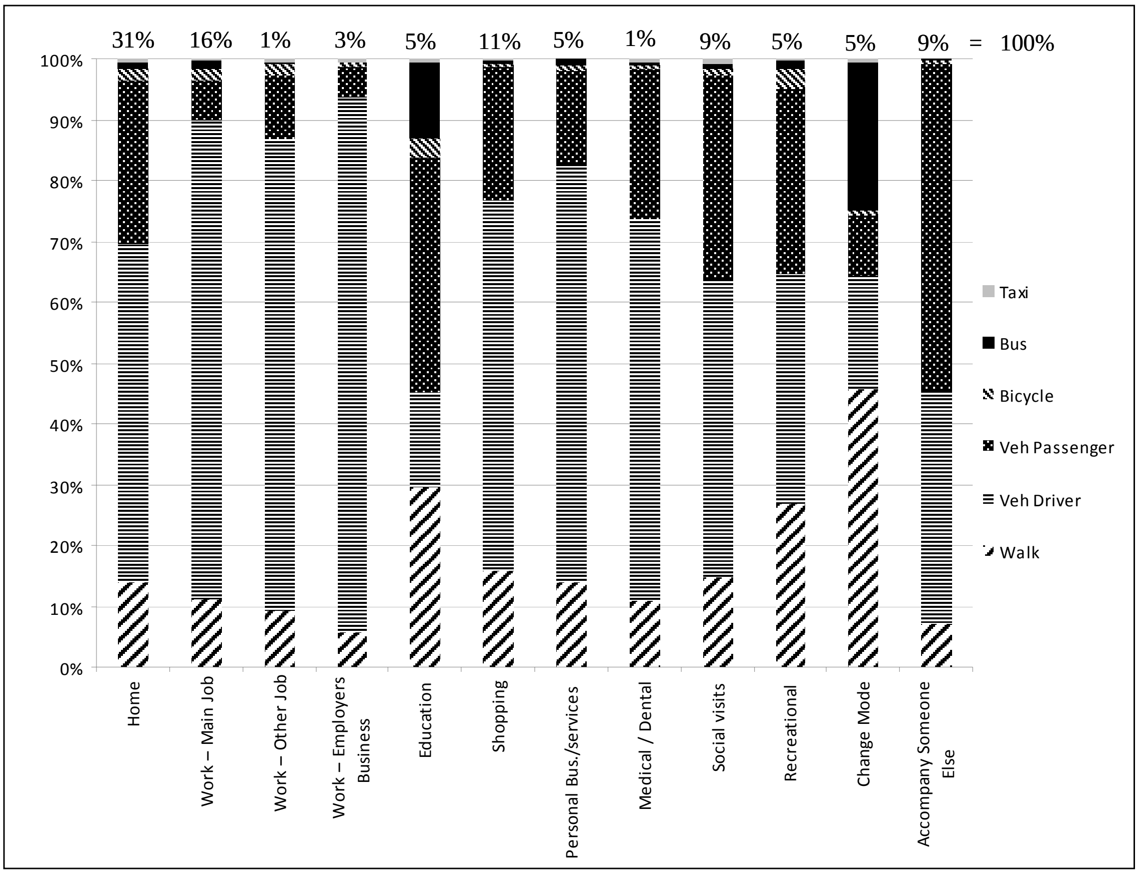
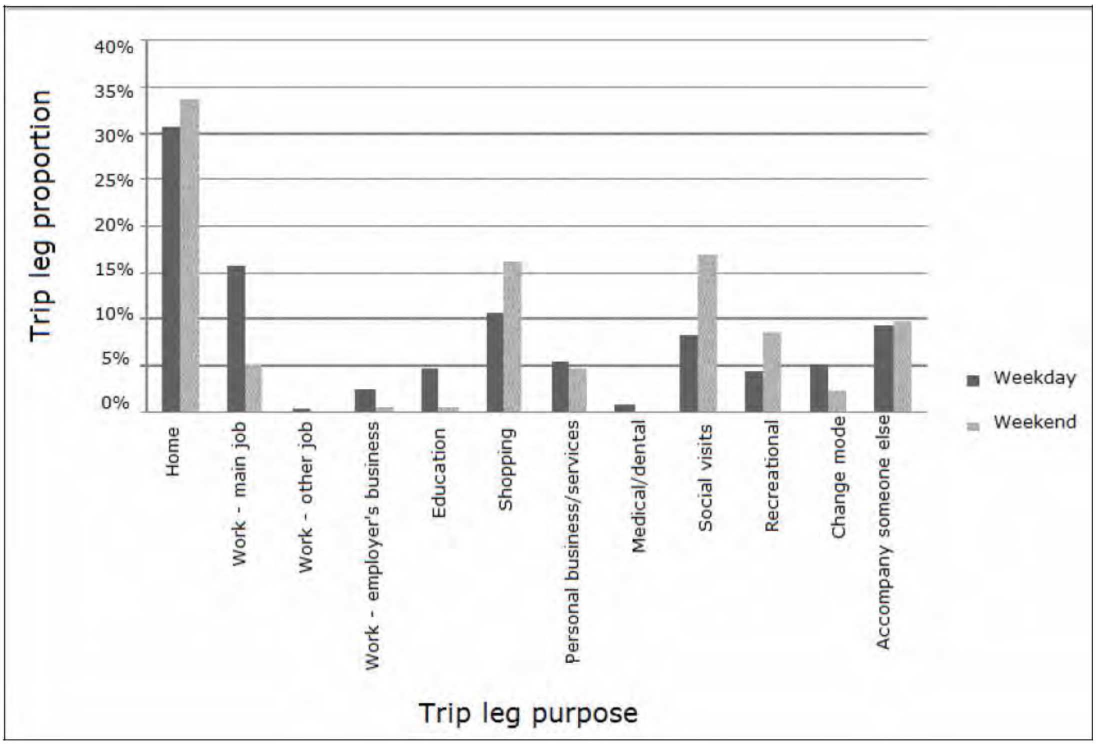


Figure 3.15 shows the proportion of trip legs by purpose on weekdays compared with weekends. During the weekend, trips to and from home and also shopping trips, social trips and recreation trips were proportionately higher than on weekdays.

Figure 3.15 The proportion of trip legs by purpose on weekdays and weekends



3.10 Summary on trips, modes and purposes

This chapter has considered how New Zealanders travel by trip leg purposes and mode of transport on a typical weekday. Highlights from this section include:

3.10.1 Trips

- The differences in trip numbers and duration of trips did not vary greatly between MUAs and SUAs. RAs had longer distances and durations of trips.
- Overall the mean number of trip legs per person per day for all areas was around 4.4.
- Trips where the mode was 'vehicle driver' had the highest trip leg proportion accounting for over 50% of all trips on a national basis.

3.10.2 Purposes

- Individuals travelled more trip legs and trip leg distance as vehicle drivers for nearly all purposes apart from 'education' and to 'change mode' and to 'accompany someone else'.

- For all working purposes, trip legs made as a ‘vehicle driver’ (56%) comprised the highest proportion. Shopping, personal business/services, social visits and medical/dental trip legs purposes showed a similar pattern.
- The purposes which had the highest proportion of trips made as a vehicle passenger were ‘education’ (39%), ‘social visits’ (33%) and recreation (30%).
- The purposes that showed the highest proportion of individuals walking were ‘education’ (30%), followed by ‘shopping’ (16%).
- The purposes that showed the highest proportion of bus use were to ‘change mode’ (22%) and ‘education’ (12%).
- Recreation and education showed the greatest proportion of bicycle use (3% each), followed by work trips (2%).
- Taxis were a minor contributor for trips to ‘work’ (1%), and for ‘medical/dental’ (1%) and social (1%) purposes.

4 Residential trips and parking

4.1 Background

Among the ongoing trends affecting residential trip generation patterns, particularly in the rapidly growing urban centres, is the increasing variety of household types and their make-up. Instead of the standard single dwelling-house there is now a range of residential options across a variety of income brackets, from townhouses, unit-titled apartments, long-term serviced hotel-style apartments and elderly villages together with the traditional single-unit suburban dwellings. On the rural periphery, where a significant amount of the growth in residential-related travel is occurring, a dispersed style of high-cost family home has emerged.

Another trend is for inner-city apartments to be developed on smaller CBD sites. This proximity to the variety of employment, entertainment and recreation options in these areas may result in car ownership and vehicle trip generation rates being marginally lower than for a typical suburban dwelling. However, two-car households, parking and trip making continue to increase for all household types.

The third significant trend is the increase in vehicle ownership and general car availability in all income brackets. Between the 1986 and 1996 censuses, the average household car ownership rate rose from 1.32 to 1.40 and in 2006 to 1.80, cars per household, largely reflecting the continued availability of cheaper vehicles in the form of second-hand vehicles. The trend away from vehicle driver trips toward higher levels of bus, cycle and pedestrian trips has not been significant or as great as that sought in the New Zealand Transport Strategy (MoT 2008b)[2].

This research did not attempt to isolate the particular factors involved in determining the household trip generation rate for a particular location. That information will be contained in the soon to be published NZTA research report 'Travel profiling part B'. In very general terms, the primary factors explaining the variation in household trip generation include:

- topography (hill suburbs generate fewer trips and tend to a lower average trip generation rate)
- demographic make-up (younger families tend to make more trips than a retired or ageing population)
- socio-economic factors (car ownership and availability have a large influence on the number of trips made per day)
- proximity to employment centres (satellite commuter towns close to major metropolitan areas typically have lower average residential trip generation rates than suburbs of a metropolitan area)
- increased opportunity to work from home (advances of internet and other telecommunications technology)

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[2] The New Zealand Transport Strategy uses a planning horizon to 2040. *Connecting New Zealand* (MoT 2011) is a summary of the government's transport policy and is largely focused on the government's direction for the next decade.

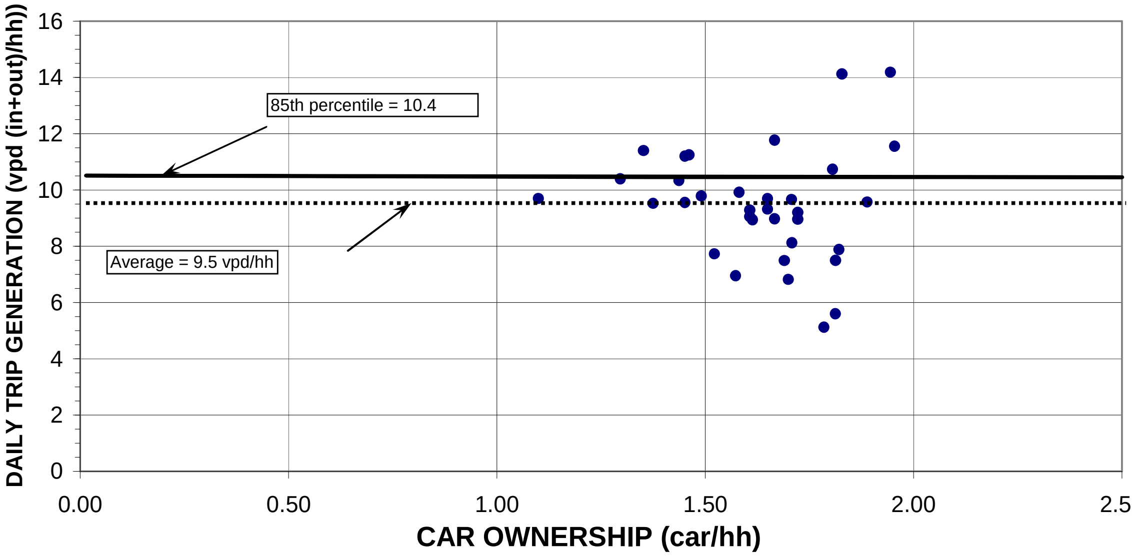
- availability of alternative travel modes and public transport (households with fewer than average vehicles may be located on convenient bus routes or have cycle access to schools, etc).

4.2 Trip making

Survey information obtained through this research indicated typical inner suburban single-unit households generated on average 9.5 vehicle movements (in + out) per day per household. This average daily rate per household increased rapidly during the 1970 to 2001 period (from about five trips per day up to nine trips per day) but there has been no significant change in the past 10 years.

For each of the suburban residential subdivisions surveyed in the project, the 1996 Census data on car ownership rates was also collected and the trip generation rate for the average household and its car ownership level was established. The resulting relationship between these variables is presented in figure 4.1, which shows the daily trip generation rates and the local household car ownership level. As the raw data in the survey database shows, the smallest subdivision sampled contains 32 households and the largest 538 households. It was found the subdivision household numbers were not a significant variable. It could also be seen high car ownership did not establish a basis for predicting trips overall. However, the highest trip rates did come from suburbs which also had the highest car ownership. But as shown in figure 4.1, there were also some suburbs with high car ownership where low household trip rates were found.

Figure 4.1 Suburban residential trip generation [ex-2001]



Surveys undertaken in Manukau City in 1991 and again in 1996 confirmed the range established here. They also pointed to the key variable of the number of persons based at home with access to a vehicle during the day. Trip rates per household did not appear to be well correlated with income or other obvious socio-economic factors. High rates emerged from households at both ends of the income and valuation scale.

As this research was unable to determine the variation in trip making by sub-groups of houses, divided between household size or car ownership within each of the subdivisions surveyed, the variation are shown only as an average for each of the suburbs considered. As figure 4.1 shows, the 85th percentile figure of 10.4 vpd (in + out) per household is recommended as an appropriate figure for design and assessment purposes when considering the full range of households within a city. However, there will be many suburbs where a lower figure is appropriate and suitable rates per household may need to be selected in different urban areas.

It is noteworthy that car ownership did not appear to be the sole dictator of household trip making: for households with 1.8 cars, the trip rate varied widely, from about four to 13 trips per household per day.

As the surveys show, lower trip generation rates have typically been found in more rural subdivisions. Surveys near Queenstown and Christchurch indicated daily rates of between 6 and 8vpd (in + out) per household reflected the increased trip linking which occurred when the primary employment trip was longer, eg greater than 20 minutes, as with rural lifestyle properties located in the outskirts of an urban area.

4.3 Car ownership patterns and parking demand

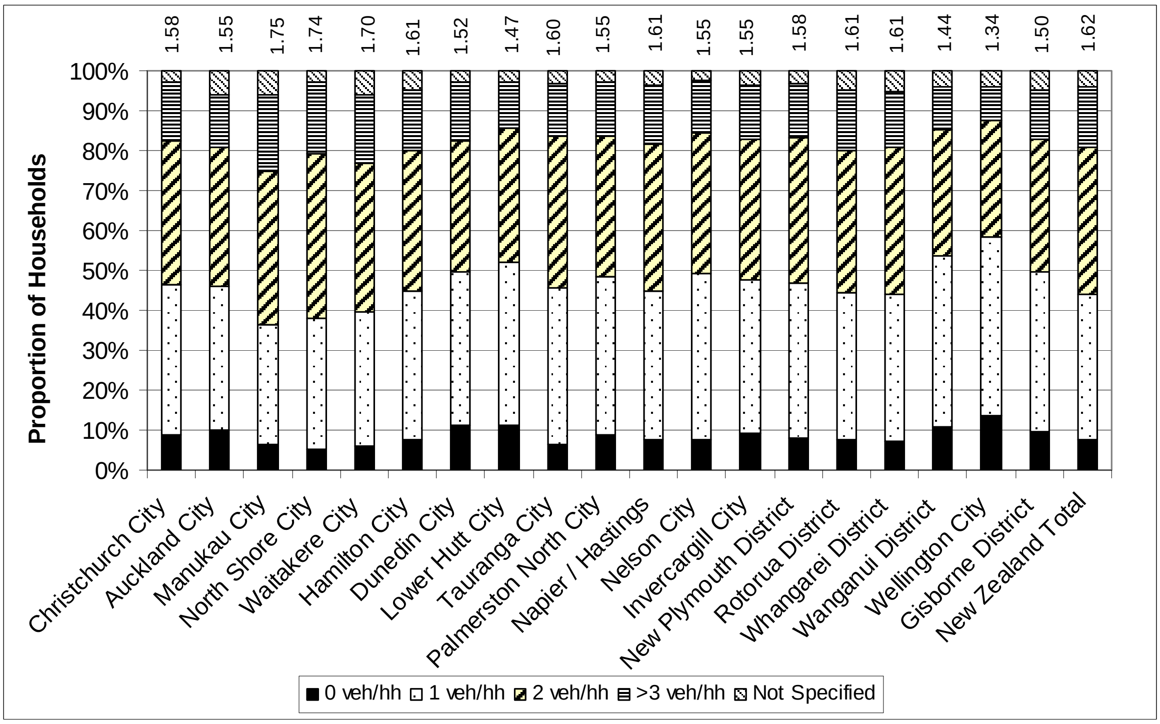
In the residential areas in 1970, 20% of all households had no car. This dropped to 12% in the 1990s and 7% in 2006. In 1970, 26% had 2+ cars and this figure increased to 44% in the 1990s. In 1970 there was an average of 1.10 cars per household while this figure increased to 1.4 cars in the 1990s. Over the whole country in 2006, 55% of all households had 2+ cars and there was an average of 1.57 cars per household. This made New Zealand one of the highest car owning countries in the world.

The information in this section was derived from the national census information of 1996 and 2006.

There were some variations in car availability between cities. Figure 4.2 shows the average and distribution of car ownership for the 19 largest urban areas. The variation in the average between cities was 1.34 to 1.75 cars per household. The variation between suburban areas did not appear to be directly related to household vehicle ownership.

The vehicle ownership range varied less between cities than the contrasts from suburb to suburb within a city.

Figure 4.2 Household car ownership in 20 New Zealand centres (2006)



Household car ownership numbers for 20 New Zealand centres are included in table 4.1. The proportion of cars owned and the average per household are tabulated for the 1996 and the 2006 census.

On a national basis, car ownership increased from 1.45 veh/hh to 1.62 veh/hh. In 1996, the ownership range was from 1.23 veh/hh to 1.6 veh/hh. In 2006, these figures ranged from 1.34 veh/hh to 1.75 veh/hh.

Figure 4.3 shows a range of selected Wellington city area units and the 2006 Census data relating to car ownership rates. Wellington has one of the highest proportions of zero household car ownership in New Zealand at 14% across the whole city. This may be attributable to the quality and frequency of public transport, residential and employment distributions, and the geographical/topographical limits on available off-street parking within the city.

The variations in car ownership at 18 individual suburbs in Wellington were greater than those existing between cities. In 1996 the average for Wellington was 1.27 veh/hh while in 2006 it had risen to 1.34 veh/hh. Both these figures were significantly less than those for the nation as a whole. At the individual suburb level, the 1996 figures varied from 0.8 veh/hh to 1.66 veh/hh while for 2006 the figures ranged from 0.92 veh/hh to 1.78 veh/hh.

Table 4.1 Comparison of household car ownership in 20 New Zealand centres (1996 & 2006)

1996 Census	Christchurch	Auckland	Manukau	North Shore	Waitakere	Hamilton	Dunedin	Lower Hutt	Tauranga	Gisborne
0 veh/hh	12%	14%	11%	8%	8%	11%	17%	15%	9%	14%
1 veh/hh	40%	38%	36%	36%	37%	41%	43%	43%	45%	45%
2 veh/hh	32%	30%	33%	38%	36%	32%	28%	30%	34%	27%
>3 veh/hh	12%	11%	14%	14%	14%	12%	9%	9%	10%	8%
Not specified	3%	7%	5%	4%	5%	3%	3%	4%	3%	6%
Average veh/hh	1.46	1.42	1.54	1.6	1.59	1.47	1.3	1.33	1.46	1.5%
2006 Census										
0 veh/hh	9%	10%	6%	5%	6%	8%	11%	11%	6%	10%
1 veh/hh	38%	36%	30%	33%	33%	37%	38%	41%	39%	40%
2 veh/hh	36%	35%	38%	41%	37%	35%	33%	34%	38%	33%
>3 veh/hh	15%	13%	19%	18%	17%	15%	15%	12%	13%	12%
Not specified	3%	6%	6%	3%	6%	5%	3%	3%	3%	5%
Average veh/hh	1.58	1.55	1.75	1.74	1.7	1.61	1.52	1.47	1.6	1.5

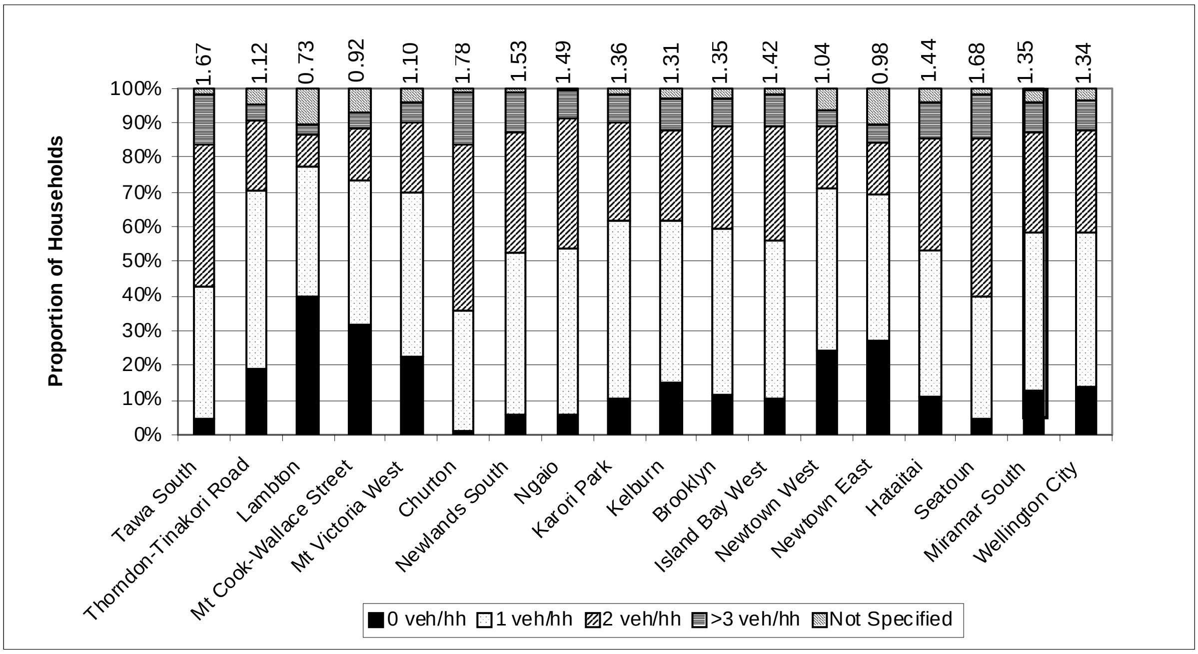
1996 Census	Palmerston North	Napier/ Hastings	Nelson	Invercargill	New Plymouth	Rotorua	Whangarei	Wanganui	Wellington	New Zealand
0 veh/hh	12%	12%	11%	14%	13%	14%	14%	16%	16%	11%
1 veh/hh	44%	43%	43%	45%	47%	43%	46%	47%	45%	41%
2 veh/hh	30%	31%	32%	29%	30%	30%	28%	25%	27%	32%
>3 veh/hh	11%	11%	11%	9%	7%	9%	8%	7%	8%	11%
Not specified	3%	4%	3%	3%	4%	4%	5%	5%	4%	4%
Average veh/hh	1.42	1.41	1.45	1.34	1.33	1.37	1.3	1.23	1.27	1.45
2006 Census										
0 veh/hh	9%	8%	8%	9%	8%	8%	7%	11%	14%	8%
1 veh/hh	40%	38%	41%	39%	39%	37%	37%	43%	45%	36%
2 veh/hh	35%	37%	35%	35%	36%	36%	37%	31%	29%	37%
>3 veh/hh	14%	15%	13%	14%	14%	15%	14%	11%	9%	15%
Not specified	3%	4%	3%	3%	3%	5%	5%	4%	4%	4%
Average veh/hh	1.55	1.61	1.55	1.55	1.58	1.61	1.61	1.44	1.34	1.62

Table 4.2 Comparison of household car ownership in 18 Wellington suburbs (1996 & 2006)

1996 Census	Tawa south	Thorndon-Tinakori Road	Lambton	Mt Cook-Wallace Street	Mt Victoria west	Churton Park	Newlands south	Ngaio	Karori Park
0 veh/hh	4%	19%	35%	35%	27%	6%	8%	8%	14%
1 veh/hh	39%	50%	39%	40%	45%	44%	48%	50%	52%
2 veh/hh	42%	19%	13%	13%	15%	38%	31%	33%	25%
>3 veh/hh	13%	6%	4%	4%	6%	13%	10%	7%	7%
Not specified	2%	6%	9%	7%	6%	0%	3%	2%	2%
Average veh/hh	1.66	1.13	0.85	0.86	0.99	1.56	1.44	1.39	1.25
2006 Census									
0 veh/hh	4%	19%	40%	32%	22%	2%	6%	6%	10%
1 evh/hh	38%	51%	38%	41%	47%	53%	47%	48%	51%
2 veh/hh	41%	20%	10%	15%	20%	75%	35%	37%	29%
>3 veh/hh	15%	5%	3%	5%	6%	23%	11%	8%	8%
Not specified	2%	5%	10%	7%	4%	2%	1%	1%	2%
Average veh/hh	1.67	1.12	0.73	0.92	1.1	1.78	1.53	1.49	1.36

1996 Census	Kelburn	Brooklyn	Island Bay west	Newtown west	Newtown east	Hataitai	Seatoun	Miramar south	Wellington city
0 veh/hh	14%	15%	13%	34%	38%	14%	11%	20%	16%
1 veh/hh	45%	46%	46%	43%	39%	45%	37%	46%	45%
2 veh/hh	27%	26%	25%	13%	12%	28%	40%	24%	27%
>3 veh/hh	7%	8%	12%	5%	3%	8%	11%	8%	8%
Not specified	8%	5%	3%	6%	7%	5%	2%	2%	4%
Average veh/hh	1.3	1.29	1.38	0.88	0.8	1.32	1.52	1.19	1.27
2006 Census									
0 veh/hh	15%	11%	10%	24%	27%	11%	4%	13%	14%
1 evh/hh	47%	48%	45%	47%	42%	43%	35%	46%	45%
2 veh/hh	26%	29%	33%	18%	15%	32%	46%	29%	29%
>3 veh/hh	9%	8%	9%	5%	5%	1%	13%	9%	9%
Not specified	3%	3%	2%	6%	10%	4%	2%	4%	4%
Average veh/hh	1.31	1.35	1.42	1.04	0.98	1.27	1.68	1.35	1.34

Figure 4.3 Household car ownership in 18 Wellington suburbs (2006)



Those census area units closest to the Wellington CBD experienced a higher proportion of zero car ownership. Up to 40% of households within the Lambton, Mt Cook–Wallace and Newtown area units had no car available to the household. In stark contrast, those areas further out from the centres of employment and less well serviced by public transport displayed greater car ownership levels, with typically only 10% of households having no access to a vehicle.

Wellington is a particular example, with large variations in household car ownership across the city. It is recommended that a typical household parking (ie for residents and not including visitors) demand of around 1.5 to 1.8 cars per household should be adopted if no other information is available. As a planning rule this would normally result in an off-road parking standard of two car spaces per household.

4.4 Inner-city apartments

4.4.1 Trip generation

A week-long survey was undertaken in May 2000 by staff at Christchurch City Council. The purpose of the survey was to quantify the level of daily household vehicle trip generation from 27 multi-unit residential apartments. All the buildings included over 20 units and were located within the Christchurch central area (ie the area bounded by Christchurch's 'four avenues').

While the extent of survey reporting was less than anticipated, the response from postal interview survey forms returned gave a useful indication of trip generation rates.

Table 4.3 Christchurch inner-city apartment vehicle trip generation [ex-2001]

	Units surveyed	Daily trip generation vehicles/day (in + out)		
		Average	Maximum	85th %ile
One bedroom units	15	3.1	13	6.0
Two or more bedroom units	12	4.8	17	8.0
All units	**27**	**3.9**	**17**	**6.8**

To provide design and assessment guidance here, it was concluded that multi-unit, multi-storey residential dwellings within inner-city areas typically generated between 6.0 and 8.0 traffic movements per household per day. These lower levels of daily trip making might result from, for example:

- the relative proximity to CBD employment
- limited on-site parking availability
- the composition and small size of the households, which tended to be a couple with no children (so there was less ‘taxi-ing’ of children to other venues, etc).

Further information on inner-city apartment dwellings needs to be collected by both councils and consultants to further define the differences between standard detached dwelling-houses and multi-unit apartment developments in both the city centre and the suburbs.

4.4.2 Parking demand

Christchurch City Council also collected information on the relationship between the number of bedrooms in an apartment unit and the number of cars available to each unit. While the low response rate from the survey forms limited the value of the results, it is considered useful to show the general relationships developed.

Table 4.4 summarises the car availability for 27 individual units and the on-site parking demand.

Table 4.4 Christchurch inner-city apartment parking demand

Number of bedrooms	Units	Cars available to unit		
		0 cars	1 car	2 cars
1	15	1	12	2
2	9	-	7	2
3	3	-	1	2
Total units	**27**	**1**	**20**	**6**

The average car ownership and hence parking demand for these inner-city apartments was found to be approximately 1.2 vehicles per unit. No statistically significant relationships were developed in this survey between the car ownership levels and the number of bedrooms in each unit.

There was a greater range of family types and car ownership levels in central-city apartments compared with outer suburban residential single-unit dwellings. The combination of various socio-economic characteristics, student flats, retired and elderly occupants, varying partnership arrangements, with and without children, all led to widely varying vehicle use and associated parking demand and traffic generation. However, the range for trips or parking did not differ greatly from that for other residential suburbs.

There are few surveys of inner-city parking information in the TDB database. While not technically in the inner-city area, information from two inner city suburban surveys was investigated for this section of the report. A survey was undertaken by Christchurch City Council in the Riccarton area of Christchurch in May 1999. The survey gathered trip generation and parking demand information for a 21 unit apartment building. The parking demand is shown in table 4.5. Another survey was undertaken by Traffic Design Group in a high-density location in the Parnell area of Auckland in August 2003 which gathered trip generation and parking demand information. Together this parking demand information is summarised in table 4.5.

Table 4.5 Parking demand (inner suburban)

Area	Date surveyed	Number of residential units	Parking demand	
Christchurch (Riccarton)	May 1999	21	Average	1.23 spaces/flat
				0.31 spaces/room
			85%ile	1.51 spaces/flat
				0.38 spaces/room
Auckland (Parnell)	August 2003	18 (91 beds)	Average	1.89 spaces per unit
				0.37 spaces per bed

4.5 Transit-oriented developments

Transit-oriented developments (TOD) (or public transport oriented developments) have been advocated in many cities across the world.

Research and surveys in Philadelphia, Portland, San Francisco and Washington DC areas have generally confirmed these multi-land use residential/commercial TOD blocks have vehicle trip generation rates around 35% to 75% of the typical database trip rates. The most significant reductions were those adjacent to high-quality transit stations on the fringe of the city centre.

The travel characteristics and behaviour reflect TOD households that do not own a car, and two person households with a quality neighbourhood design and high transit ridership with transit service headways of 10 minutes. More detail is included in the Transit Cooperative Research Program (TCRP) (2007) *Report 128*.

In New Zealand, these unique characteristics only exist in Wellington and Auckland at a few selected locations.

5 Retail trips and parking

5.1 Background

There is a wide range of styles and sizes of retailing locations, each with different traffic and parking activity levels. Of the 500 or so records collected, 40% related to a variety of retail shopping centres and groups of local shops. Information on 90 shopping centres, ranging in size from under 1000m^2 GFA up to 20,000m^2 GFA, has been included. While each survey and site did not always yield the full complement of parking and traffic generation survey data, the number of survey sites available allowed a representative sample of these performance indicators to be obtained from a variety of locations and floor area sizes.

While shopping centres, supermarkets and local shops would be of most interest, survey information was also obtained for other specific retail activities.

5.2 Changing character of shopping centres

The traditional or suburban shopping precincts around New Zealand were based on the provision of kerbside parking along existing roads directly in front of a small to medium-sized retail units. This arrangement of shopping and traffic activity may be appropriate for those centres where most shops remain at that size. When larger stores such as supermarkets are established alongside the local shopping precinct, it is necessary to develop substantial off-street car parking areas at the rear of the strip-shopping area. This change in focus of both shopping and traffic has altered the overall patterns of activity within the town centre.

Shopping centre areas of different sizes offer a predictable range of shop types. The larger the centre, the wider the variety of retail, commercial and service functions available to the catchment area of the town or suburb. With a diverse mix of different land-use activities, the traffic and parking activities that derive from such land uses will also be diverse in both scale and timing. Where there is no single major retailer, such as a department store or discount supermarket, all retailers commonly share the parking resources and shared off-street private parking areas, and also those provided by the local authority.

The proximity of kerbside parking areas to the retail shops leads directly to an expectation by shoppers that they will be able to park their cars for short-term parking relatively close to each of their shopping locations with average durations typically between 10 and 20 minutes. The corresponding off-street retail shopper at major shopping centres parks for over 30 minutes and up to 1 or even 1½ hours if multi-destination shopping occurs at a large mall.

Traditional town centre shopping areas experience a range of vehicle and pedestrian journeys. In smaller towns and suburban areas, the proximity of retail areas to residential catchments means about 10% to 15% of shopping trips are made on foot or by bicycle. This limits the type of shopping undertaken, because of both the distance able to be walked and the limited carrying capacity of a pedestrian or cyclist.

Small to medium-sized towns and quieter suburban areas within large cities display the lowest visitor/shopper parking demands, about 3 to 4 spaces per 100m^2 GFA. Some small centres fronting busy arterial roads, however, have a 30th highest hour, or 85% satisfaction, design parking rate of 5 to 7 spaces per 100m² GFA. For the largest centres and supermarkets, the 30th highest hour is 4 to 6 spaces per 100m² GFA.

Medium-sized collections of shops of about 4000–6000m² GFA display trip generation (at design or 50th highest hour level) rates of 20vph (in + out) per 100m² GFA at midday or in the late afternoon. Very busy smaller shopping centres of, say, 3000m² can have trip generation rates of 25vph per 100m² GFA. With the larger centres, in excess of 9000m² there is a lesser rate of trip generation at 10–15vph per 100m² GFA.

Retail activities in the UK are compared with their equivalent New Zealand sites later in section 8.3 of this report.

5.3 Major suburban retail centres

From the mid-1970s, the development of supermarkets at suburban shopping centres gained momentum and began to change the concept of town and suburban centres. Suburban shopping centres brought together a range of retail and service facilities either under one roof or in the form of a ‘pedestrianised’ shopping street. Centres such as Northlands and Riccarton Malls in Christchurch and St Lukes and Pakuranga in Auckland began to develop integrated centres of over 15,000m² GFA or more during the 1970s and 1980s.

Today the largest shopping centres provide in excess of 30,000m² GFA and create fully air-conditioned environments where shoppers are encouraged to visit various retail outlets. The collection of such a wide variety of individual retailers and other services within a single site has the effect of increasing the average length of stay of customers, as well as the duration of vehicle parking in the associated parking lots. Furthermore, the largest centres such as Sylvia Park in Auckland take advantage of bus and rail public transport accessibility.

Data provided by the contributors to this research suggests the typical suburban shopping centres generate average design parking demands of five spaces per 100m² GFA, and average design traffic generation rates of 15vph (in + out) per 100m² GFA for floor areas of 10,000m². The range about these averages can be diverse, depending on catchments, exposure to passing traffic and promotion of the centre.

Figures 5.1 and 5.2 show the range of design (ie 50th highest hour or 85% demand) trip generation and parking demand rates. Both figures indicate the ‘economy of scale’ effects of a decreasing rate of trip generation with increasing floor area. The graphs of the 30th highest hours for both parking demand and trip generation show a reducing relationship with increasing floor area.

The degree of scatter appears to reduce with increasing floor area, but this may be due in part to the lower number of data points available for this research relating to floor areas over 10,000m² GFA. The variation in parking demand at around 15,000m² GFA is from 2 to 6 spaces per 100m² GFA. The variation in trip generation at these larger centres is from 7 to 14 trips per 100m² GFA.

Figure 5.1 Design (30th highest hour) average trip generation (sample of 27 shopping centres) [ex-2001]

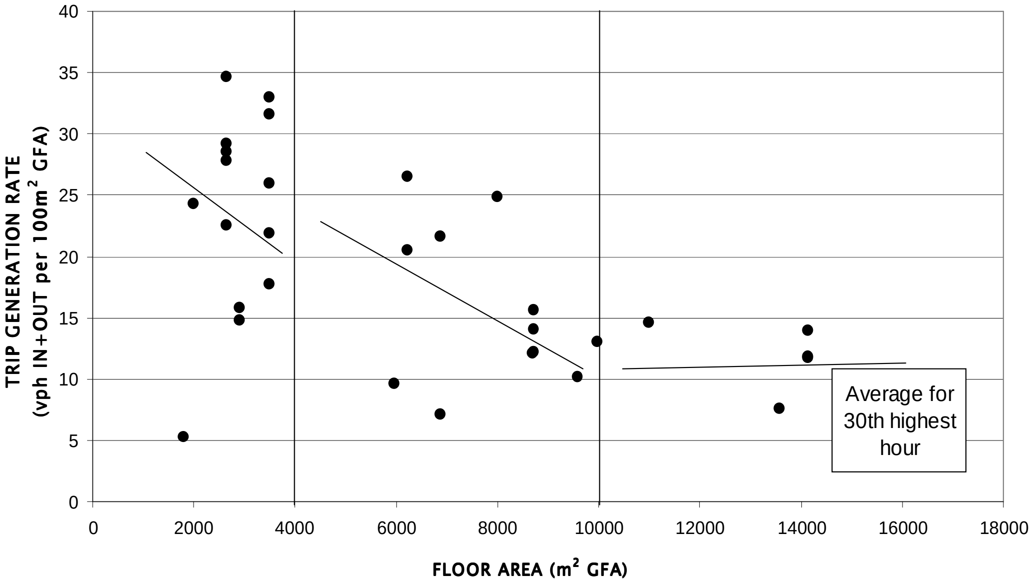
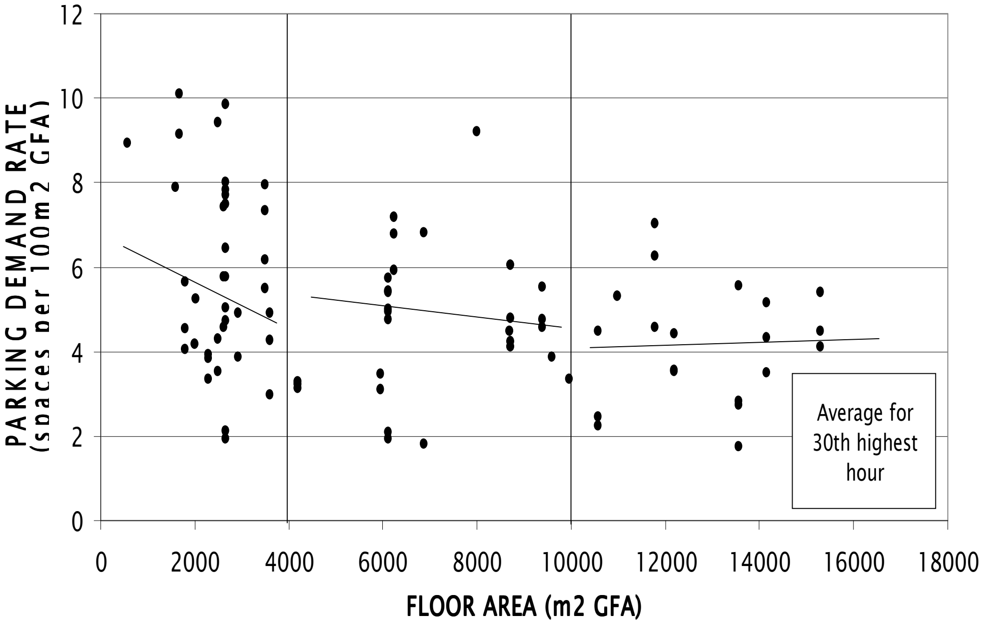


Figure 5.2 Design (30th highest hour) parking demand (sample of 76 shopping centres) [ex-2001]



Note: For figures 5.1 and 5.2, on the basis of the trip generation and parking demand figures, the shopping centres can be grouped conveniently in centres of the following sizes:

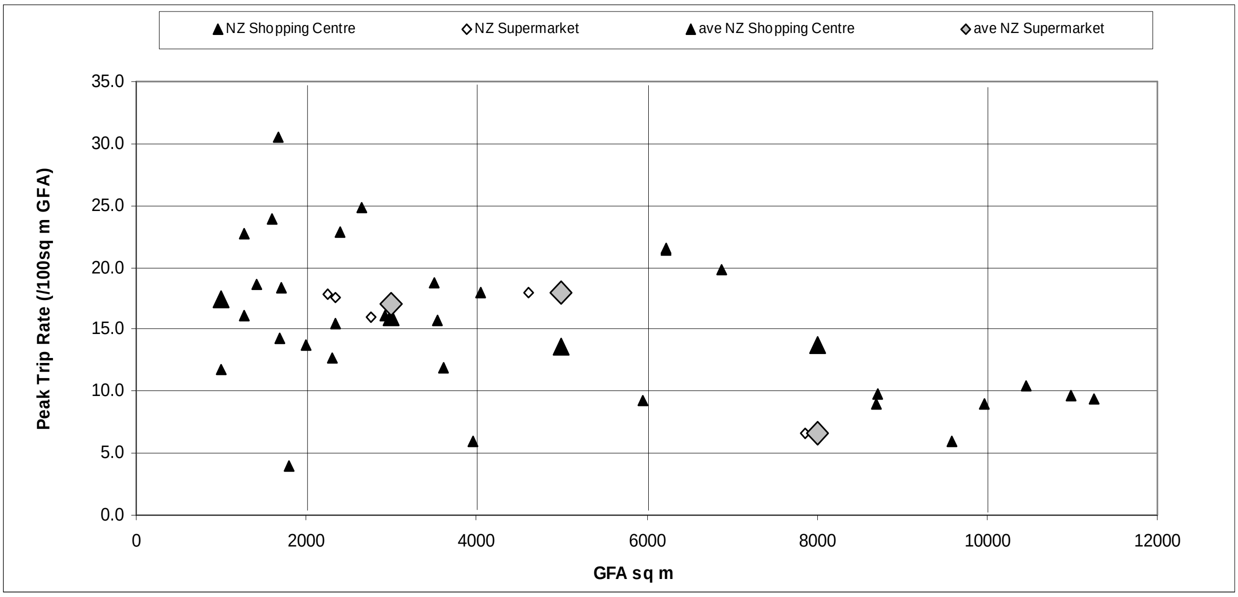
Small:	<4000m² GFA
Medium:	4001 – 10,000m² GFA
Large:	>10,001m² GFA

As already identified, the range of parking demand at individual sites varies greatly. For new developments of either a standard shopping centre or the large format retail centres, it is necessary first to establish a typical design standard figure for the particular site development. Due consideration can then be given to adjustments for the sharing of parking space, making allowance for possible changes over time.

5.4 Overview of New Zealand shopping centres

The New Zealand data in this section is extracted from Abley et al (2008). The shopping centre data and the supermarket data in figure 5.3 and table 5.1 show the relationship between these two types of retail activities for New Zealand. For trip generation purposes they fall into the same retail land-use category.

Figure 5.3 GFA v peak trip rates for New Zealand shopping centres and supermarkets



The sample size associated with free-standing New Zealand supermarkets was only five sites, three of which corresponded to the 2000–4000m² GFA range. Figure 5.3 shows large variance in trip rates associated with these retail activities. Table 5.1 shows a combined New Zealand supermarket and shopping centre dataset.

Table 5.1 Average trip rate for combined NZ retail dataset (supermarkets and shopping centres)

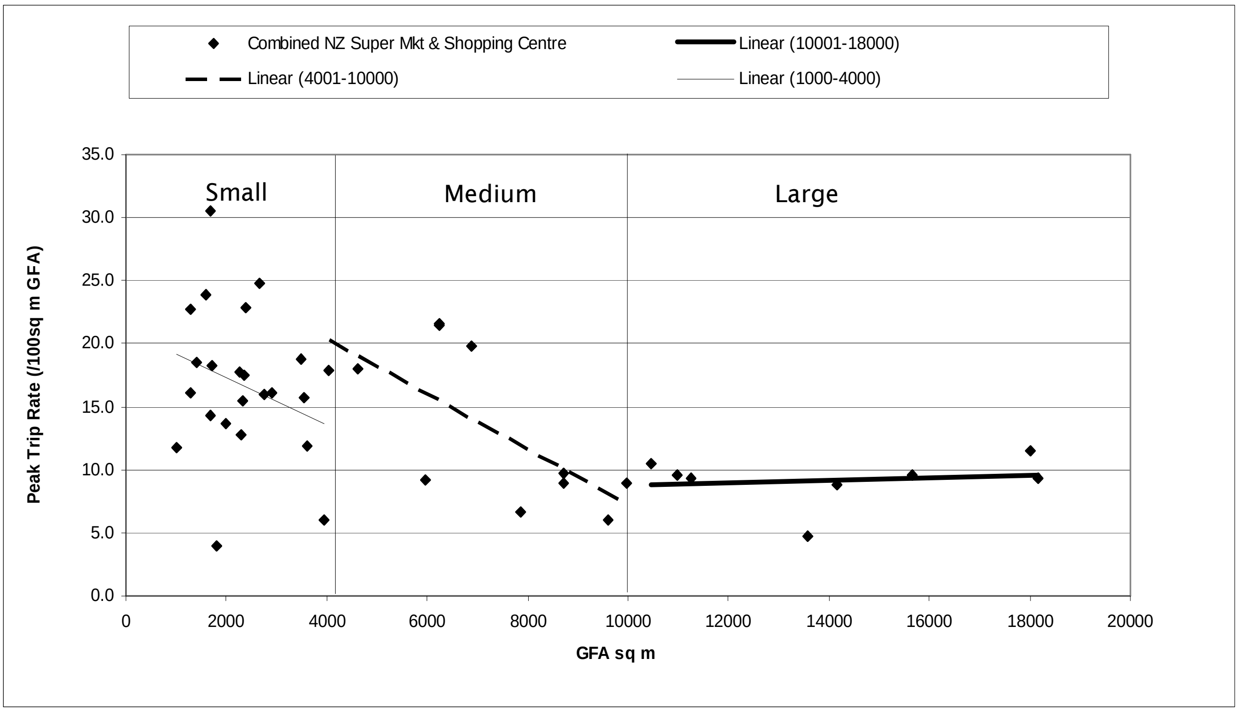
	Combined New Zealand supermarket and shopping centre		
GFA	**n**	**Ave**	**Sdev**
0–2000	9	17.40	7.32
2001–4000	13	16.30	4.38
4001–6000	3	15.04	4.35
6001–10,000	8	8.42	6.43

n = number of sites
Ave = average for sites surveyed
Sdev = standard deviation

The survey data used in the analysis has been screened to remove repeat surveys of particular sites and to ensure common explanatory variables are applied to each dataset.

Figure 5.4 shows the emergence of a pattern suggesting the relationship between peak trip rates and GFA takes the form of a negative exponential relationship.

Figure 5.4 Relationship between GFA and peak hour trip rates for all NZ retail



5.5 Large format retail

Large format centres provide a range of large warehouse and retail areas for the sale of bulky goods and home supplies. Typically, they have several major 'anchor' stores and other tenancies complementing them.

These large format retail centres have been shown by surveys, and other results to which the research team had access, to have a design parking demand rate of around 3 spaces per 100m² GFA to match the 50th highest hour. The lower parking demand rate was caused by the larger display and warehouse area occupied by these retailers, and by the pattern of customer visits to such centres. During promotion periods it was not unusual to observe a 30th highest hour parking demand of around 4.5 spaces per 100m² GFA,

The surveys reported in the database indicate large format retail centres of the form seen in Auckland and Porirua display trip generation rates of around 4vph (in + out) per 100m² GFA during the weekday late afternoon peak, rising to 6vph (in + out) per 100m² GFA during the midday peak on a Saturday. It is recommended that applying such rates to the planning and assessment of large format retail centres be tempered with a thorough review of the form and scale of the particular activities proposed. Where possible, the practitioner should undertake a component analysis of all retail activities within the site and then consider the overall economies that can be achieved by calculating a joint figure for the whole site.

The above rates for both parking demand and trip generation for large format retailing should be used for guidance only, pending more detailed analysis.

5.6 Trip generation – trip types

5.6.1 Pass-by and diverted trip types

The establishment of a new activity will attract trips from a variety of sources. Some of the trips will be completely new to the transport network, while others will be diverted from trips already being made on the network. Diverted trips are trips that, under normal circumstances would already be on the network, and may be considered as 'convenience-oriented' trips'. They can be split into two trip types: pass-by trips and link diverted trips.

The ITE (2008) defines a pass-by trip as '…trips [to a site, that] are made as intermediate stops on the way from an origin to a primary trip destination without a route diversion'. Whereas 'link diverted trips' are trips that normally use adjacent sections of the transport network around the site and change their route choice to 'divert' to the site.

The extent of diverted trips (pass-by and link diverted) varies by activity and is also dependent on the geographical location of the site and where it is in comparison to similar land-use activities. While the proportion of diverted trips may reduce the traffic generation effects of a new activity on the wider transport network, it does not change the number of trips that arrive 'at the gate' Therefore, it is important to derive the total external trip generation before applying any reduction that can be attributed to trips of a diverted nature.

5.6.2 Cross linkage trip types

Cross linkage trips are those where the vehicle occupant has more than one destination to visit, either within the development site boundary, or close to the site, accessed using the surrounding road infrastructure.

An example of this may include trips to food and non-food retail outlets within a development site, or between a new site and an adjacent, pre-existing retail site. Where it is likely there will be a high proportion of cross-linkage trips, it is common for the practitioner to count these trips on the network only once, thus avoiding double counting.

It is prudent to understand the nature of each individual development and the surrounding retail offer, as some of the trips within the development or to existing sites in the vicinity of development could be made on foot if there are good quality pedestrian facilities in place.

The potential for cross-linkage trips disappears if two potential destinations in a trip chain are dissected by infrastructural or natural barriers such as railway lines, motorways or rivers, all of which sever the logical route choice of people wishing to continue their onward trips to another destination. In this situation the next destination is effectively in a different traffic zone.

5.6.3 Internalised trip types

Internalised trips are where both the origin and destination are contained in the same area or model zone, for example a place of residence to a local store. These destinations can vary in terms of the purpose of the trip and are classed as internalised trips as long as they do not impact on the road network outside of a small, localised area. From a trip rate perspective, these trips require special attention as they are not distributed onto the wider network, but instead stay within the confines of the adjacent road network to access an amenity. Internalised or ‘intrazonal’ trips are therefore much shorter in distance and duration, but may still have a profound effect on the function of the internal or local suburban road network.

Caution should be exercised when applying factors reflecting internalised trips, as indicated by the *Transportation impact handbook* (FDOT 2010). The internalisation rates within this research are derived from studies where the developments are extremely large, ranging from 132ha to 6280ha, well beyond the scope of developments found in New Zealand.

The *Transportation impact handbook* (FDOT 2010) states trip internalisation can be dependent on a variety of factors the transport professional should bear in mind when considering a reduction factor as a result of internal trips. Practitioners should always take into account the proximity of other existing land uses that may compete with a development and therefore affect trip generation. Another important factor is the internalised road layout of a development. If a road layout is not conducive to internal movement, for example a circulatory layout, the trip rate should not be adjusted.

The *Transportation impact handbook* (FDOT 2010) also states trip rates should be calculated for each phase of a development, broken down by the three main types of trip function: pass-by/diverted trips, cross linkage trips and internalised trips.

5.7 On-site petrol filling stations at supermarkets

Another recent feature at supermarkets has been the introduction of petrol filling station (PFS) in the parking areas. It is appropriate to include information from the UK on their experience.

Figure 5.5 and table 5.4 demonstrate UK sites that include PFSs can be expected to generate higher trip rates per 100m^2 GFA. For UK sites with a PFS, trip rates at the entry/exit may be as much as five trips per 100m^2 GFA more than non-PFS sites and typically two trips per 100m^2 higher than the New Zealand sites. The figure also shows the difference in trip rates reduces as GFA increases and establishes that in future databases retail facilities with PFS should be considered as a different land use from retail facilities which do not have an associated PFS.

Figure 5.5 Comparison trips rates of UK retail sites, UK retail sites with a PFS and New Zealand retail sites

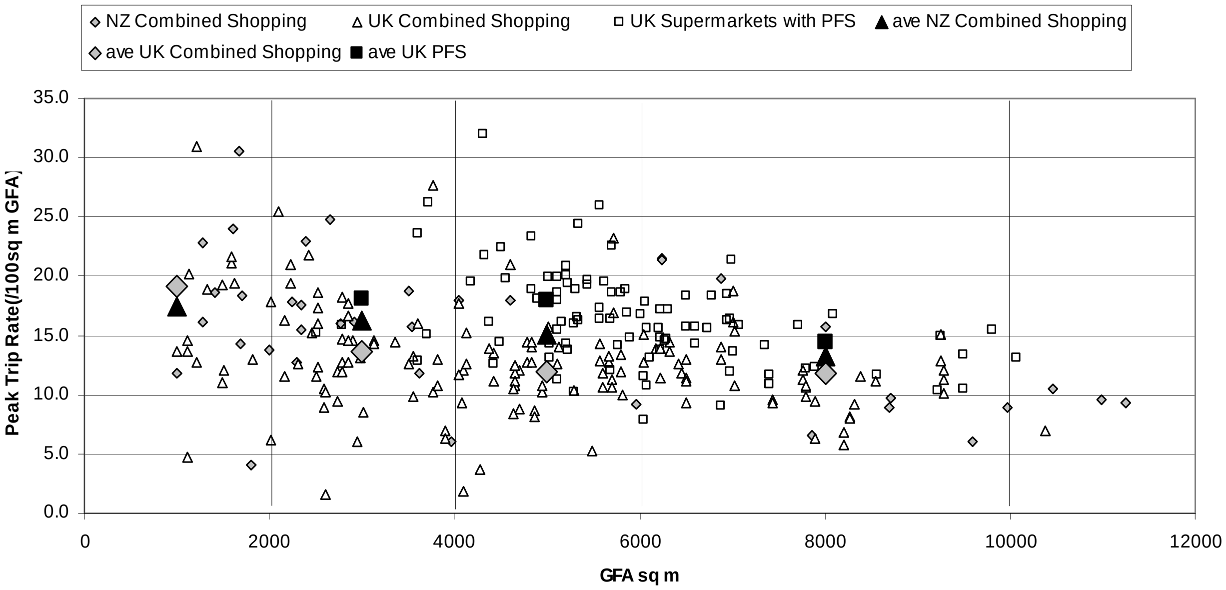


Table 5.2 Average trip rates for New Zealand retail sites, UK retail sites and UK outlets with a PFS

	New Zealand			UK			UK + PFS		
GFA (m²)	**n**	**Ave**	**Sdev**	**n**	**Ave**	**Sdev**	**n**	**Ave**	**Sdev**
1-2000	9	17.40	7.32	17	19.12	9.64	-	-	-
2001-4000	13	16.3	4.91	47	13.62	4.94	6	18.14	5.41
4001-6000	3	15.04	5.02	50	11.97	3.58	47	17.96	3.98
6001-10,000	8	13.19	6.43	43	11.75	2.78	40	14.37	2.83

n = number of sites
Ave = average for sites surveyed
Sdev = standard deviation

Table 5.2 is a summary of the sites surveyed in each of the floor area categories illustrated in figure 5.5. It includes the sample size and their corresponding average and standard deviation.

5.8 Effect of centre size on parking duration

An example of site-specific predictive models based on additional site data was illustrated by surveys in 1992 by the Waitakere City Council for a small fruit-and-vegetable outlet on a busy road, a local mall and a regional mall. Table 5.3 sets out the information collected at the three sites.

Table 5.3 Trips and parking information collected by Waitakere City Council [ex-2001]

Establishment	GLFA (m^2)	In-trip+ out-trip (veh/hr/100m^2)	Visit-duration (min)	Parked (#/100m^2)
Regional mall	32,740	10.4	60	5.2
Local mall	6230	21.7	30	5.4
Small fruit-and-veg	355	48.4	8	3.3

The data shows the greater the size of establishment, the fewer the trips per GFA and the higher the visit duration. This can be explained by more visitor shopping purposes being satisfied per trip. A link can be established between visit duration, trip generation rates and parking demand.

5.9 Central city parking supply

5.9.1 Background

Established city centres must work with the historical layout, property ownerships and heritage assets. While some of the larger satellite or suburban areas may be 5% to 10% of the size of the city centre in employment and car parking, none of these have the extent of floor area, variety of activities and scale of interaction between land uses present in a city centre.

As cities become larger and the central areas more diverse, there is an increasing need to consider the area as a whole and how best to determine the policies for parking and management of the car parking resource. This role can only be led and managed by the council on behalf of all the central city community. While the council may not manage all of the car parking spaces and will rely on private landowners to provide much of the parking resource, it is still the council that has to propose and oversee policies for parking space supply and management in the city centre.

Correctly locating shared car parking resources for both short- and long-term parking, is most important in the city centre. In addition, the city centre has the highest level of public transport use and may have considerable bicycle access, a high ratio of car passengers and a high level of pedestrian access compared with the typical suburban shopping area.

Parking provision is the one land use that directly links traffic accessibility and development. It is here where the vehicle trip has its origin or destination and the car drivers and passengers transfer from their vehicles to become pedestrians and bus passengers. The appropriate location of parking is also key to the successful functioning of all the activities in the central city.

An adequate supply of short-term parking at a competitive price is essential for the survival of any city centre in New Zealand. Sustainable modes can significantly reduce commuter parking numbers; however, the need for short-term parking for car driver/passenger shopping traffic still remains. The level of short-term parking in city centres varies from 45% to 55% of the total parking stock.

The creation of CBD public parking spaces has, over the past 40 years, involved major investment by local authorities. Parking spaces act as an adjunct to major developments. The provision of rental and free spaces, and the identification of long-stay and short-stay parking, must all be incorporated in the management of the parking resource.

Parking policies in district plans and council management policies generally try to match supply to realistic design demands. However, in some areas, particularly in congested parts of the city centre, placing a parking maximum on parking supply may be necessary to reduce accessibility in the interests of balanced flows on the network.

The planning authority can, by policy on land-use control, redress the imbalance in traffic flows where they would otherwise exceed road capacity. Limiting parking levels could be an effective means of managing traffic flows and congestion in an area. Additional provision in a complementary area may be needed to offset the first area's shortfall.

5.9.2 Comparison of parking in 11 city CBDs

It is appropriate to make a brief comparative assessment of city centre CBD parking supply and the broad characteristics for 11 New Zealand cities of varying size. This analysis was undertaken in 2001.

In preparing table 5.2, Quotable Value New Zealand (formerly Valuation New Zealand) records were used for the floor areas and census information from the Department of Statistics for the population and employee numbers. The car space numbers were derived from the councils' own reports and surveys.

The table summarises the general characteristics of each city centre as determined by city population, floor area and employment. The typical average floor area per employee is between 20m² and 35m². The parking rates have been recorded with the floor areas shown. The information is therefore indicative only, and more precise information for planning purposes would require more detailed analysis for each individual centre.

The table shows the rate of parking provision in the late 1990s had progressed to a similar level, in terms of street and short-term parking, for all cities. Cities that set out to encourage retail and commercial development had a higher short-term parking provision, as shown by the ratio of short-term street plus off-street parking to the retail plus commercial floor area.

The long-term parking provision is generally correlated to the total floor area and in turn to the total employment in the central city. There is, however, a wide range in the rate of supply of long-term parking, reflecting the physical and geographic character of the city and the balance between travel modes. The availability of peripheral spaces, both on-street and in off-street areas, to accommodate all-day employee parking also varies greatly between cities. Such overflow may, in some locations, be at the expense of nearby city centre residential convenience and amenity.

The short-term figure is for visitors/customers only and excludes commuter parking of a further 1 to 2 spaces per 100m².

Short-term parking related to retail plus office floor areas, a figure of about 2 spaces per 100m² GFA emerges. If related to CBD retail space alone, this parking ratio will be 2.5 to 3 spaces per 100m² GFA. The employee commuter parking adds a further 0.5 to 2 spaces per 100m² GFA depending on land-use group.

The ratio of parking to floor area is constant over a wide range of city centre sizes. Parking is directly related to turnover and economic activity. Thus, the parking will be related to turnover per square metre, which may not vary greatly from city to city. The provision of employee parking is not always adequate, and the overspill parking can be seen spreading outward to the edge of CBD streets and into the inner suburbs as a result.

To ensure all users have access to central parking, Manukau City District Plan states:

> *The owner or occupier of a site shall not unreasonably allocate or manage the parking spaces so as to prevent staff, fleet-vehicles, visitors, or particular occupiers associated with that site from utilising this parking.*

The results shown in table 5.2 are indicative and are subject to the limitations of the surveys and statistics available.

Table 5.2 City-centre parking supply [ex-2001]

City centre	**Christchurch**	**Dunedin**	**Hamilton**	**Hutt City**	**Tauranga**	**Palmerston North**	**New Plymouth**	**Rotorua**	**Porirua**	**Wanganui**	**Taupo**
District population	319,000	119,000	118,000	98,000	87,000	75,000	69,000	65,000	46,000	45,000	34,000
Survey date	1999	1995	1998	Mid 1992	1997	1994	1994	1991	1997	1995	1997
Area of CBD + periphery (km)	1.5 x 1.5	1.7 x 0.6	2.0 x 0.7	0.8 x 0.2	1.5 x 0.4	1.6 x 2.0	1.8 x 0.5	1.1 x 0.9	1.0 x 0.4	1.0 x 1.5	0.7 x 0.5
Floor areas (000m²) GFA)											
Commercial retail	300	213	181	117	74	215	179	125	120	220	92
Commercial office	400	127	222	120	101	95	138	83	46	130	10
Industrial & other	900	100	124	44	93	60	117	2	506	30	23
Total floor area	1600(7)	430(1)	527(8)	281(2)	268(3)	370	434	210(4)	216(6)	380(5)	125
Residents(10)	9000	4000	1560	150	1,800	500	3600	2000	0	500	1600
Employment											
Retail/wholesale	14,800	7156	7430	4396	4465	6405	4653	4143	2284	2672	2764
Commercial & admin.	17,900	16,018(1)	15,800	7999	6732	8301	5730	7325	3129(6)	3,670	2,295
Industrial & other	5,000	4074	1270	1344	1604	2231	1956	818	882(6)	1530	776
Total employment	37,700	27,248	24,500	14,739(2)	12,801(3)	16,937	12,339	12,286(4)	6295(6)	7872(5)	5835
Car drivers trip to work %	61.2%	58.0%	59.5%	56.8%	63.2%	57.6%	59.9%	62.3%	54.3%	59.2%	60.6%
Parking supply											
Street	10,000	4,172	2,776	2,730	2,153	3,385	2,070	3,276	600	2,815	1,569
Off street	23,955	8,583	14,136	1,614	3,466	8,306	7,190	2,750	3,100	4,504	1,722
Total survey	34,000	12,755	16,912	4,344	5,618	11,691	9,260	6,026	3,700	7,315	3,291
Parking distribution											
Short term (11)	15,000	6506	5027	2438	2881	4618	4800	2436	2100	4106	2161
Long term (11)	19,000	6,249	11,885	1,906	2,737	7,703	4200	3590	1600	3209	1130(9)
Total survey	34,000	12,755	16,912	4344	5618	11,691	9000	6026	3700	7315	3291
Parking rates											
Short-term cars/100m² GFA (Retail + commercial)	2.14	1.91	1.25	1.02	1.64	1.48	1.51	1.17	1.26	1.17	2.12
Total (ST + LT) cars/ 100m² Total floor area	2.13	2.96	3.20	1.54	2.09	3.15	2.07	2.86	1.71	1.93	2.63

1. Hamilton: off-street parking includes surrounding industrial areas (assumed as 24,000m²) and Hamilton Polytech area.
2. Taupo: some of long-term parking in adjacent streets omitted.
3. Residents, including residences, flats and commercial hotel/motel accommodation, estimated population based on 50m²/residential floor area/person.
4. Parking short term is up to two hours. Long term is not subject to time control but does include all-day leased spaces.
5. The parking supply and distribution figures are based on the surveyed spaces supplied for parking. It has not been possible to collect peak or design parking demand figures. It is noted, however the street parking and short-term parking areas will as a rule be occupied on all peak days of the year. The off-street and long-term spaces will be subject to greater variation.
6. Hamilton: off-street parking includes surrounding industrial areas (assumed as 24,000m²) and Hamilton Polytech area.
7. Dunedin: includes hospital and employment area and floor area extends outside parking on north, west & south – Foreshore Industrial area is excluded.
8. Hutt: covers wider area than CBD parking area surveyed.
9. Tauranga: includes Cameron Road employment area.
10. Rotorua: area excludes hospital and Government Gardens.
11. Wanganui: excludes top of Victoria Avenue – Cooks Gardens unit only.
12. Porirua: hospital and Elsdon industry excluded.
13. Christchurch: whole of area inside the Four Avenues, including inner industry and housing.

5.10 Retail before and after studies

Retail land uses and their trips and parking represent the most significant nodes of trip making and parking provision in the whole urban fabric. These centres have also attracted the largest number of traffic and parking surveys with extensive results held in databases in New Zealand and elsewhere.

Once the centres are established there is, at present, little effort made to check their traffic performance by way of monitoring ‘after studies’. The absence of any monitoring of trips and parking after completion of the development, which would compare the real-life situation with the estimates at the time of applying for planning permission, is a major gap in the validation and further development of travel databases.

6 Changes in selected uses

6.1 Basic factors of change

Since the 1971–73 surveys reported in *RRU bulletin 15* (Douglass 1973), there have been some dramatic changes in New Zealand's major urban areas and in transport habits. Report 209 recorded the significant changes, and research analysis detailed in this current report has confirmed the continuation of these trends.

The document *Christchurch city centre – 40 years of change', traffic planning 1959–1999* (Douglass 2000) reported the following changes in Christchurch from 1970 to 1996:

- population increased by 20%
- registered vehicles increased by 2.3 times
- average number of vehicles parked at households increased from 1.1 to 1.4
- total vehicle trips increased by 2.2 times
- car drivers' proportion of all travel modes increased from 43% to 61%
- professional and administration employment increased by 75%
- retail employment increased by 40%
- industrial employment increased by only 5%
- car trips per household increased by 66%
- bus passenger numbers decreased by 60% (ie from 10% to 4% of all modes)
- motor cycle trips decreased from 3% to 1% of all modes
- bicycle use decreased from 13% to 3% of all modes
- walking decreased from 8% to 3% of all modes.

While these figures relate specifically to Christchurch, similar figures would probably be recorded for most other cities in New Zealand, with the trends being even greater in Auckland.

The Greater Christchurch Metro Strategy 2010–2016 (Christchurch City Council 2007) shows bus patronage has continued to rise steadily since a trough in 1992. Patronage doubled between 1996 and 2010; however, this was still only half of the 1970 percentage mode split and has remained at a lower daily total than earlier 1970s travel numbers.

All these factors lead to the conclusion that there continues to be a major increase in vehicle trip generation related to all land uses. In reality, the major urban areas have grown and the shopping centres and industries within them have become dispersed and larger, to the extent that, at the individual site level (with one or two exceptions), the trip generation and parking demand rates (related to floor area and employment figures) are still at levels similar to those presented in *RRU bulletin 15* (Douglass 1973) and Report 209. However, some of the industrial locations, which in 1970 were relatively quiet from a traffic generation viewpoint, have now been converted to warehouse retailing and other visitor-attracting uses and this may bring many more visitors to their front door. Furthermore, residential areas are producing approximately 66% more trips for the same number of households.

It appears market competition and real estate decisions have seen equal or even better vehicle accessibility created for a range of new establishments. Overall, what was the single dominant town centre is now complemented by a range of supermarkets, larger shopping centres and other retailing and commercial attractions in the suburbs, ie the cities are becoming multi-nodal in character. This disperses the traffic more evenly between more sites and spreads it throughout the urban area and road network. The traffic generation rates at individual sites have remained relatively constant over time, but there are now more sites scattered throughout the urban area increasing vehicle kilometres travelled. At the same time, the extension of evening and weekend business has reduced the previously significant Friday peak.

6.2 Trip and parking databases

The quality of trip and parking databases is improving all the time. This is led by the UK data services of TRICS. The ITE has a very extensive summary system but, unlike TRICS and TDB, it is grouped and not left at individual site levels. These databases are described in more detail in chapter 10. They are essential tools that describe trip rates, parking demand and (increasingly) the mode split of arrivals at different land uses.

The land uses in the TDB database are in nine major activity groups with between 2 and 12 subgroups in each, as set out in appendix A. The definitions give 46 two-key-word groups. Some of the results from the database are summarised in appendix C, grouped according to land use and, where appropriate for retail and other visitor uses, adjusted for seasonal, weekly and hourly factors to the 50th highest hour or 85% satisfaction. The 15% and 50% rates are also included.

The surveys in the TDB database have all been undertaken since 1990. The results are compared with those from the 1970s and are discussed in chapter 7. The following sections 6.3 to 6.8 identify a selection of land uses including recreation, education, medical and churches and include more detailed discussion.

6.3 Places of entertainment and assembly

The earlier provision was generally 1 parking space per 10 seats (there are typically 10 to 20 seats per 100m^2 GFA). Figures derived from recent surveys of cinemas and theatres show 2.5 to 4 car-parks per 10 seats (ie 5 to 8 spaces per 100m^2). There are now many more cinemas available to the public and, in multiplex cinemas, up to eight screens at any single site. Overall, however, the cinemas have shrunk in size from 1000 seats per screen to 400 or 200 seats and even smaller. This better reflects the current demand and gives rise to higher car driver/car passenger attendance than in the past. On the other hand, with more venues available, the average occupancy has dropped. Museums, galleries, libraries, recreation, health and fitness gymnasiums and indoor sports courts have also entered the list of uses to be considered. From surveys, the parking demand at museums, galleries and libraries seldom exceeds 2 spaces per 100m^2 GFA. On the other hand, gymnasiums and sports court activities have been surveyed at 5 spaces per 100m^2 GFA. This depends, however, on whether the sports hall provides major seating accommodation for events, such as indoor basketball. If so, it may be appropriate to do two calculations, one based on general use by participants and spectators, and the second on the seating area as a place of assembly.

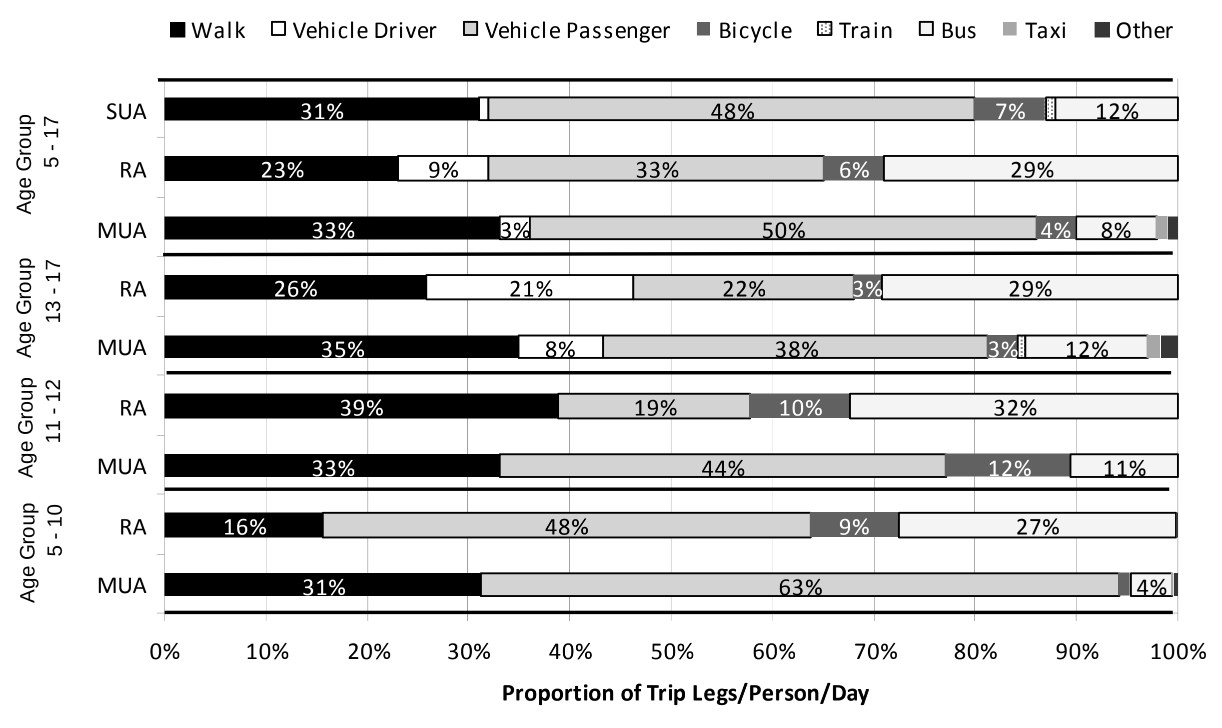
More surveys are warranted for this group of activities.

6.4 Pre-schools, primary and secondary schools

6.4.1 Travel by 5 to 17 year olds

Figure 6.1 shows the trips made by 5 to 17 year olds, as reported in Abley et al (2008), and illustrates the proportion of trips by mode per day for each age group and catchment area. In this chart, MUA includes major urban areas, SUA includes secondary urban areas and RA includes rural areas. The differences in mode split vary with each geographic area and in each age group. In the 11 to 17 age group, vehicle passengers and drivers vary between 44% and 53%. Bicycle use at 10% is highest in the 10 to 12 year old group. Obviously, for the preschool and younger 5 to 10 year group, travel as passengers is highest at 63%. Bus use is highest in the rural areas at 27% to 32%; in the urban areas bus use is lower at 8% to 12%. A small proportion of student travel is undertaken by 'other' modes which include skateboards, scooters and taxis.

Figure 6.1 Proportion of trip legs/person/day for 5 to 17 year olds



The data in figure 6.1 can be used as a guide to assist school travel planners identify age groups within certain locations that can benefit the most from school travel plan initiatives.

6.4.2 Preschools

Childcare centres are increasingly part of community life and smaller units in residential areas are common. The TDB database includes six surveyed sites where between 20 and 29 children attended the centres. In addition comparisons are made with equivalent UK preschools in section 8.3.5.4 of this report.

Maximum on-site parking varies between three and nine spaces with an average of four spaces. The area of the buildings ranges from 140m² to 220m².

The trip generation rates at morning and afternoon peak periods are similar, 0.6 to 1.5 vehicles per hour per enrolled child and 3.5 to 7.6 vehicles per hour per employee. The average figure is 1vph per child and 5.3 vehicles per employee.

The parking demand varies. For the smaller centres of up to 40 children (16 sites), the lowest number of off-street parking spaces is 4 and the highest is 8, representing between 1.2 and 3.2 car spaces per 100m². This is equivalent to 0.16 spaces per pupil or 1.6 spaces per 10 pupils. As there are typically six employees at each of these childcare centres, it is apparent that there is a lot of set-down ride-sharing for visiting parents.

The area for set-down, either on-site or kerbside, varies greatly. A layby set-down area of three to four carparks is commonly provided.

Table 6.1 Preschool traffic activity (taken from TDB database)

Measure	**1990s**		**2000s**	
Peak hour trip rate	**am**	**pm**	**am**	**pm**
vph (in + out) per 100m² GFA	18.9	16.9	16.3	13.2
vph (in + out) per pupil	1.10	1.12	1.01	0.82
Peak parking demand				
Spaces per 100m² GFA	3.16		4.18	
Spaces per employee	0.97		1.57	
Spaces per pupil	0.17		0.25	

6.4.3 Primary schools

All educational institutions at primary, secondary and tertiary levels now have a significantly higher vehicle arrival rate for both staff and students. The most dramatic change has occurred in the primary school pupil's mode of arrival, as car passengers for the trip between home and school. Unfortunately, the TDB database includes few primary schools, but intensive survey at one yielded useful information.

Typical mode distribution in the 1970s and 2000s for a school in south Christchurch is shown in table 6.2.

Table 6.2 Primary school travel mode

Travel mode	**1970s**	**2000s**
Car passenger	10%	50%
Walk	40%	34%
Bus	5%	1%
Bicycle	50%	15%
Total	**100%**	**100%**

This major mode shift from bicycle to car passenger has greatly affected the arrival patterns and the need for set-down space and school road patrols to control vehicle movements near the school. The near or short home-to-school trips tend to remain pedestrian, while the distant trips within the catchment, which used to be predominantly by bicycle, are now as car passengers, adding to vehicle travel. This has been exacerbated since some New Zealand schools were 'dezoned'.

It would appear there is a strong desire among today's parents to take their children to school by car, even within the local primary school catchment, despite the wider system costs and parental obligations of providing this transport service every day.

A comparison of primary schools was done to investigate the differences in modal split between geographic locations. As shown in table 6.3, the majority of trips for a typical suburban primary school (Christchurch) are done by car at 68% with 21% arriving on foot, 9% by bicycle and 1% by bus. The same holds true for a typical primary school in a mixed rural-urban setting (Wanaka) where the majority of the trips are made by car at 73%. However, there is a significantly lower percentage of trips being made by foot at only 5%, and 18% by bus. For a typical provincial city primary school (Timaru), the majority of trips arrive by foot at 62% with only 34% arriving by car, 4% by bicycle and 4% by bus.

Table 6.3 Primary school arrival travel mode – trips (percentage)

	Total legs	Walk	Driver[(a)]	Passenger	Bicycle	Bus	Other
Christchurch suburb	2120	450 (21%)	850 (40%)	600 (28%)	180 (9%)	20 (1%)	20 (1%)
Wanaka rural	470	24 (5%)	140 (30%)	200 (43%)	20 (4%)	86 (18%)	0 (0%)
Timaru city	451	279 (62%)	60 (13%)	93 (21%)	19 (4%)	0 (0%)	0 (0%)

a Drivers are parents and others escorting the children to school

There has also been a shift in teacher and staff use of cars. Surveys now show up to 90% of staff arrivals as car drivers, with a corresponding need for off-street staff and visitor parking at the rate of about one space per staff member.

The arrival and departure trip and parking rates have increased correspondingly, as shown in table 6.4.

Table 6.4 Primary school staff trips and parking activity

Measure	1990s		2000s	
Peak hour trip rate	**am**	**pm**	**am**	**pm**
vph (in + out) per employee	12.62	11.05	8.86	5.08
vph (in + out) per pupil	0.68	0.63	0.62	0.52
Peak parking demand				
spaces per 100m² GFA	6.24		9.69	
spaces per employee	4.19		1.89	
spaces per pupil	0.30		0.14	

It is noteworthy these trips are not spread over a whole hour but all occur within the half-hour periods 8.20am to 8.50am and 3pm to 3.30pm. The pupil/car occupancy rate is typically 1.2 pupils per car in the morning and 1.4 pupils per car in the afternoon.

For a primary school of, say, 300 pupils and 12 classrooms (typically 600m^2) there will be a need for 20 parking spaces on-site for staff and site visitors. There will also be a need for 'set-down' space (either on-site or at the street kerbside) for 60 cars at the morning arrival and afternoon departure times. The section of street serving the school will be subject to a peak morning and mid-afternoon traffic generation of 180vph (two-way).

These are significant changes in the effects of the land use, and few sites have sufficient area to handle such peak flows and parking needs off-street. Where schools are located on minor streets this situation may be acceptable, but where they front arterial roads sometimes the situation is intolerable and corrective action to provide off-street parking and set-down areas may be necessary.

6.4.4 Secondary schools

Secondary schools reflect many of the same characteristics as primary schools in trip generation, parking and set-down patterns. The six secondary schools in the TDB database have not been fully site surveyed but some information can be obtained from the data.

Parking areas are not provided for students at secondary schools and, in the absence of off-site parking surveys, it is not possible to make a full appraisal. However, for these schools, which all have rolls of more than 950 students, the on-site parking provided varies between 70 and 210 spaces. This parking is primarily for full-time equivalent (FTE) staff, who number between 110 and 150. Part-time staff and supporting administrative staff may bring a further parking demand above that calculated, which is based on FTE staff alone.

Generally, if on-site (ie off-street) parking is provided at the rate of one space per staff member, it will yield sufficient for staff and official school visitor demand during the day. Some secondary schools now have halls or gymnasiums which are available for community use. This may not be able to take advantage of on-site parking, however, and will require surrounding on-street parking to satisfy demand.

From these surveys an average figure of only 2.4 car-parks per 100m² emerges, which is equivalent to 0.07 car-parks per pupil.

Trip rates of arrivals and departures for dropping off and picking up students were measured at three sites. Morning and afternoon peak hour trips were similar, with arrivals being similar to departures within the hour. Surveys yielded peak-hour trip rates (in + out) of between 100 and 420vph. These translate to 10 trips per peak hour per 100m² GFA, ie equivalent to 0.2 trips per student per peak hour. These low rates may be due largely to the omission from the surveys of adjoining street set-down and parking areas.

Further detailed study of this secondary school land use is needed, in particular the set-down and pick-up rates and the off-site street parking by students. Some questionnaire mode of arrival information would be of great assistance.

A more recent survey undertaken for a typical suburban secondary school had significantly higher trips with 420 trips per morning peak hour and 140 per afternoon peak hour. It should be noted 40% of trips were made by foot, 27% by bus, 2% by bicycle and 27% by car.

The following two examples, tables 6.5 and 6.6, show how information such as trip generation by travel mode and vehicle kilometres travelled can be estimated using the NZHTS data for a chosen school. The examples are based on the assumption the same mode of travel is used for both the arrival and departure trip legs. It is acknowledged these assumptions represent simplified scenarios and there may be a different mode balance of travel when returning from school. For instance the number of pupils leaving school per car is typically higher (1.4 per car in pm) compared with the morning arrival (1.2 pupils per car). However, for the information available, variations in school sizes do not appear to result in marked changes in the modal split. The soon to be published NZTA research report ‘Travel profiling part B’ includes an expansion of this methodology and interactive model.

Table 6.5 Example application – high school in rural area

School type	High school
Area type	Rural area
Approx. enrolment age	13–17 years old
Enrolment size	400 students

Students by mode of travel

	Walk & Bicycle (29%)	Public Transport (29%)	Vehicle Passenger (22%)	Vehicle Driver (21%)
No. Students by mode	116	116	88	84

School trips undertaken by private motor vehicles

Passenger vehicle trips/day = 182

Student driver vehicle trips/day = 267

Staff trip legs (two-way)/day = 40

Service vehicle trips/day = 4

Total daily vehicle trips/day = 493 vehicle trips

Peak-hour private motor vehicle trips

am peak hour (8am to 9am) = 212 vehicle trips

pm peak (3pm to 4pm) = 123 vehicle trips

Travel by private motor vehicle kilometres per day

Travel distance by vehicle/day = 2677 vehicle kilometres travelled

Abley Transportation Consultants (2009)

Table 6.6 Example application – high school in major urban area

School type	High school
Area type	Major urban area
Approx. enrolment age	13–17 years old
Enrolment size	400 students

Students by mode of travel

	Walk & Bicycle (38%)	Public Transport (14%)	Vehicle Passenger (38%)	Vehicle Driver (8%)
No. Students by mode	152	56	152	32

School trips undertaken by private motor vehicles

Passenger vehicle trips/day = 253

Student driver vehicle trips/day = 72

Staff vehicle trips (two-way)/day = 40

Service vehicle trips/day = 3

Total daily vehicle trips/day = 368 vehicle trips

Peak-hour private motor vehicle trips

am peak hour (8am to 9am) = 158 vehicle trips

pm peak (3pm to 4pm) = 92 vehicle trips

Travel by private motor vehicle kilometres per day

Travel distance by vehicle/day = 1413 vehicle kilometres travelled

Abley Transportation Consultants (2009)

6.5 Tertiary institutions

Since the 1970s tertiary educational institutions have altered dramatically, with a much larger number of students attending for different periods throughout the day. Generally, the traffic generation and consequent parking demand at these institutions have increased significantly. The equivalent full-time student (EFTS) is probably an appropriate tool for assessing car parking demand. However, this figure itself will fluctuate in the years ahead, regardless of the floor area of the institution involved. It follows that a ratio per GFA should still be applied to check the density of occupation of the site and also it may vary for different private and public tertiary institutions. With the exception of the University of Canterbury it has not been possible to obtain the GFA figures for the following sections, which rely on student numbers.

6.5.1 University and polytechnic parking

This section looks at the parking demand for four universities and two polytechnics. These reflect a wide range of situations, including inner-city, suburban and broadfield locations.

Table 6.7 Car parking at universities and polytechnics (2000)

	No. of students (FTEs)[a]	No. of staff, teaching and general	No. of car parks for staff and students		No. of car parks per staff and student	
			Staff	**Student**	**Staff**	**Student**
A. Institutions meeting demand on site						
Canterbury	11,900	1540	661	3000[d][e]	0.43	0.25
Lincoln	4,000	726	120[b]	1722	0.17[b]	0.43
Waikato	12,000	1628	864	1486	0.53	0.12[f]
B. Institutions with restricted supply[c]						
Otago[g]	14,500	3950	1094	(1500)[e][f]	0.27	0
Chch Polytech (now)	11,000	709	264	554	0.38	0.05
Carrington (now)	5500	600	200	1650	0.33	0.30

a Where part-timers are included, their number is reduced by a factor of ½ of that assumed for EFTS. Otago has 5000 and Christchurch Polytechnic 10,600 part-timers.

b Lincoln staff are present over a wide variety of times and the 120 spaces are reserved. Staff also park in the general student car park. Staff parking is therefore more than the 120 shown.

c The tertiary institutions in group B with restricted on-site parking supply may also have parking charges varying from $200 to $700 pa (depending on circumstances) for staff and $33 to $200 for students.

d At Canterbury, the surveys show about 20% or 600 additional student cars are being parked in adjacent residential streets. The on-site parking provided for students is 2380 spaces.

e Universities also provide cycle stands (eg Otago 334, Canterbury 1500).

f Waikato, Otago and Canterbury may be lower because of the extent of student hostels on campus.

g Otago is unique because it is largely a residential university with the cars of these students being parked at the boarding colleges and flats in the nearby north Dunedin streets. However, it is accepted that some additional off-street spaces will be required and the table includes (1500) spaces assumed as off-street parking adjacent to the university in the future. This assumes a simple rate of 1 car park per 10 students.

Note: All sites have some reliance on off-site street parking for both convenience and overflow. Group A institutions do not rely on street parking at this stage, but those in Group B expect students to find parking off-site.

The parking demand and supply situation for these major institutions is a mix of matching staff needs and where possible meeting student needs on site. Table 6.7 sets out the situation for the six institutions surveyed in 2000.

Staff parking is the first priority and the site supply is 0.53 to 0.27 car parks per member, equivalent to about 0.2–0.35 spaces per 100m².

Student parking in group A, which has unrestrained and available on-site parking, shows a ratio varying from 0.12 to 0.43 car parks per student. For the Canterbury campus, where the on-site figure is 5.0 students per car park (ie 0.20 car parks per student), the surrounding street parking for students has been included to yield the total demand of 4.0 students per car-park spaces (ie 0.25 car parks per student). The Canterbury demand rate (where the total floor area is 230,000m²) for staff and students combined is equivalent to 1.6 car parks per 100m² GFA. On-site supply there is 1.3 car parks per 100m² GFA.

The parking needs for the group B institutions (those within CBDs) cannot be met on-site. The few spaces available are in high demand and parking is charged to both staff and students permitted to park on site.

Shared parking with adjacent council or private parking buildings may need to be considered in the future to supply space to meet the demand at these sites.

6.5.2 University of Canterbury parking

The University of Canterbury has undertaken extensive surveys both in house and through consultants. This section provides a comprehensive summary of the parking, trips, travel modes and daily travel associated with this extensive campus with its 20,000 students.

Some University of Canterbury car parking occurs on the streets surrounding the university. Table 6.8 compares the change in staff and student numbers with the number of car parking spaces available on campus and the on-street demand for parking by staff and students from 2000 to 2008. Note that in 2007, the Christchurch College of Education merged with the University of Canterbury and the figures in table 5.6 reflect this change.

In general, the quantum of on-street parking used around the university has been steadily increasing while on-campus parking has been decreasing. Generally the university has provided a campus car parking ratio of 0.19 per staff/student. This increases to approximately 0.24 spaces per staff/student if on-street parking demand is included.

Table 6.8 University of Canterbury car parking (2000–2008)

		2000	2004	2008
Population[(a)]	Staff (teaching and general)	1540	1588	1874
	Students (EFT Students)	11,900	12,951	14,860
Gross floor area[(a)]			203,997	245,453
No. of car parks[(b)]	Staff	661	776	933
	Students	2380	1325	1319
	Unallocated/other	-	640	941
	Total on campus spaces	3041	2741	3193
	On-street	620	770	849
Car parking ratio[(c)]	Staff	0.43	0.49	0.50
	Students	0.25	0.21	0.21
	Overall (excl. on-street demand)	0.23	0.19	0.19
	Overall (incl. on-street demand)	0.27	0.24	0.24

a University of Canterbury Data Handbook 2008 for 2004 and 2008 data, Report 209 for 2000 data

b 2000 car park numbers from Report 2009, 2004 and 2008 numbers from parking survey. On-street parking demand estimated from on-street surveys and motorist survey responses (66% of responses parked on street on university business)

c Unallocated/other and on-street parking assumed to be used by students

6.5.3 University of Canterbury modes of arrival

The Canterbury University information is derived from historic surveys undertaken by the Civil Engineering Department since 1966 (University of Canterbury 1966–2008). The most recent surveys were undertaken for the university by consultants in 2008 and these results are included in the tables that follow.

Information was made available on travel surveys of staff and students since 1966 for the University of Canterbury. The mode split results from the 1971, 1993, 2000, 2004, 2008 surveys are summarised in table 6.9. Car ownership rates were collected until 2000 and are shown in table 6.10.

Table 6.9 University of Canterbury mode split (1971–2008)

	1971		1993		2000		2004		2008	
	Staff	**Students**	**Staff**	**Students**	**Staff**	**Students**	**Staff**	**Students**	**Staff**	**Students**
Car driver	56	27	58	33	63	41	65	39	61	32
Car	4	4	5	5	4	4	4	4	5	4
Motorbike	6	18	2	4	1	1	0	1	1	2
Bus	11	10	1	2	2	5	4	11	6	13
Bicycle	16	28	23	38	18	15	16	12	17	20
Walk	7	13	11	18	13	33	11	33	9	28
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 6.10 University of Canterbury car ownership rates (1971, 1993 and 2000)

		Car ownership rate		
		1971	**1993**	**2000**
Staff	Male	90%	90%	95%
	Female	53%	90%	95%
Students	Male	45%	65%	70%
	Female	15%	65%	70%

As in the rest of the community, the mode split has shifted more to car drivers over the period, with over 60% of staff and 30% to 40% of students arriving as car drivers with a peak in car driving between 2000 and 2004.

Car ownership has risen to over 90% for staff and 70% for students. On wet days the majority of these car drivers seek a parking space in the university car parks and parking extends into the surrounding residential streets.

The changes in modal split over time are shown figure 6.2 for staff and figure 6.3 for students.

For staff, car driving has now slightly decreased, while bus use has increased. It is also of interest that staff have continued to cycle (17% mode share) while walking has decreased slightly since 2000.

The number of students as car drivers climbed steadily until 2000 and then decreased to less than a third in 2008. Bus use declined to only 2% of students in 1993 and then steadily increased to 13% in 2008. The largest change in mode share for students is the increase in walking, up to 33% in 2000 and 2004, showing a willingness to relocate to closer residential origins. This is a positive response to increasing congestion and possibly inconvenience when seeking parking.

Travelling to the university as a car passenger did not change significantly for staff or students during the period studied, despite the implementation of measures to encourage car pooling such as dedicated parking and a car share database.

Figure 6.2 Mode split (staff) travel to/from university

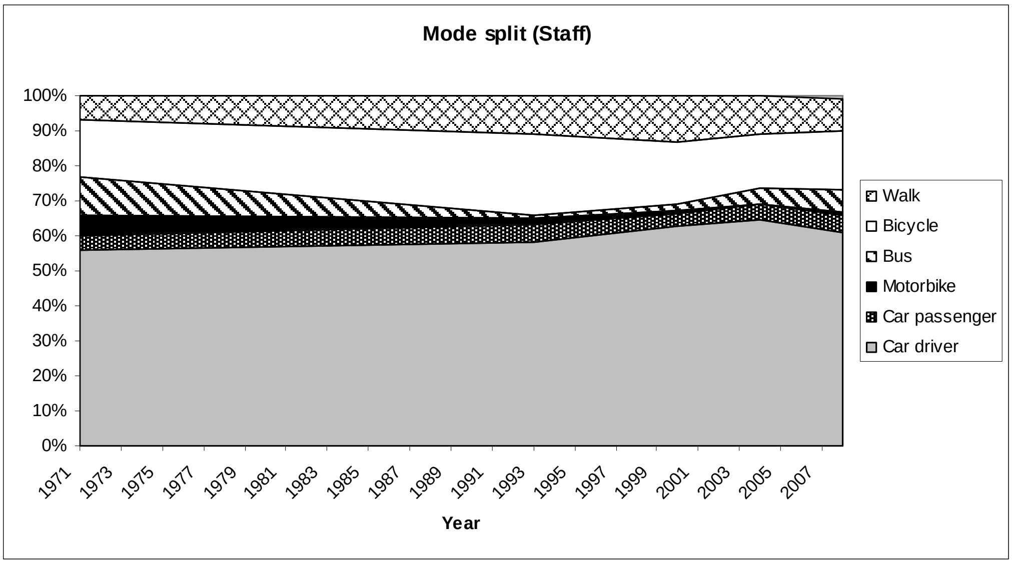
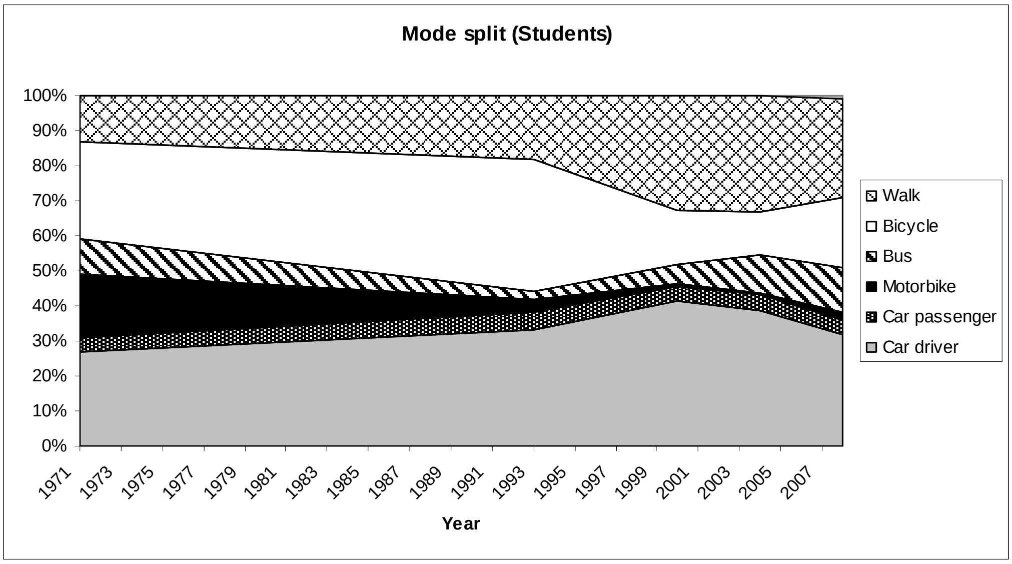


Figure 6.3 Mode split (students) travel to/from university



6.5.4 Trip generation

Tertiary institutions are among the land uses generating the highest hourly traffic, due to their size and the arrangement of lectures and attendance. Like schools, there are short peaks (eg arrival for 9am lectures and departures after the academic day ends at 5pm).

In April 1993, a traffic survey was done at Canterbury University with 11,000 students and 1275 staff. The vehicle trip generation rates are shown in table 6.11 and figure 6.4.

The corresponding figures for the peak trip generation at Carrington Polytechnic (now Unitec Institute of Technology) are: morning, 20.5 vehicle trips per 100 students plus staff per hour, and afternoon, 18.1 vehicle trips per 100 students plus staff per hour, a very similar result.

Figure 6.4 Campus trip generation [ex-2001]

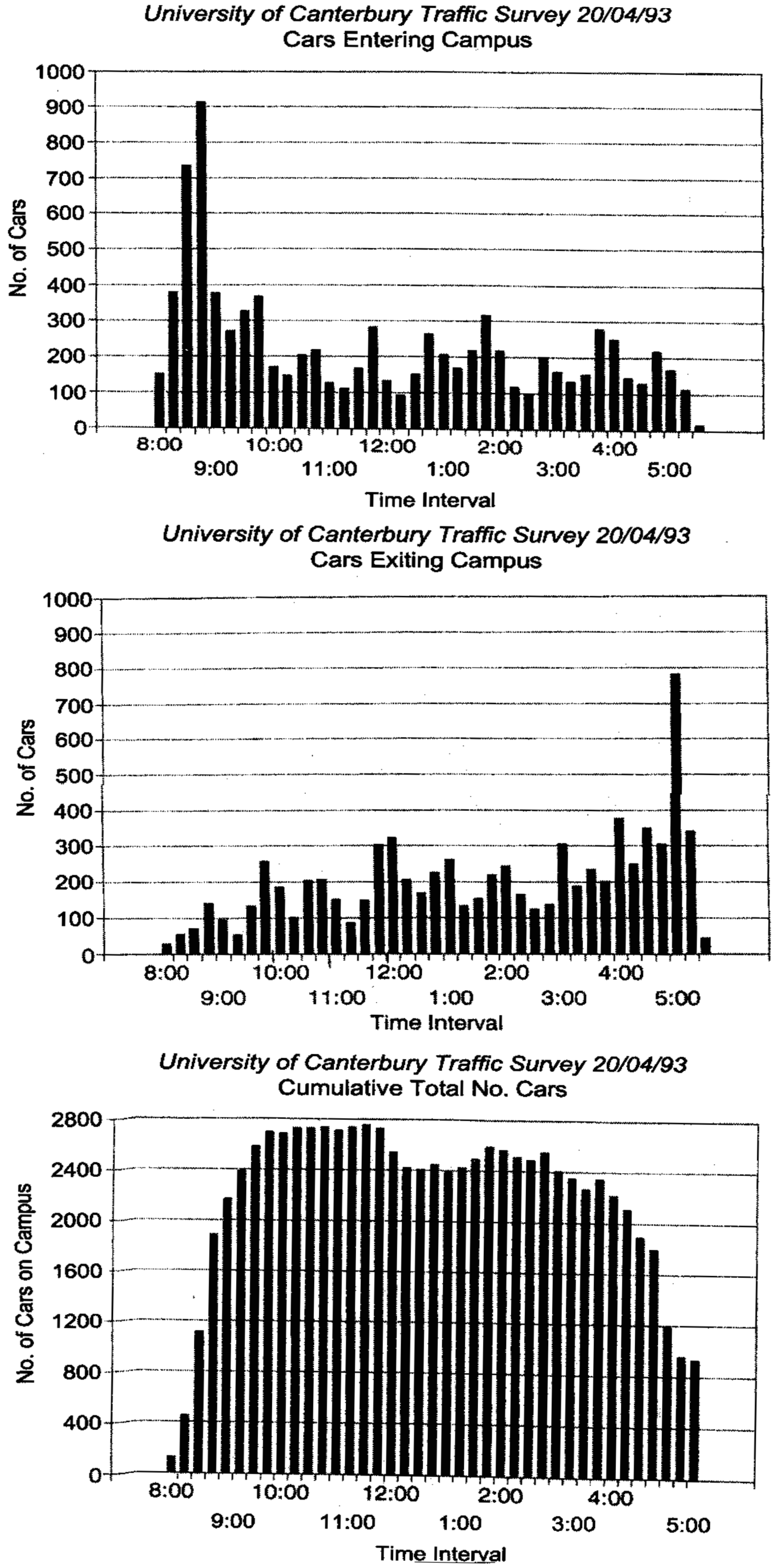


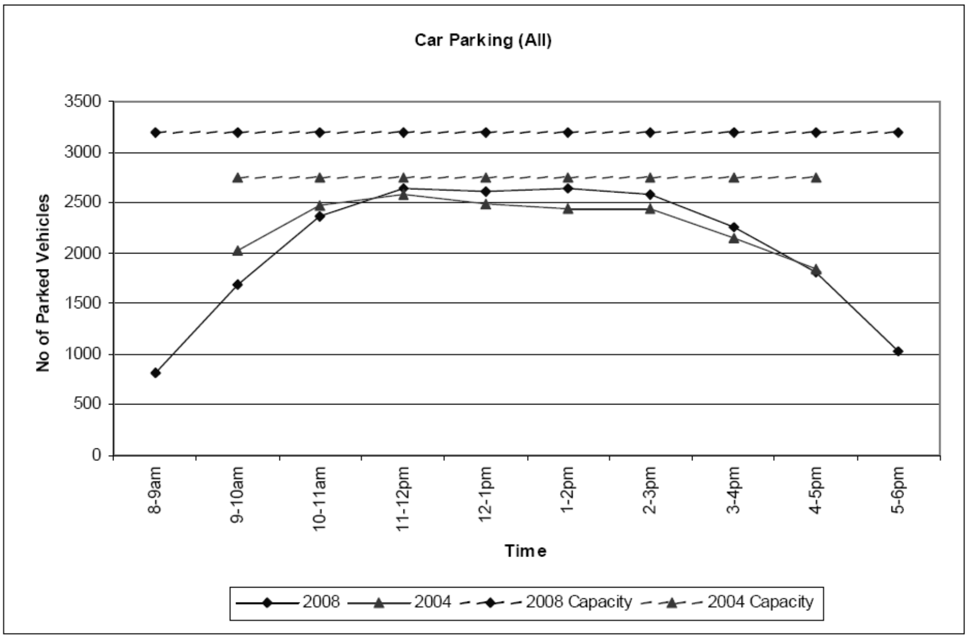
Table 6.11 Car trip generations Canterbury University (20 April 1993) [ex-2001]

Total traffic movement (veh/15 min)					
		In	**Out**	**In + out subtotal**	**Trip generation staff and student and GFA**
am peak	8 - 8.15	140	25	165	2420vph = 20 trips/hr/ 100 S + S or 1.05 trips/100m²
	8.15 - 8.30	380	50	430	
	8.30 - 8.45	720	80	800	
	8.45 - 9.00	900	125	1025	
Midday	11.45 - 12.00	160	300	460	1675vph = 14 trips/hr/ 100 S + S or 0.71 trips/100m² GFA
	12.00 - 12.55	290	320	610	
	12.15 - 12.30	130	205	335	
	12.30 - 12.45	90	180	270	
pm peak	4.30 - 4.45	130	340	470	2380vph = 19.8 trips/hr/ 100 S + S or 1.03 trips 100²m GFA
	4.45 - 5.00	120	300	420	
	5.00 - 5.15	220	780	1000	
	5.15 - 5.30	160	330	490	

This trip generation rate is high because of the numbers of students and the large floor area (Canterbury 230,000m²). This leads to a consideration of design for several entrances and traffic management through distribution of traffic over a surrounding city road network.

Figure 6.5 indicates there is generally a heavy demand for campus car parking throughout the whole day and it is therefore well utilised. The change in car-parking capacity is a result of the Christchurch College of Education merging with the University. The car parking at the College of Education was very under-utilised and tended to only ever be 50% full.

Figure 6.5 Campus car parking occupancy (2004, 2008)

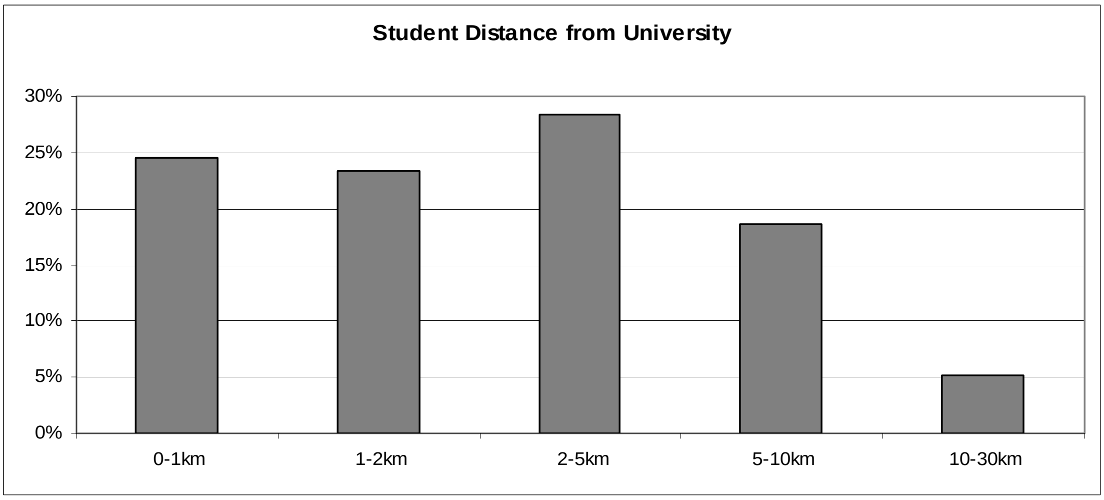


6.5.5 Home to university distances

Information on the distance staff and students live from the university was collected in 2008. A summary of distances from home to the university for staff and students is shown in figures 6.6 and 6.7 respectively. These graphs indicate more than three quarters of students live within 5km of the university, and almost 95% of students live within 10km. There is a trend for staff to live further away from the university than students with less than 60% of staff living within 5km and 90% within 10km.

Figure 6.6 Distance from home to university for staff

Figure 6.7 Distance from home to university for students



6.5.6 Bicycle ownership

The level of cycle ownership or access was collected as part of the 2008 survey. Table 6.12 shows the bicycle ownership or access levels for staff and students taking into account whether they believe they are within a reasonable cycling distance to the university.

Table 6.12 University of Canterbury bicycle ownership or access to a bicycle

	Staff	Students	All
Own or have access to a bicycle	29%	24%	25%
Do not own or have access to a bicycle	23%	25%	24%
Not within reasonable cycling distance	49%	51%	51%

Of the staff and students who indicated they were within reasonable cycling distance to the University, approximately half of staff and students own or have access to a bicycle.

6.6 Recreation spaces and stadiums

Another area of considerable interest is reserves, recreation spaces, stadiums and associated facilities. These are often unique and one-off design situations. Several surveys and design calculations have been provided in this research report, though more attention and detailed surveys are required in the future. The end result from a design hour viewpoint is given below.

6.6.1 Parking for sports courts and fields

The range is from 2 to 3 car spaces per 100m² of court area, eg tennis court or green and 0.5 to 0.7 car spaces per 100m² of playing field or pitch area for participants.

6.6.2 Aquatic centres

These facilities have gained popularity over the older, more traditional swimming-pool complexes by offering a wider range of water-based recreations such as splash and wave pools, fitness and other sports facilities. The information in the TDB database shows design trip generation at around 1.5 to 2.0vph (in + out) per 100m² GFA and parking demand of 2.5 to 3.5 spaces per 100m² GFA.

Research was undertaken to establish an appropriate vehicle trip generation rate and anticipated modal split for a proposed aquatic centre in Timaru. Table 6.13 provides a summary of the survey data available relating to aquatic centres. The terms used to describe the land-use activities relating to an aquatic centre vary from ‘leisure pool’, ‘athletic centre’ and ‘swimming pool’; however, these are essentially of a similar nature to an aquatic centre and include recreations such as swim pools, whirl pools, spa pools, as well as other fitness and sports facilities.

Table 6.13 Trip generation sources – aquatic centres/leisure pools

Country	Source	Site	GFA (m²)	pm peak vehicle trip rate (per 100m² GFA)	Average pm peak vehicle trip rate per 100m² GFA)
New Zealand	NZTPDB[(a)] 2007-08	Wellington	2400	4.3	4.6
	Client	Greymouth	2700*	4.5	
	Abley	Christchurch	2500*	5.1	
Australia	-	-	-	-	-
US	ITE	-	4600	6.29	6.29
			1110		
UK	TRICS 2008, v6.22	Nottingham	2970	3.59	3.1
		Putney	4300	3.28	
		Mansfield	2500	3.21	
		Worcester	2695	2.75	
		Cardiff	2450	2.69	

a NZTPDB = New Zealand Trips and Parking Database Bureau

6.6.3 Major stadiums

Several major factors influence travel to and from sports and entertainment events at major stadiums. The inner-city location of the Wellington Stadium and its proximity to public transport including bus and rail, enables high levels of public transport and pedestrian accessibility. Data from several major Auckland and Hamilton sports events indicates a spectator parking demand equivalent to 1 car space for every 4.2 to 5.8 spectators. Bus parking demand for crowds of around 40,000 spectators has been observed to range from 42 buses for a sports fixture to over 160 buses for an operatic performance. No information is available on the associated traffic generation.

6.7 Medical centres, hospitals and rest homes

Government policies and the changing face of general medicine in New Zealand have given rise to new facilities (eg increased numbers of medical centres) and different modes of operation for existing facilities (eg increased outpatient care at base hospitals). While the changes are continuing, the TDB database has captured a number of surveys, particularly of community medical practices as well as of several hospitals and rest homes. This information is summarised below.

6.7.1 Medical and health centres

These community facilities now offer a range of professional health care and advice, including the services of GPs, physiotherapists, radiographers and dentists and some level of treatment. On-site pharmacies mean prescriptions can also be filled without patients travelling elsewhere. The data collected to date shows on-site parking demands and trip generation are most accurately represented on a per health professional basis.

The measured design levels based on the survey information are:

- trip generation from 3 to 6vph (in + out) per peak hour per health professional
- parking from 2.5 to 3.5 spaces per health professional.

On a 100m² GFA basis, the figures are:

- 5 to 12 trips per 100m² GFA in the peak hours (generally 10am to midday, and 3pm to 4pm)
- 2.5 to 6 car parks per 100m² GFA.

Medical centres have a wide range of patronage and may require detailed individual site assessment. This is one of the land uses in the UK/New Zealand comparative study which is discussed further in section 8.3.5.3.

6.7.2 Hospitals

Survey information for hospitals in Auckland, Wellington and Christchurch shows design parking demand from 1 to 1.5 spaces per bed with an average of 1.3 spaces per bed. Clearly, the range and nature of activities performed on-site will be essential to understanding the total parking demand. Staff and doctor parking varies from 30% to 60% of the total, depending on the type of hospital. Outpatient numbers and consultant specialists are significant indicators of overall parking activity.

Trip generation in the peak morning and afternoon hours is from 0.9 to 1.7 trips per bed per hour and 10 to 16 trips per bed per day. As a rule, the area for hospitals is around 100m² per bed. So bed spaces and GFA, as a general approximation, yield similar parking ratios.

6.7.3 Rest homes

Rest homes have lower traffic demands than hospitals. The typical parking demand is from 0.5 to 0.7 spaces per bed, with a trip generation rate of from 0.3 to 0.6 per bed in the peak hours and 4 to 6 trips per bed per day.

6.8 Churches

District plans have been liberal in their approach to off-street parking for churches and have generally accepted such ratios as 1 car park per 10 congregation members or seats. This has meant accommodating about three-quarters of the parking on adjacent streets. At sites near the city centre or on busy arterial roads, the need for more off-street parking is frequently evident.

From the surveys in the TDB database, the parking demand based on actual attendance of the congregation varied from 1 car park to 5 seats to 1 car park to 2 seats. However, many churches are full only on particular occasions such as for special services, weddings and funerals. For the 18 churches surveyed, some on several occasions, there were only four occasions when the churches were full. Some of these were weekday services and car parking needs varied from 2.3 to 4.5 spaces per 10 seats available. As for the mode of arrival at churches, car drivers varied from 30% to 76%, with an average of 46.5%. Car passengers made up about 50% of arrivals at churches.

Seating numbers are considered to be the best variable for churches and places of assembly, and the rate of car-parks to 10 seats or seating places is a convenient measure. To relate seating to GFA is also useful. Analysis of this group of churches shows a range from 64 seats to 120 seats per 100m² GFA with an average of 100 seats per 100m² GFA. In terms of parking per 100m² GFA for the church in full use, ie a design figure for, say, the 50th highest occasion, is equivalent to between 26 and 48 parked cars per 100m².

This research has not suggested that district plan standards need to be revised from, say, 1 to 10 seats up to 1 to 3 seats. That is a policy, not a research matter. However, it should be appreciated that, in congested arterial road or inner-city situations, additional parking (above the 1 in 10 rate) of up to 3 more spaces per 10 seats may need to be accepted on-street or at adjacent public parking areas on peak-use occasions.

A parking demand survey for 20 places of worship was undertaken by the Palmerston North City Council in 2004. The summary for suburban and central city places of worship for the main service on a 'typical' Sunday is shown in table 6.14.

Table 6.14 Parking demand for churches

	Suburbs		CBD	
	Mode split	**Demand**	**Mode split**	**Demand**
Drivers and passengers arriving by car	62%	1.94 person/car	59%	1.98 person/car
Other modes w/arrival as a rate per car parked	28%	1.19 other modes/car	41%	1.36 others modes/car
Total persons in congregation as a rate per car	100%	3.13 person/car	100%	3.34 person/car

These levels of parking are about half that for a major funeral during the week or a major wedding on a Saturday.

There are two scenarios for demand:

1 Scenario A for normal congregation activity, as shown in table 6.14 with 50%–75% of seats occupied.

2 Scenario B, which is about twice the demand shown above, generated by major funerals or weddings when all seats are occupied to overflowing.

The surveys establish that 1 car park to 3.3 seats is appropriate to match a typical Sunday attendance. However, it should be appreciated that, in congested arterial road or inner-city situations, additional parking of 4 spaces per 10 seats (or higher) may be required for peak-use occasions.

In conclusion, these uses, together with many others are summarised in table 7.4.

7 New Zealand trip generation and parking trends, 1970s to 2000s

7.1 Trip generation comparison

Trip generation is assumed to cover all person trips by all modes of travel arriving and departing from any establishment during the survey peak hour or the survey whole day as specified. Earlier survey information in Douglass (1973) included a comprehensive tally of arrival by all modes. In the Report 209 summary and in the research for this revised version, unfortunately, few establishments were surveyed so comprehensively. Most of the 1990s trip generation information was for vehicle drivers only and goods vehicles and other non vehicle modes of travel were not reported. More comprehensive surveys including all modes will need to be undertaken in the future.

While trips per employee are often a more reliable unit for some activities, this information has not always been available. In addition, there has been an increase in the number of part-time employees and on-site staff parking demand varies greatly. Relating trips and parking to the number of employees is difficult even if the number is known.

Table 7.1 indicates the trip generation rates (including seasonal adjustment for retail and intense visitor uses) by land use derived in the 1970s. With a few exceptions, a similar grouping was adopted for the 1990–2009 analysis. The information available for preparing the 1990–2009 summary was, in some instances, based on a small sample.

The peak hours for retail in the 1970s were 4pm to 5pm on Thursday and Friday. For city offices, the lunch-hour movements were greatest. For industry, the peak hours were arrival, 7am to 8am, and departure, 4pm to 5pm. In the 1990 and 2010 surveys, the peak hour for major shopping centres had become Saturday 2pm to 3pm. Other land uses had similar peak hours as in the past.

Table 7.1 shows marked thresholds in trip generation. The most significant factor is the extent of trips made by visitors. Naturally, retail and shopping activity yields the highest trip generation. For comparability, these volumes are averages for all the establishments related to floor area. The 85th percentile trip rates will be a ratio approximately 1.25 times the volumes shown here.

Thus the major changes in vehicle trips and peak hours have been in the following land uses.

- service stations, due partly to the selected number of larger establishments which were redeveloped in the 1990s (+20%)
- fringe CBD offices due to increased vehicle access from a wider city customer catchment (+23%)
- suburban supermarket vehicle trips have climbed (+30%) at the expense of some of the local primary road shops (-20%)
- some manufacturing has changed its character and now includes both warehouse distribution and direct sales to the public
- shopping centres, because of the increased number of establishments, have generally experienced moderate increases of between 30% and 50% in trip making

- residential, a significant increase (+80%) due to increased car ownership, more people running businesses from home and increased daytime non-family visits.

Most trip rates based on floor space increased in the peak hour by between 12% and 50% from the 1970s to 2010.

Table 7.1 also includes the person trip generation by land uses as surveyed in the 1970s. These were not surveyed in the period 1990 to 2010.

A comparison of the typical trip generation of different land uses is illustrated in figure 7.1.

Table 7.1 Comparison trip generation rates 1970s and 1990–2010

	Trips (in & out)/100m² 1970s				Trips (in & out)/100m² 1990–2010		
	Peak hour		Daily total		Peak hour	Daily total	Change peak-hour vph % (1970--2010)
	Vehicle trips	Total person trips	Vehicle trips	Total person trips	Vehicle trips	Vehicle trips	
Shopping(a)							
Suburban supermarket	22	90	100	320	18	130	-18%
Primary road store	30	75	170	345	19	137	-37%
Neighbourhood store	24	55	135	330	19	139	-21%
Service stations	70	100	450	600	101	717	+44%
Offices							
Fringe centre (few visitors)	2.4	3.6	21	32	2.0	26(c)	-17%
City centre (few visitors)	0.8	2.9	14	28	1.2	14(c)	+50%
Industries(b)							
Distributive (high goods veh)	2.4	3.4	13	23	3.0	35	+12%
Manufacturing (mod. visitors)	1.6	3.0	9	16			
Manufacturing (few visitors)	1.03	2.0	6	10			
Warehouse	0.90	1.5	4	8	1.0	2.4	+11%
Residential							
Trips/household	0.8	1.6	6.0	10.0	1.1	11	+25%

a Inferred results derived on groupings not entirely identical to earlier research

b Industrial peak hour is morning and evening peak at commuting times

c Small survey sample

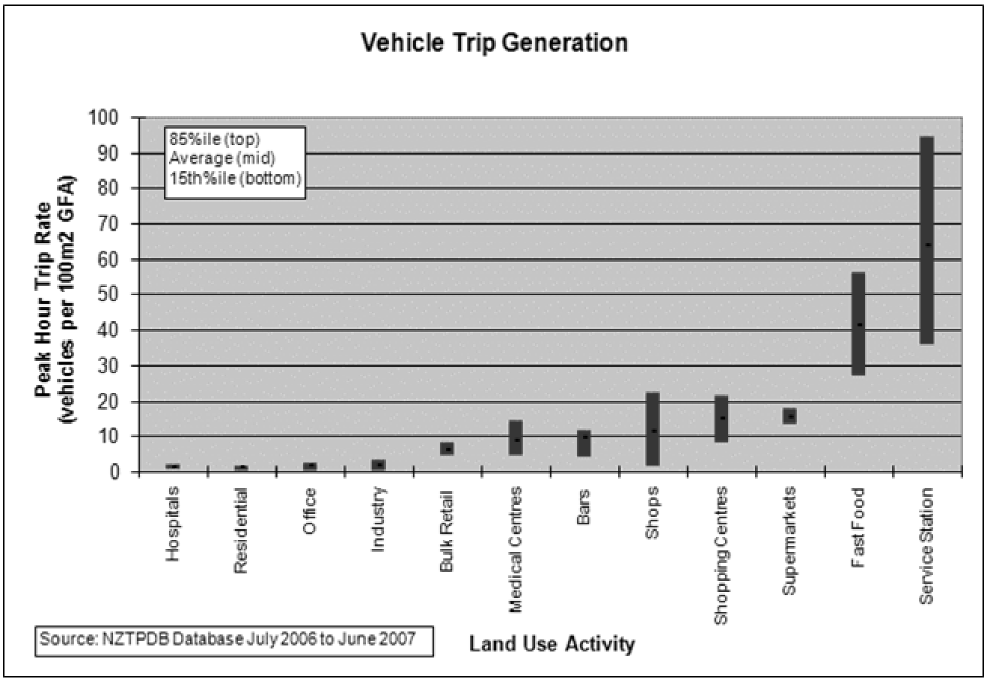
A more detailed analysis of average trips and parking rates comparing changes in New Zealand over the past 10 to 15 years shows little change for most land uses. There are three exceptions:

- Tertiary education trip rates in the peak hour increased from 1.7vph per 100m² (+50%) and parking demand increased from 2 to 4.4 parks per 100m².
- Supermarkets and medium shopping declined slightly from 25vph to 17vph per 100m² and parking demand for these high performing centres also reduced from 7.5 to 5.5 parks per 100m².

- Large format retail footprint stores have now become established and the previous trip rates of 6vph increased to 12vph per 100m². Over the same 10–15 years, the parking demand increased from 2 to 4.5 parks per 100m².

These figures show with regards to vehicle trip generations, retail land uses that attracted visitors had a high trip generation rate compared with other land uses. Even retail uses with relatively low trip generation rates were comparatively higher than light industrial trip generation rates and residential trip generation rates.

Figure 7.1 Vehicle trip generation rates by land uses 2006–2007



Source: NZTPDB Database July 2006 to June 2007

7.2 Parking demand comparisons

Table 7.2 originally appeared in the *RRU bulletin 15* (Douglass 1973) and has been updated to include rates for the 1970s and the period 1990–2009.

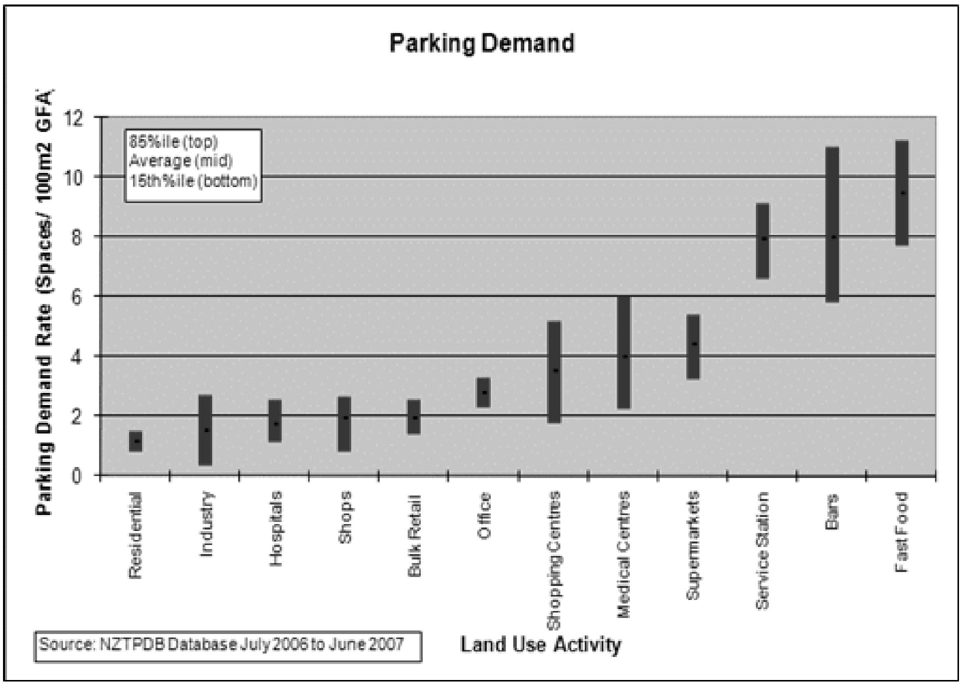
Table 7.2 Comparison of design parking rates 1970s and 1990–2009

Activity	**Parking demand (spaces/100m^2 GFA)**				
Activities in buildings	**Percentage satisfaction 1970s**		**1990–2009**		**Change based on 85%**
	50%	**85%**	**50%**	**85%**	**%**
Hotel, taverns, bar (GFA)	60	70	6.8	11	-84%
Churches, halls, places of assembly (GFA)	20	40	21	32	-20%
Supermarkets and main road shops (GFA)	6.0	8.0	3.5	5.2	-35%
Medical centres (GFA)	4.8	6.5	4.0	6.0	-8%
Local road shops (GFA)	4.0	6.0	3.5	5.0	-17%
Offices (GFA)	1.5	2.8	2.7	3.2	-13%
Precision manufacture and textiles (GFA)	1.8	2.5	2.0	2.8	+12%
General manufacture and engineering (GFA)	1.1	1.7	1.1	2.0	+18%
Warehousing (GFA)	0.6	0.8	0.9	1.7	+113%
Other activity units	**Parking demand (spaces per other unit)**				
	50%	**85%**	**50%**	**85%**	
Residential (per household)	1.1	2.0	1.4	2.8	+40%
Cinemas and theatres (per patron)	0.3	0.5	0.4	0.6	+20%
Churches (per congregation)	0.2	0.3	0.3	0.4	+30%
Hospitals (per bed)	0.7	1.0	1.5	2.2	+120%
Primary schools (per staff) plus (per pupils (3pm))	0.5 0.01	0.7 0.05	0.8 0.15	1.0 0.20	+42% +300%
Sport: major fixture (per spectator)	0.2	0.3	0.3	0.5	66%
Service station (per employee)	1.0	4.5	1.9	2.5	-44%
University (per staff) (per student)	0.3 0.15	0.4 0.2	0.4 0.2	0.6 0.33	+50% +65%

While the ratio of parking and other parameter such as seats, beds and employees is appropriate to cover a wider range of land uses, the most practicable unit for most district plans is still spaces per 100m^2 GFA. This unit has the advantage of being easily measurable and is independent of employee occupancy. Table 7.2, however, gives many uses on a per employee or per patron basis, where floor area may not be the most appropriate means of definition.

Figure 7.2 illustrates the range of car parking demand by land use in the period 2006 to 2007. Contrasted with the 1970s, the trend in parking demand, with the exception of retail, showed an increase of between 20% and 30%. Retail car parking demand did not increase and in some instances reduced because of the increased number of shopping centres. Increased parking at hospitals (+15%), universities (+65%), schools (+42%) and sporting fixtures (+66%) reflected the major change in demand and community needs and interests. The dramatic drop in hotel car parking was probably due to both a change in the hours of business and a major increase in the number of bars and licensed restaurant outlets.

Figure 7.2 Vehicle parking rates by land uses 2006–2007



Source: NZTPDB Database July 2006 to June 2007

7.3 Travel changes, 1970s to 2000s

The changes in retailing are discussed in chapters 2 and 5. Two other significant changes since the 1970s have been the disappearance of the central post office, which had a very large employment base and its replacement by post shops, along with the decline in government administrative offices. In addition, some industries which used to have heavy distribution activities are now supported by a much expanded transport and courier service. Thus the distributor industry class has been replaced by transport centres and courier depots and the latter have not been well surveyed as of late.

Another change since the 1970s has been the major increase in fast-food outlets, such as McDonald’s, Pizza Hut and Burger King. Surveys of such outlets indicate they have high vehicle trip generation. When they are located in conjunction with a shopping centre, a large number of patrons arriving on foot may also contribute to the total person trip generation.

The essence of the pattern of increasing trip generation lies, as it did in the 1970s, with the number of visitors on a personal errand, especially shopping. Employee and business-related trips, including goods vehicles, have remained relatively constant over a wide range of uses. However, where the establishment has a specific distributive or ‘drive-in’ function (eg petrol, liquor, fast food), the vehicle trips have increased significantly in relation to both the employment numbers and floor area.

Service stations have been subject to change, with a smaller number of higher capacity and higher functionality (including conveyance) stations. The abolition of motor spirits trade licensing means many service stations no longer have a mechanical workshop, and now frequently sell food, soft drinks and newspapers and so serve a ‘corner store’ function.

The various trip types (eg home-based work, employees on business or private trips and visitors making business or private trips to an establishment) have not been resurveyed comprehensively for all modes for the 1990–2010 period. However, based on car driver trips modelled in 1999 for Christchurch, the relative contribution of the trips to the four grouped trip purposes is given in table 7.3.

Table 7.3 Trip purposes, 1969, 1996 and 2006

Purpose	1969	1996	2006*
Home to/from work	26%	22%	20%
Home to/from visit shops	24%	17%	15%
Home to/from other	16%	18%	20%
Non-home based	34%	43%	45%
Total car trips (24 hours)	350,000	760,000	1,000,000

*These 2006 figures are inferred from the MoT NZHTS surveys reported in Abley et al (2008).

The trend is increasingly to a more diverse pattern of vehicle trips for 'home-based other' trips (home to/from other) and also for 'non-home-based' trip purposes, both of which are steadily increasing.

Table 7.4 summarises the TDB database's typical 85% design values for a wide range of uses. More detailed analysis will require the selection of specific sites comparable with the subject site or sites being investigated and are included in the TDB database.

Table 7.4 Summary of design trip rates and parking demand in NZ in 2010

Land use categories		Design parking demand (spaces/100m^2 GFA)		Design peak hour trips (vph/100m^2 GFA)		Design daily trips (vpd/100m^2 GFA)	
1. Assembly	1.1 Church	0.5/ congregation	(6)	1.1/ congregation	(3)	-	
2.Commercial	2.1 Office	3.2	(6)	2.5	(12)	26.1	(4)
3. Education	3.1 Preschool	0.3/child	(25)	1.4/child	(26)	4.1/child	(4)
	3.2 Primary	0.3/pupil	(4)	0.7/pupil	(6)	1.6/pupil	(3)
	3.3 Secondary	0.1/pupil	(5)	0.1/pupil	(2)	0.4/pupil	(2)
	3.4 Tertiary	0.3/student	(6)	0.2/student	(2)	1.4/student	(2)
4. Industry	4.1 Warehousing	1.7	(13)	1.0	(21)	2.4	(2)
	4.2 Contractor	5.1	(7)	6.2	(7)	-	
	4.4 Manufacture	2.0	(17)	2.7	(18)	30	(6)
5. Medical	5.1 Centre	1.5/prof staff	(1)	11.6/prof staff	(4)	79.4/prof staff	(5)
	5.2.1 Hospital (small)	2.3/bed	(5)	3/bed	(3)	13.5/bed	(1)
	5.2.2 Hospital (large)	2.1/bed	(4)	0.4/bed	(1)	3.1/bed	(1)
6. Recreation	6.1 Stadium	0.2/spectator	(6)	-		-	
7. Residential	7.1.1 Inner city (multi unit)	1.2/unit		0.3/unit	(2)	6.8/unit	
	7.1.2 Dwelling (suburban)	1.6/unit		1.2/unit	(14)	10.9/unit	(38)
	7.1.3 Dwelling (outer) Suburban)	1.8/unit		0.9/unit	(1)	8.2/unit	(6)
	7.1.4 Dwelling (rural)	1.9/unit		1.4/unit	(4)	10.1/unit	(4)
	7.4.1 Retirement home	0.4/bed	(5)	0.4/bed	(4)	2.4/bed	(4)
	7.4.2 Retirement units	1/unit	(4)	0.3/unit	(1)	2.6/unit	(1)
	7.5 Hostel	0.4/bed	(5)	0.6/bed	(1)	2.5/bed	(1)
	7.6 Motel	1.4/occ. unit	(17)	1.4/occ. unit	(21)	3.0/occ. unit	(17)
	7.7 Hotel	1.8/room	(4)	1.2/room	(3)	6.4/room	(3)
8. Retail	8.1 Shop	9.5	(9)	42.5	(11)	128.6	(6)
	8.2.1 Shopping (small)	5.0	(79)	18.9	(54)	141	(13)
	8.2.2 Shopping (medium)	4.9	(39)	17.2	(23)	101	(5)
	8.2.3 Shopping (large)	3.7	(40)	9.9	(19)	84	(3)
	8.2.4 Shopping (CBD)	2.9	(8)	8.5	(2)	56	(1)
	8.3 Garden centre	6.1	(4)	27.8	(7)	147	(7)
	8.4 Discount	6.5	(6)	15.3	(6)	100	(1)
	8.5 Supermarket	5.3	(12)	17.9	(11)	129	(3)
	8.6 Large format	2.2	(17)	5.6	(20)	45	(7)
	8.7 Restaurant	0.6/seat	(7)	0.5/seat	(9)	6.1/seat	(5)
	8.8 Fast food	10.8	(5)	52.2	(5)	362	(4)
	8.9 Bar	10.9	(19)	15.6	(10)	92	(3)
	8.10 Service station	9.1	(3)	101	(11)	718	(4)
	8.11 Market	3.3	(3)	2.4	(2)	22	(3)
	8.12 Produce	6.7	(3)	69	(2)	487	(2)

Notes: Numbers in brackets represent the sample size.

The purpose of this summary schedule is to provide a quick 'initial value' at the start of an analysis.

Household parking rates are median figures from census.

The 'rural' land use category is omitted due to small sample size.

7.4 Parking management

Good parking management is a key component to the economic success and strength of any urban settlement.

Generally, parking management strategies and programmes should be coordinated throughout a district or region as a whole, including in particular the town centre and significant retail and employment locations. There is a balance to be found between over provision, which may be wasteful of resources and land as well as encouraging greater vehicle usage, and having a shortage of supply, which may lead to additional congestion and be a restraint on land-use activity.

The provision of free or cheap parking within urban areas causes a market distortion that encourages additional vehicle use. When users are not charged appropriately the resource tends to be exploited and the demand for paid parking can be lower than the demand for free or cheap parking.

Providing more parking than is necessary is undesirable as it may use land best retained for other development and community uses.

The accessibility of an activity is not just a function of car parking supply. Where the site is readily accessible then there may be justification for applying maximum car parking rates rather than minimum rates. Maximum parking requirements in central city areas may encourage active transport modes including walking, cycling and public transport, and may be part of a policy package to assist in making these modes more desirable. Maximum parking rates can also cement public investment and reduce the shift from active transport modes to the private car.

A public policy of support for easy access by walking, cycling and public transport reflects the 'will' within the community to move towards, or stop the shift from, sustainable modes such as walking and cycling. This in turn assists with the shift towards the improved management of parking resources.

The range of management techniques to make best use of existing parking resources includes:

- encouraging and permitting shared parking
- requiring 'in-lieu fees' for the provision of new public parking facilities instead of requiring private, single destination facilities
- implementing restrictions that promote short-stay parking in high-demand areas with longer-stay parking provided away from core activities
- increasing the capacity of existing parking facilities by modifying layouts on-street and off-street to improve efficiency and minimise unutilised space
- Improving the quality of walking connections between parking areas and destinations to increase the attractiveness of parking areas
- changing rules to maximum rather than minimum parking rates for certain land uses
- using parking pricing to influence parking demand in terms of duration and mode of travel
- applying parking levies for certain land uses

- providing end-of-trip cycling facilities to encourage short-to-medium distance trips by cycle instead of private vehicle.

These management tools typically complement the policies and rules associated with the provisions of district plans.

7.5 Application to district plans

Chivers (1981) discussed the site-specific car parking requirements in district schemes for business and employment uses as follows:

> *All New Zealand district schemes contain requirements for private developers to provide off-street car parking for new developments. Different land uses have different requirements, based on the expected intensity of the use and its vehicle parking demand and trip generating capability. These standards are partly historic and based on experience and partly based on the results of research into traffic activity at the site specific level (eg RRU Bulletin 15).*

The Chivers report included results from a comparative survey of district scheme codes of ordinances and parking requirements for the more common land uses and commented:

> *It would be expected that these car parking standards would be related to fairly specific policies in the Scheme statement about the level of car parking to be provided related to say a 30th highest hour standard or an 85% satisfaction to be achieved. Unfortunately this is rarely the case.*

In this situation, car-parking standards might appear somewhat arbitrary.

> *As with many town planning and resource management matters, control is achieved through the application for a consent to develop or redevelop either by new building or by a change of use not permitted as of right. Where an area is being developed from vacant land, then the car parking requirements will be achieved on all developments as they progressively occur. However in an existing area that was fully developed before the District Plan scheme became operative and where there was already a substantial parking deficiency, then the rate at which that overall deficiency will be removed will depend on:-*
>
> *(a) The rate at which redevelopment takes place, and*
>
> *(b) The standard of car parking prescribed.*

In addition, many councils have purchased land for at-grade public parking and parking buildings. These general conclusions also apply to the 2000s. In the 40 years since 1970, most retail areas have, due to both council rules and developer investment interest, added extensive off-street parking areas which now more closely match demand, or potentially increase demand because of the oversupply of parking.

In the context of the use of a particular building over its life of, say, 50 years, it is difficult to anticipate at the outset whether parking demand will vary with changes in future activity uses. The definition of uses in the current effects-based district plan should use car parking demand as one of the standards of site performance in each zone. This should then enable the car parking provisions of a development to be correctly adjusted in the event of an application being made for a consent to a change in the character of the use. This does require, however, that the district plan rules be explicit in terms of parking thresholds.

This research has suggested the proposed car-parking standard should be related to an appropriate design hour and, for commercial retail uses, this should generally be equivalent to the 50th highest hour of the year or 85% satisfaction for unconstrained car parking. This level of parking is realistic and has been shown to be economic in site development.

A high car parking supply rate leads to greater parking investment while a lower figure would be more obviously a restraint on parking. Councils may also wish to include provisions for cash in lieu and parking dispensations, ie the number of car-parks supplied in practice may be reduced, subject to pre-determined rules, from the district plan standard. This may be a viable option for a building in close proximity to public car parking that may be located on or off street. This relationship between the parking management policies, the rules in the district plan, standards for design, and the shared responsibility between the council and the developer, are matters appropriately dealt with in district plans or other supporting documents.

District plans should recognise the number and location of short-term visitor parking in contrast to the needs, number and location of long-term and commuter parking. This is essential in city CBDs.

The important issue is that the district plan's objectives, policies and rules should be justified rationally. District plans should not, as several at present unfortunately do, rely on arbitrary definitions of land use or political decisions as to the parking spaces to be provided for different uses. It appears a number of district plans still have parking provisions which were rolled over from the pre-1991 era without any rational or detailed survey and review to update the standards.

7.6 Industry

For industrial uses, the figures established in the 1970s generally still apply. The figure cited in *RRU bulletin 15* (Douglass 1973) for all industries was between 1 and 2 spaces per 100m² GFA. In addition, provisions must now be made for visitors as more retailing is added in these industrial parks. Where industrial buildings are being converted to retail or wholesale (as has occurred, for example, along Blenheim Road in Christchurch, and in the inner-city periphery areas of Dunedin and Wellington), a considerably increased visitor parking supply is required. This applies particularly to the conversion of traditional warehouses to warehouse-retail or large format retailing establishments and also to manufacturers selling direct to the public. Obviously, under New Zealand's 'effects-based' planning, the monitoring of changes should reveal the extent of parking demand or the alignment with district plan objectives and policies.

7.7 Discussion of changes from the 1970s to 2000s

The first conclusion is the change in trip generation and parking demand for many individual land uses has not been as great as might have been expected. This is largely because of the averaging effect of more dispersed communities. The higher level of mobility enjoyed by almost everyone and the market-led nature of current developments, where a greater number of retail or service outlets are available, have contributed to a spreading of activities throughout the urban areas. The result is individual sites enjoy about the same, or only a modest increase in turnover activity and associated parking and trip characteristics.

Some sites, however, have experienced an increase in motor vehicle trip generation because of a falling-off in public transport use, bicycle trips and walking trips. Other sites have experienced a marked decrease because of changed shopping or patronage habits (eg for hotels and restaurants, the marked change in drinking hours and the increased number of outlets). For retailers, the shift to Saturday and Sunday trading has, in some cases, shifted the design day (ie the day containing the nominated 50th highest design hour) from Friday to Saturday.

Parking is provided both on-street and off-street. The combined effect of increased traffic congestion and traffic management improvements and the gradual implementation of district scheme parking requirements for off-street parking has significantly altered the balance between on- and off-street parking over 40 years. In suburban areas, it is now expected that all parking associated with major shopping centres and other land uses will be provided on-site and off-street. In the city centre, some of the former street parking areas have now been taken over by ‘pedestrian only’ streets, while others have been taken up by bus stops, bus lanes, cycle lanes and peak hour clearways. However, the first-used short-term parking is still kerbside and in most cities depending on city size 1000–5000 or more street spaces are used in that way. These spaces are limited, however, and in the future will be complemented by more off-street parking areas and parking buildings for short-term as well as long-term parking.

Trip generation rates by most land uses have on the whole undergone only small changes. Overall, mid-morning and afternoon have seen an increase in trips. The increase on Saturday and Sunday associated with retail and recreational activities has been dramatic. This change has resulted in many suburban streets and highways carrying their 1990s design hour peaks on Saturday rather than Friday, as in the 1970s, and some roads now have higher off-peak flows throughout the weekend.

The advent of integrated transportation assessments, when developments are proposed, has increased the need for better quality surveyed trip and parking information. There is also the need for rational application of policies and rules based on comprehensive multi-modal surveys and improved standards of design so as to better match future needs. A recent NZTA research report ‘Integrated transportation assessment guidelines’ (Abley et al 2010) develops a framework for undertaking ITAs and seeks that best practice is implemented to match the needs of planning for land uses in the New Zealand regulatory structure.

8 Overseas comparisons

8.1 One transportation planet

Research and comparative studies of the national databases for the USA (ITE), UK (TRICS), Australia (RTA) and New Zealand (TDB) have demonstrated the travel characteristics and modes of travel in these four economies have much in common. One of the more important research projects was *NZTA research report 374*, 'Comparisons of NZ and UK trips and parking rates' (Milne et al 2009). This study was essential to both the application and use of information from the UK TRICS database in New Zealand and also the upgrading of the TDB database to be consistent with UK practices.

It was effectively an analysis to correlate land uses and traffic situations and demonstrate the similarities and differences between UK and New Zealand land uses and trip generation patterns. TRICS has a much larger file of information, about 5000 sites, compared with 1000 on the New Zealand database. In the longer term the two bodies are expected to progress on very similar paths reflective of best practice.

It is apparent in the urban areas of these countries there is a travel environment which is not dissimilar and looking more coincident over time. See section 8.3 for a summary of Milne et al's (2009) comparison of retail and six other land uses.

The TDB has now crossed the Tasman with an increasing Australasian membership and New Zealand and Australian surveys are now recorded in parallel. This has already confirmed the similarities and general coincidence of the trips rates and parking demand together with the modal split of travel that exists for comparable cities, land uses and sites.

Report 209 established a comparison of trip rates, based on New Zealand, Australian and US data available in the 1990s. These are briefly reviewed here, and tables 8.8 and 8.9 bring together the trip rates and parking demand figures for all four countries. These comparisons indicate a convergence and similarity between trip rates in New Zealand, Australia, the UK and USA.

A key advantage of TRICS and TDB compared with the ITE (2003a) *Trip generation* and RTA (2002) *Guide to traffic generating development'*, is that with the UK and New Zealand databases the investigator can search a range of sites of the same land use and character and select just those that relate to the particular site being investigated. The Australian RTA database has now been made available to TDB at the surveyed site-by-site level. This increases the TDB database utility and the ability to define equivalent Australian sites for comparison.

It has been found from the comparative research, including all the TRICS and TDB retail sites, there is a close similarity for the full population of retail and shopping sites in New Zealand and the UK.

It is obvious they represent a basket of sites which all belong, in a generic sense, to the same travel patterns relating to similar sizes of shopping centres. The average results demonstrate this similarity, which is even greater in the 85th percentile results. The differences between individual premises relate to very specific issues of the descriptions of the activities taking place at the individual site and the location of the shopping centres relative to population catchments, network accessibility etc. These characteristics can readily be defined in the same manner as already provided for in the TRICS (2008) good practice guide and also the user guide developed by TDB (2009).

8.2 National organisations and databases

In New Zealand, the Ministry of Transport (MoT) and the NZ Transport Agency (NZTA), including its administration of the planning and operation of 10,000km of state highways, together with NZ Police in their traffic enforcement role, are the three major agencies of central government involved in planning and funding transport. There are also special agencies such as the Ministry for the Environment (MfE) in national planning, KiwiRail for rail transport, and others who feed into this mix. These agencies also have regional offices that collaborate with the regional councils in the preparation of regional land transport strategies, and the city and district councils who are equal partners involved in the planning and operation of transport networks. This is a general framework that has equivalent arrangements in Australia, the UK and USA. In addition, in each country the consultant transportation practitioners make a significant contribution to these services.

The local government portion (approximately half) of the public funding purse is a shared responsibility for the 85 local government councils, who also maintain 80,000km of local roads. These roads are of every variety from motorways to limited access roads. Half of the funds for this work come from rates and petrol excise tax and the other half from government grants. Other modes, such as rail and bus, are established as trading activities but they also receive some limited public funding and, in urban areas, subsidies for passenger transport.

Understanding trips and parking generation and transport planning responsibilities fall primarily with local government councils. The NZTA’s role includes the allocation of government funding to councils and a national research programme. Local government contains the planning and knowledge related to future transport proposals, management of the existing networks and responsibility for town planning issues including control of development fronting the road system.

It is local government, through its town planning under the Resource Management Act 1991 and its strategic planning required under the Local Government Act 2001, including preparation of the long-term council community plans, where policy decisions on network maintenance and improvements are made. Local government also requires the knowledge on trip generation and parking demands when giving planning consent for new land uses.

With this mix of administration it is not surprising the relatively small professional institutions of engineering practitioners (1000 belonging to the IPENZ Transportation Group) and planners with a special interest in transportation planning and its effects (about 200 belonging to the New Zealand Planning Institute) have got together and cooperatively set up the TDB. This is designed to provide a national database as a ‘public interest’ resource, a focus for research and the production of publications such as this revision of Report 209. Most importantly the TDB maintains an impartial database to keep such factual information available to all parties. This New Zealand model has now been adopted by the Australian Institute of Traffic Planning and Management (AITPM) as a ‘focus group’ providing information on trip and parking generation and supporting the TDB Database as an Australia–New Zealand cooperative.

This New Zealand arrangement is a variation on the same theme which engineering and administrative practitioners cooperatively established in the UK (the TRICS model is slightly more commercial with JMP Consultants Limited currently providing the consultant service) and the USA (with ITE having a longer experience of inter-state and inter-collegiate services run by professional practitioners out of Washington). A number of the TDB transportation engineers have come to New Zealand from the UK and also a few from the USA and South Africa. These professionals happily adopt their new country and seem to readily adapt their talents to fit and share with kiwi needs. In response to the seminar questionnaire (appendix D), they are generally keen to see this TDB database service expand and become more effective.

8.3 Comparison of New Zealand and UK trips and parking

8.3.1 Retail trips and parking

A more detailed research study (Milne et al 2009) shows how similar New Zealand and the UK are in retail trip making. Figure 8.1 indicates the average development peak-hour trip generation rates per 100m² GFA for the two countries, with retailing activities showing very little difference in trip generating characteristics between them. In each case, a higher variability of trip rates is associated with smaller shopping centres. In general, a large proportion of sites between 1000–10,000m² assume a trip rate that lies between 10–15 trips per 100m² GFA.

Figure 8.1 Comparison of UK and New Zealand average peak vehicle trip generation rates vs GFA – retail

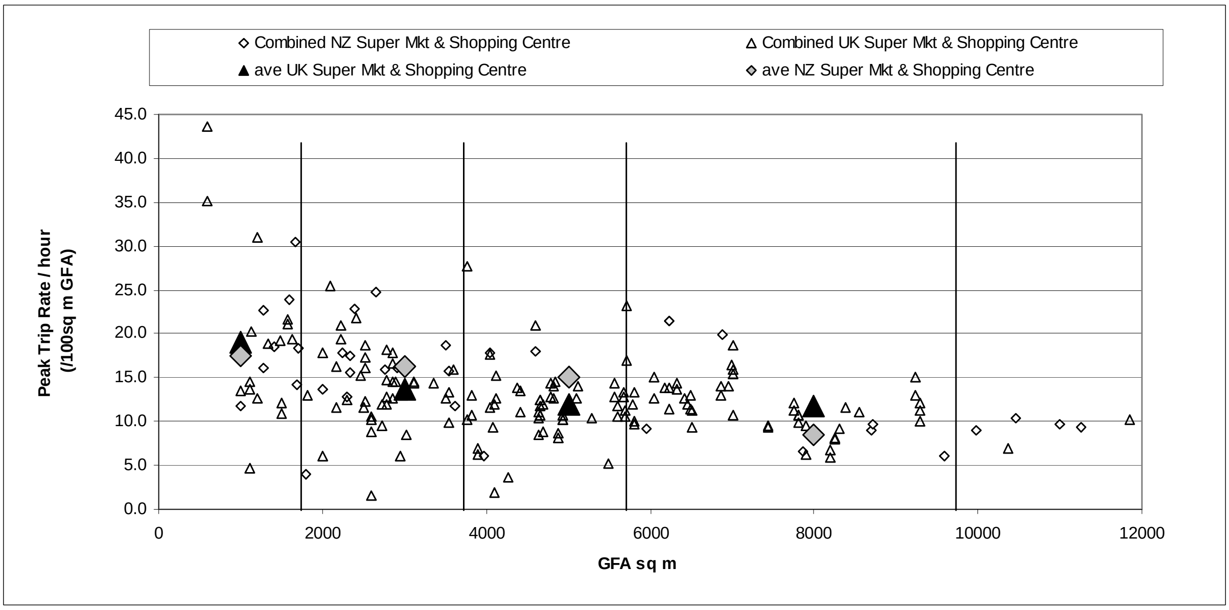


Table 8.1 Comparison of UK and New Zealand average vehicle trip generation rates – retail

	Combined UK			Combined New Zealand			Combined UK & New Zealand		
GFA (m²)	n	Ave	Sdev	n	Ave	Sdev	n	Ave	Sdev
0–2000	17	**19.12**	9.64	9	**17.40**	7.32	26	**18.52**	9.27
2001–4000	47	**13.62**	4.94	13	**16.30**	4.38	60	**14.20**	4.91
4001–6000	50	**11.97**	3.58	3	**15.04**	4.35	53	**12.14**	3.70
6000–10,000	43	**11.75**	2.78	8	**8.42**	6.43	51	**11.23**	3.68
10,000–12,000	2	**8.50**	2.12	3	**9.83**	0.58	5	**9.30**	1.35

Figure 8.2 and table 8.1 firmly support the view that the retailing trip rate reduces with increasing floor area, and variations are greatest at the low end of the range of floor space. It can be seen the difference between the UK and New Zealand average trip rates is not particularly large.

Figure 8.2 indicates the relationship between the retail average peak parking demands and GFA for New Zealand and the UK. The parking characteristics of shopping centres and supermarkets have been combined to form a single dataset for each country. While not as conclusive as the trip rate and GFA relationship, a comparison of the data shows the average shopping centre parking demand per 100m² GFA tends to be around 5.5 vehicles per 100m² GFA for the UK, and 4 vehicles per 100m² GFA for New Zealand.

Since the parking demand rate for the shopping centres falls within the range of parking demand rates displayed by the supermarket sub-group, it is reasonable to combine the two subgroups to form a single dataset for each country. Figure 8.2 and table 8.2 compare the parking demand rates of the combined shopping categories in the UK and New Zealand.

Figure 8.2 Comparison of UK and New Zealand average peak parking rates v GFA – retail

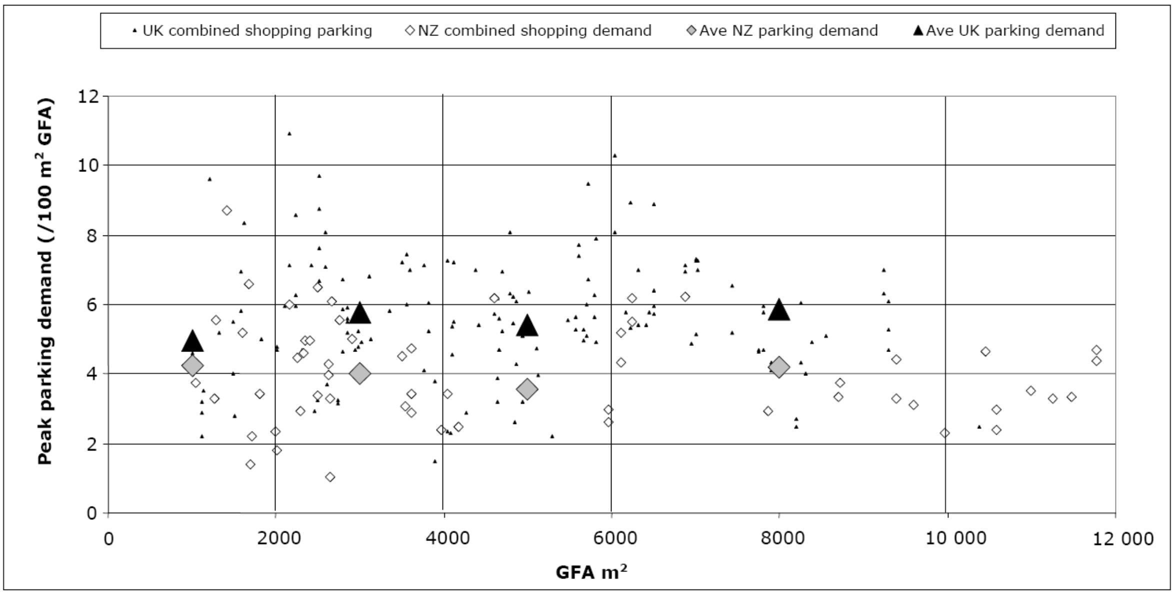


Table 8.2 Average peak retail parking rates for the UK and New Zealand

GFA (m²)	Combined UK			Combined New Zealand		
	n	Ave	Sdev	n	Ave	Sdev
0-2000	14	**4.98**	2.16	9	**4.25**	2.25
2001-4000	47	**5.78**	1.83	23	**4.01**	1.42
4001-6000	48	**5.41**	1.59	5	**3.54**	1.51
6000-10,000	42	**5.88**	1.56	12	**4.22**	1.31

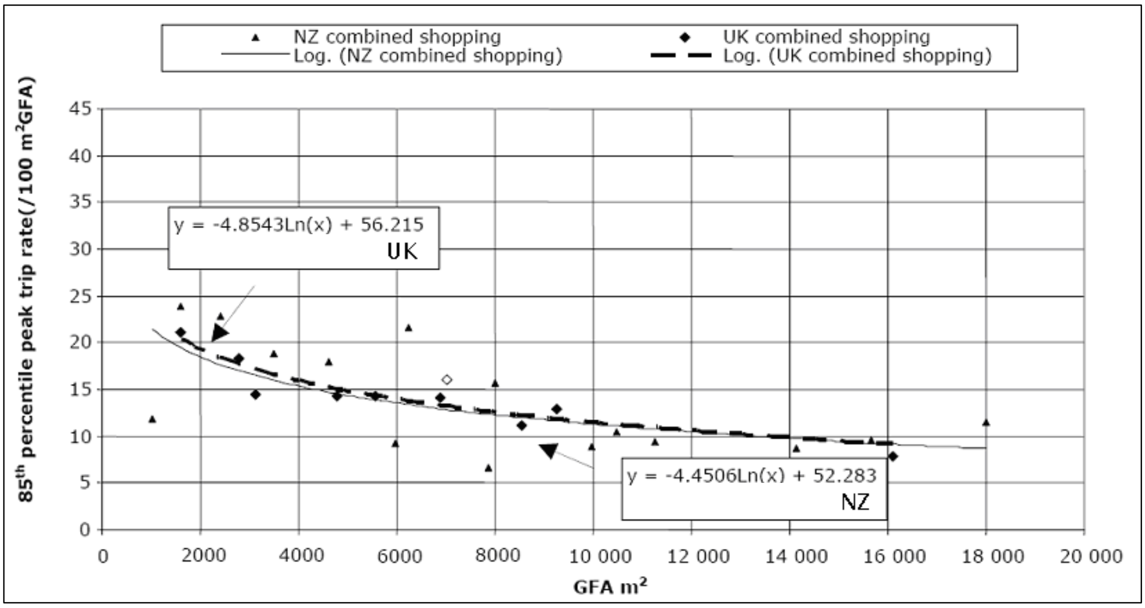
In each floor area segment, the New Zealand parking demands are lower than the UK retail parking demands. The difference between the parking demands equate to one parked vehicle per 100m² in the 1-2000² GFA range with the difference of around 2 parked vehicles per 100m² remaining relatively constant and statistically significant throughout the remaining floor area segments.

The majority of UK sites indicate average parking demands ranging from 5-6 spaces per 100m² and the New Zealand sites display an average parking demand that ranges from 3-4 spaces per 100m² GFA. In general, the UK activities generate a parking demand that is 2 vehicles per 100m² GFA higher than the New Zealand retailing equivalence. This may reflect a tendency to park for longer durations because of a wider variety of activities being available at the UK sites or it could be because people use the parking space while visiting more adjacent shopping facilities.

8.3.2 85th percentile analysis

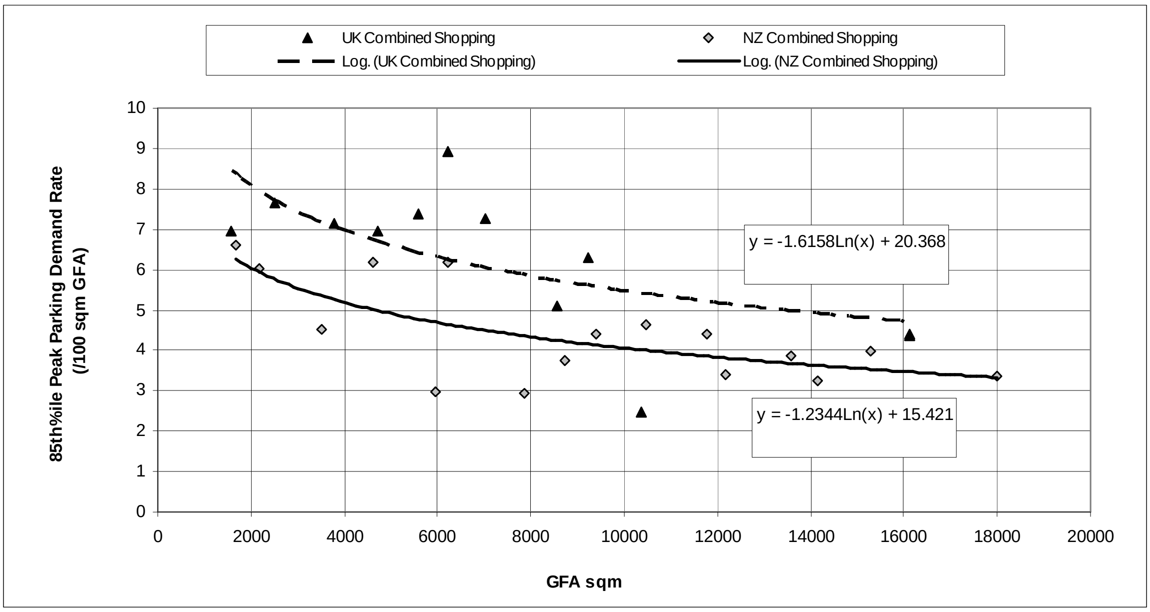
The comparisons made so far have focused on the average of the park trips and parking rates associated with the UK and New Zealand. In determining appropriate trip generation estimates, practitioners are advised if sites with comparable accessibility, scale and location cannot be found when using a standard database system, 85th percentile trip generation rates should be considered as an appropriate initial basis for design purposes. Figures 8.3 and 8.4 illustrate the 85th percentile trip generation and parking rates for sites grouped in GFA increments of 1000m² GFA. The closest fit line represents a log curve.

Figure 8.3 Comparison of UK and New Zealand 85th percentile trip rates – retail



This 85th percentile analysis provides further evidence regarding the similarity of trip making characteristics between the UK and New Zealand. Each dataset displays a similar downward trend, indicating trip generation rates and parking demand rates reduce as GFA increases.

Figure 8.4 Comparison of UK and New Zealand 85th percentile parking rates – retail



The differences in 85th percentile parking demand rates between the New Zealand and UK datasets appear to be reasonably constant and show the 85th percentile retail parking rates for the UK are higher (by 2 parked vehicles per 100m² GFA) than the equivalent 85th percentile New Zealand retail parking rates, which is consistent with the earlier comparison of the average peak parking rates.

8.3.3 General discussion of New Zealand and UK retail comparison

Figures 8.1 and 8.2 show trip rates and parking rates for retailing activities in defined floor area sub-groups. In both countries, a higher variability in trip rates is associated with the smaller retail centres compared with the larger centres. A large number of sites between 1000–10,000m² generate average trip rates in the range of 10–15 trips per 100m² GFA per peak hour. The analysis confirms, for both data sets, the trend of reducing trip generation rates occurring with increasing floor area. It also shows the rate of change in trip generation declines rapidly in the smaller centres, 1000m²–2000m², and 2000m²–4000m² floor area groups.

A general relationship also exists between the retail parking demands of New Zealand and the UK. In contrast to the variation in trip rates, which show a noticeable decline with larger floor areas, the trend associated with the average parking demands remains relatively constant throughout the range of centre sizes in both countries. The UK average parking levels are around 5.5 spaces per 100m² while the New Zealand equivalent is around 4.0 spaces per 100m².

The higher parking demand in the UK may be attributed to longer parking durations, which in turn arise from a typically wider range of activities on offer (mixed use) and/or the proximity of other nearby shopping opportunities.

8.3.4 Comparison of New Zealand and UK trips and parking rates

NZTA research report 374 ‘Comparison of NZ and UK trips and parking rates’ (Milne et al 2009) investigated the TDB database and the TRICS database to discover how similar and consistent their trips and parking demands had become. As it was a general comparison, it involved grouping travel surveys and comparing average values (rather than 85% demand values) of trip and parking rates. It was a broad study and did not attempt to predict design levels of trips or parking for individual sites. The research detailed in the report has been used here to provide additional comparisons and perspectives.

Eight general conclusions can be drawn:

- The comparison of New Zealand and UK trip making and parking demands covering eight land uses has been tested successfully and many similarities have been confirmed.
- Comparison and analysis of average trip and parking rates for eight land uses in the UK and New Zealand has shown the average and the 85th percentile, trip generation and parking demand rates are consistent and similar for equivalent retail activities.
- For retail activities the scatter diagrams have much in common with trip rates being similar. Although retail parking rates run in parallel the UK retail parking levels are consistently above their New Zealand counterparts.
- There are also similar and consistent trip making patterns for residential activities; however, New Zealand dwellings generate slightly higher trip rates than their UK equivalent.
- The analysis shows for half of the land uses analysed there appear to be consistent relationships between trip generation rates and GFA for both the New Zealand and the UK data. It is apparent similarities exist and practitioners can usefully examine the TRICS database to widen their data sources and give greater confidence in their predictions for New Zealand trips and parking rates.
- Where similar trips and parking rate trends have not been established, this is most frequently due to lack of New Zealand data. However definition issues also contribute to a lack of consistency for some land-use activities. For instance, recreational activities rely more heavily on a range of qualitative factors which tend to be site specific. Trips and parking characteristics associated with employment activities rely heavily upon the exact definition of the nature of business occurring on-site.
- The wide scatter in the trip and parking rate data, in both countries, suggests capture of additional parameters would improve the technique of predicting trips and parking rates. Examples of additional parameters may include capturing the distinction between private/rented tenure for residential activities, room occupancy levels associated with hotels, seating capacity and locational aspects for restaurants.
- Exchanges of information about databases and future sharing and exchange of basic data on traffic generation, parking and travel information and predicted parameters in each country and internationally could be increased for the advantage of both countries.

8.3.5 Six other New Zealand – UK land uses

In addition to detailed and well-researched UK and New Zealand retail centres, six other land uses have also been compared. As indicated, the survey samples are in most cases very low.

8.3.5.1 Commercial

- Comparable trends in trip rates can be seen between New Zealand and UK business parks, which may allow extrapolation of UK data in some circumstances.
- Additional New Zealand surveys are required for this land use.

Table 8.3a Average peak trip rates for UK and New Zealand business parks

GFA (m²)	New Zealand			UK		
	n	Ave	Sdev	N	Ave	Sdev
0-20,000	3	**2.14**	0.15	16	**1.32**	0.62
20,001- 60,000	1	**1.44**	-	2	**0.79**	0.40

Although New Zealand data is limited, it is apparent both sets of data share a similar trend and peak trip rates for business parks in New Zealand are higher than their UK counterparts by 0.8 trips per 100m² GFA.

Table 8.3b Average UK parking rates for business parks

GFA (m²)	N	Ave	Sdev
0-5000	9	**2.83**	1.54
5001-10,000	8	**2.56**	0.89

8.3.5.2 Industrial

- Trends in trip rates for manufacturing are comparable.
- Trends in parking demand rates for manufacturing activities are also comparable.

Table 8.4a Average New Zealand and UK trip rates for manufacturing

GFA (m²)	New Zealand			UK		
	n	Ave	Sdev	n	Ave	Sdev
0-2000	7	**1.09**	0.89	3	**0.67**	0.07
2001-10,000	1	**1.33**	-	7	**0.85**	0.43
> 10,000	-	-	-	10	**0.41**	0.38

Table 8.4b Average New Zealand and UK parking rates for manufacturing

GFA (m²)	New Zealand			UK		
	n	Ave	Sdev	n	Ave	Sdev
0-2000	8	**1.19**	0.91	3	**1.39**	0.51
2001-10,000	4	**1.49**	1.38	5	**2.22**	0.40
> 10,000	2	**0.40**	0.04	9	**1.44**	1.01

New Zealand manufacturing sites display trip rates that are generally 0.5 trips per 100m² GFA higher than the UK counterparts. The parking rates are higher for the UK data. The trip rate for New Zealand manufacturing ranges from 1.0 to 1.5 trips per 100m² GFA, while that for UK manufacturing ranges from 0.5 to 1.0 trips per 100m² GFA. The New Zealand parking rate for manufacturing ranges from around 0.5 to 1.5 spaces per 100m² GFA, while the corresponding range for the UK parking rate is around 1.5 to 2.0 spaces per 100m² GFA.

- Where sufficient data exists, New Zealand industrial sites have higher trip rates but lower parking demand rates than the UK sites
- Additional New Zealand surveys are required for warehousing activities.

8.3.5.3 Medical centres

- Based on the data available, some similarities are apparent between the New Zealand and UK trip generation rates.
- UK medical centres up to 1000m² generate higher trip and parking rates than their New Zealand equivalents
- Additional New Zealand surveys are required for medical centres.

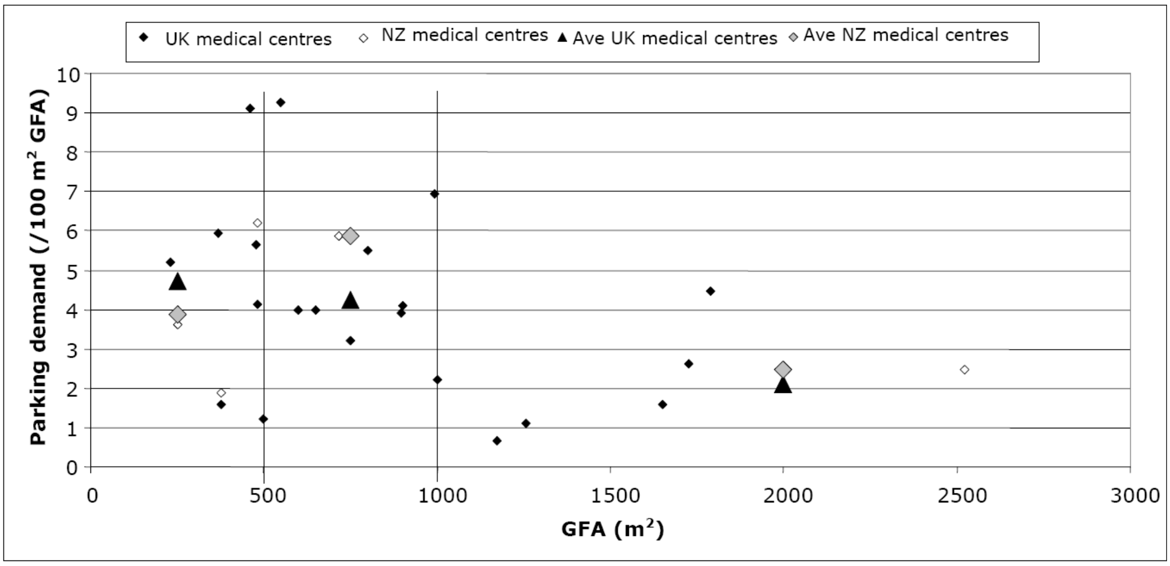
Table 8.5a Average New Zealand and UK trip rate for medical centres

GFA (m²)	New Zealand			UK		
	n	Ave	Sdev	n	Ave	Sdev
1-500	3	**11.87**	4.6	8	**12.58**	7.67
501-1000	2	**9.18**	5.07	12	**11.08**	4.19
>1000	1	**5.07**	-	5	**3.78**	3.61

Table 8.5b New Zealand and UK average parking rates for medical centres

GFA (m²)	New Zealand			UK		
	n	Ave	Sdev	n	Ave	Sdev
1-500	3	**3.89**	2.19	7	**4.73**	2.97
501-1000	1	**5.87**	-	8	**4.23**	1.43
>1000	1	**2.46**	-	5	**2.09**	1.51

Figure 8.5 Comparison of NZ and UK parking rates v GFA for medical centres



8.3.5.4 Preschools

- In general, New Zealand preschools generate higher vehicle trip rates (5-7 trips per staff) than their UK counterparts (3-4 trips per staff)
- Pupil numbers probably provide a more useful trip rate parameter than GFA or staff numbers.

Figure 8.6 **Comparison of New Zealand and UK trips rates vs staff for preschools**

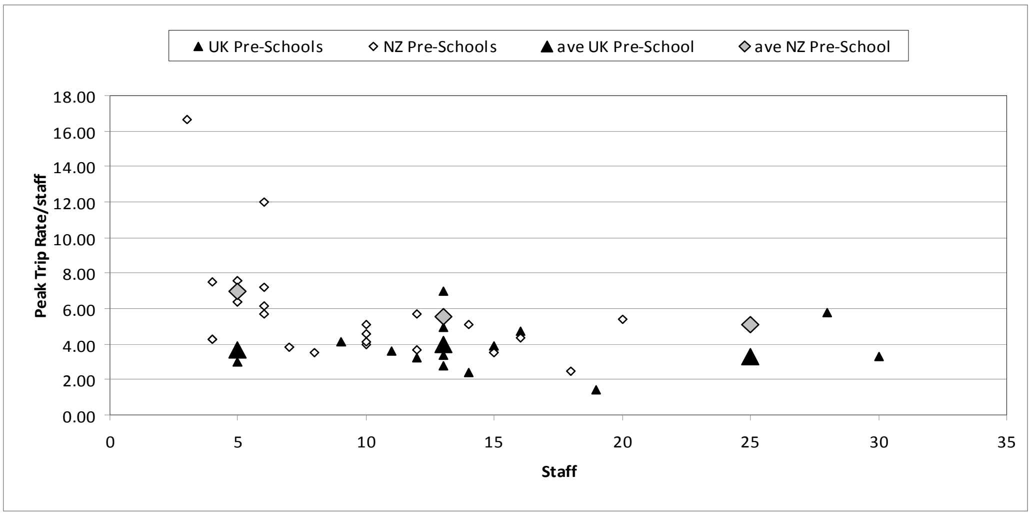


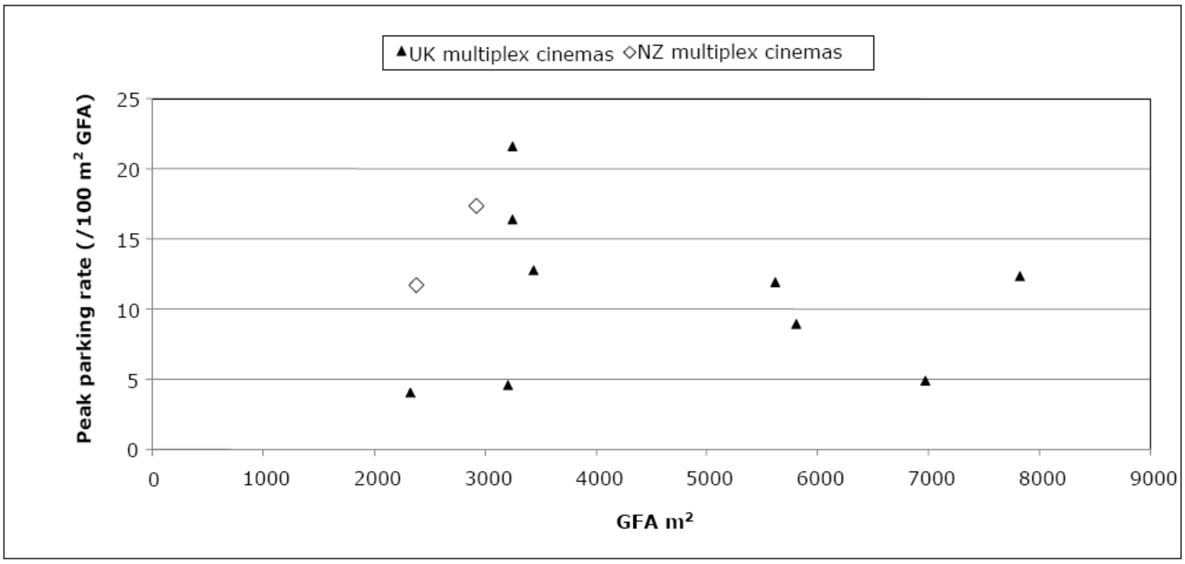
Table 8.6 **New Zealand and UK average vehicle peak trip rates vs staff for preschools**

No. staff	**New Zealand**			**UK**		
	n	**Ave**	**Sdev**	**n**	**Ave**	**Sdev**
1-10	6	**6.99**	4.81	3	**3.65**	-
11-16	10	**5.53**	2.77	9	**4.00**	1.38
>16	7	**5.10**	1.49	4	**3.28**	1.84

8.3.5.5 Multiplex cinemas

- The limited New Zealand data for multiplex cinemas sits within the general patterns established in the UK sites. The mean value is 11 parking spaces per 100m².

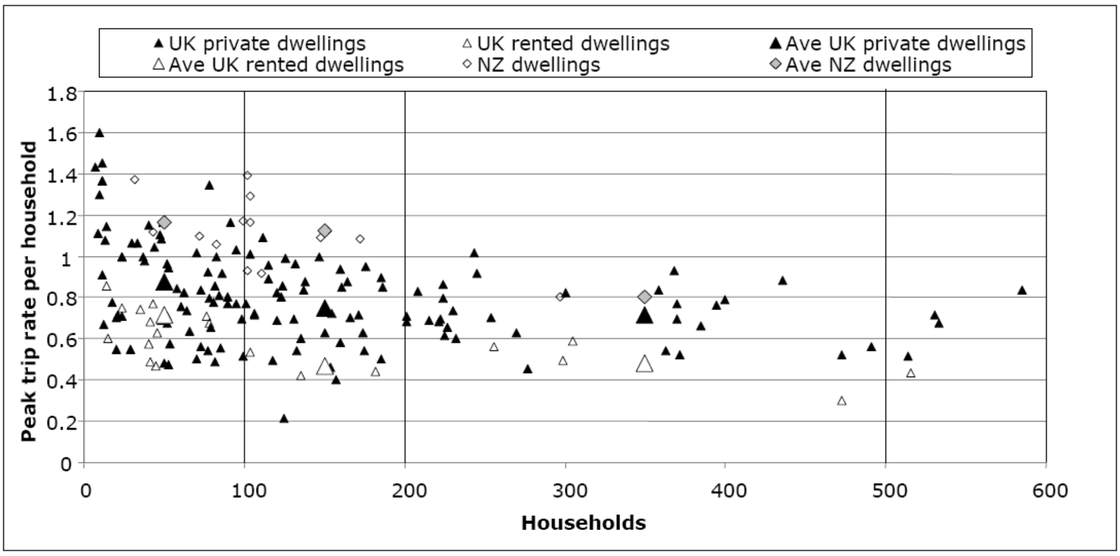
Figure 8.7 **Comparison of NZ and UK parking rates vs GFA for multiplex cinemas**



8.3.5.6 Residential

- Trends in trip rates between New Zealand and the UK associated with family dwellings have been compared, using households as the explanatory variable.

Figure 8.8 Comparison for New Zealand and UK trip rates for all dwellings



Trip rates have been related to the GFA as the only available parameter common to both countries. Usually, the number of bedrooms and/or residents is also known and is frequently used.

Table 8.7 Average New Zealand and UK trip rates for all dwellings in peak hour

GFA (m²)	New Zealand			UK rented			UK private		
	n	Ave	Sdev	n	Ave	Sdev	n	Ave	Sdev
1-100	5	**1.16**	0.12	13	**0.72**	0.22	63	**0.88**	0.26
101-200	7	**1.12**	0.20	3	**0.47**	0.06	36	**0.75**	0.20
201-500	1	**0.80**	-	4	**0.48**	0.13	30	**0.72**	0.13

Figure 8.8 shows the New Zealand dwelling dataset has a scatter of trip rates generally similar to the UK private dwellings data. Considering the New Zealand data in comparison with the UK sample size, the UK trip rates for private dwellings are 1.5 times that for rented accommodation. The New Zealand trip rates are, in turn, 1.3 times the UK private dwelling figure. Figure 8.8 shows a similar trend is associated with all three sets of data. The peak hour New Zealand residential vehicle trip generation rates of 1.12 are 0.4 trips per peak hour per household greater than the 0.75 trips per peak hour of their UK (privately owned) counterparts. For sites in excess of 200 dwellings, the difference in trip rates reduces to around 0.1 trips per hour per dwelling, with New Zealand sites producing a slightly higher trip rate of 0.8 trips per peak hour. The peak hour rate is normally between 7.30am and 8.30am. The full 12-hour daily flows vary between 8 to 10 times these peak hour rates.

8.4 Tables for four countries

Generally the trip rates for all four countries are of the same order and taking four land-use examples the results are shown in tables 8.8 and 8.9.

Table 8.8 Comparison of daily trip making (50% average)

Land use	New Zealand	Australia	USA	UK
Private dwelling: veh trips/day	10.7	9.0	9.5	7.6
Shopping centres 4000–10,000m² trip/100m/day	120	121	46	55
Service stations: per bay/day	122	170	161	196
Restaurant: trips/100m²/day	73	60	136	40

Table 8.9 Comparison of parking demand (85% satisfaction)

Land use	New Zealand	Australia	USA	UK
Private dwelling: cars/dwelling	2.8	2	2.2	1.5
Shopping centre (4000–10,000): vehs/100 GFA	5.0	5.5	4.7	6.0
Manufacturing: vehs/100 GFA	2.0	1.5	1.3	2.5
Restaurant: vehs/100GFA	13	15	18	9.5

It is appropriate to set out the current levels of trip generation and parking demand for a range of similar land uses in each of the four countries. Table 8.10 covers the current 2010 trip generation and parking demand rates for 27 equivalent land uses in New Zealand, Australia, the UK and USA. These comparative charts enable the similarities (and differences) between the four countries to be established as a basis for future comparison. The trip rate figures used here are the average, as these average figures were readily available for all four countries (as a matter of interest the analysis of New Zealand trip rates shows over all uses the 85% figure varies between x1.3 to x1.5 the average trip rate).

Table 8.11 shows the parking demand for the same group of land uses. The parking demand shown is the average and the 85% satisfaction level for all the sites in the corresponding database. The 85% would be a practical parking demand design figure for the land use group if each site was to be self contained with an adequate parking supply.

The four countries included in this comparison obviously have many trip generation and parking demand similarities. This reflects, of course, the common nature of the four economies, the way their cities work, the way the populations move around and also the style of commercial and retail services provided at these land uses in their communities.

Table 8.10 Comparison of New Zealand, Australian, US and UK trip generation rates 2010

Land use		New Zealand(a)		Australia(b)		United Kingdom(c)		USA(c)	
		Trip generation rates		Trip generation rates		Trip generation rates		Trip generation rates	
		Daily (vpd)	Peak hour (vph)	Daily (vpd)	Peak hour (vph)	Daily (vpd)	Peak hour (vph)	Daily (vpd)	Peak hour (vph)
Dwelling houses		10.7/ dwelling	1.3/ dwelling	9.0/ dwelling	0.85/ dwelling	7.6/ dwelling	0.66/ dwelling	9.57/ dwelling	1.02/ dwelling
Medium density residential flats		6.8/ dwelling	0.8/ dwelling	4-5/ dwelling	0.4-0.5/ dwelling	2.1/ dwelling	0.27/ dwelling	5.8/ dwelling	0.4/ dwelling
Retirement home		2.4/ bed	0.4/ bed	–	–	1.91/reside	0.21/reside	2.37/ bed	0.22/ bed
Retirement units		2.6/ unit	0.3/ unit	1.8/ unit	0.3/ unit	1.56/dwelling	0.18/dwelling	2.52/ unit	0.25/ unit
Motels		3/occ. unit	1.4/occ. unit	3/ unit	0.4/ unit	8.61/100m² GFA	0.69/100m² GFA	9.11/ unit	0.64/ unit
Commercial premises/offices		26.1/100m² GFA	2.5/100m² GFA	10/100m² GFA	2/100m² GFA	9.47/100m² GFA	1.32/100m² GFA	11.85/100m² GFA	1.55/100m² GFA
Shopping centres	Small	141/100m² (<4000m² GFA)	18.9/100m² GFA	121/100m² GLFA (<10,000m²)	16/100m² GLFA	122.1/100m² GFA	16.35/100m²	46.22/100m² GLA (weekday)	4.07/100m² GLA (weekday)
	Medium	101/100m² (4000 – 10,000m² GFA)	17.2/100m² GFA	78/100m² GLFA (10,000–20,000m²)	8/100m² GLFA	55.1/100m² GFA	11.68/100m² GFA		
	Large	84/100m² (>10,000m² GFA)	9.9/100m² GFA	63/100m² GLFA (20,000 – 30,000m²)	7/100m² GLFA	39.71/100m² GFA	9.3/100m² GFA	53.79/100m² GLA (Saturday)	5.26/100m² GLA (Saturday)
				50/100m² GLFA (>30,000m²)	6/100m² GLFA				
Service stations		718/100m² GFA	40.7/100m² GFA	680/site	40/site	196.6/filling bay	15.3/filling bay	161.39/filling station	13.73/filling station
		122/bay	20.4/bay	340/100m² GFA	20/100m² GFA				
Supermarkets		129/100m² GFA	17.9/100m² GFA	150/100m² GLFA	15.5/100m² GFA	121.7/100m²	12.2/100m²	110.05/100m²	10.50/100m² GFA
Plant nurseries		147/100m² GFA	27.8/100m² GFA	-	57+0.7/100m² GFA	14.7/100m² GFA	2.5/100m² GFA	38.84/100m² GFA	3.80/100m² GFA
Discount stores		100/100m² GFA	15.3/100m² GFA	-	-	-	-	61.61/100m² GFA	5.38/100m²
Large format retail stores/ home improvement		44.8/100m² GFA	5.6/100m² GFA	33/100m² GFA	5.6/100m² GFA	78.8/100m² GFA	10.3/100m² GFA	38.54/100m² GFA	3.56/100m² GFA

Land use	New Zealand(a)		Australia(b)		United Kingdom(c)		USA(c)	
	Trip generation rates		Trip generation rates		Trip generation rates		Trip generation rates	
	Daily (vpd)	Peak hour (vph)	Daily (vpd)	Peak hour (vph)	Daily (vpd)	Peak hour (vph)	Daily (vpd)	Peak hour (vph)
Video stores	74.1/100m^2 GFA	25.4/100m^2 GFA	–	–	–	–	–	14.64/100m^2 GFA
Drive-in fast food restaurant	362/100sm^2 GFA	52.2/100m^2 GFA	–	180/site	387.61/100m^2 GFA	39.41/100m^2 GFA	534.04/100m^2 GFA	36.43/100m^2 GFA
Restaurants	73.3/100m^2 GFA	18/100m^2 GFA	60/100m^2 GFA	5/100m^2 GFA	40.35/100m^2	5.96/100m^2	136.87/100m^2 GFA	12.0/100m^2 GFA
							4.83/seat	0.41/seat
Bars & taverns	92.1/100m^2 GFA	15.6/100m^2 GFA	-	-	56.5/100m^2	5.81/100m^2	-	-
Gymnasiums	37.2/100m^2 GFA	7.4/100m^2 GFA	45/100m^2 GFA	9/100m^2 GFA	25.2/100m^{2}GFA	3.0/100m^2 GFA	-	3.92/100m^2 GFA
Manufacturing	30/100m^2 GFA	2.7/100m^2 GFA	5/100m^2 GFA	1/100m^2 GFA	–	–	4.11/100m^2 GFA	0.79/100m^2 GFA
Warehouses	2.4/100m^2 GFA	1/100m^2 GFA	4/100m^2 GFA	0.5/100m^2 GFA	5.55/100m^2 FA	0.27/100m^2 GFA	3.83/100m^2 GFA	0.34/100m^2 GFA
Medical centres	64.1/100m^2 GFA	14.2/100m^2 GFA	60/100m^2 GFA	15/100m^2 GFA	39.23/100m^2 GFA	5.78/100m^{2}GFA	7.75/ employee	131/ employee
	31/ prof staff	6.5/ prof staff						
Hospitals	14.1/100m^2 GFA (12/ bed)	2.3/100m^2 GFA (1.3/ bed)	7.5/ bed	1 bed	12.88/100m^2 GFA (15.07/bed)	1.3/100m^2 GFA (1.53/ bed)	11.8/ bed	1.45/ bed
Preschools	4.1/ child	1.4/ child	–	1.4/ child	2.4/ pupil	0.5/ pupil	4.48/ student	0.82/ student
Primary schools	1.6/ pupil	0.7/ pupil	–	–	1.19/ pupil	0.39/ pupil	1.29/ student	0.45/ student

Notes: This is a comparative chart for identifying the general similarities (and differences) shared by traffic generation in these three countries. It is a summary table and should not be used alone as a basis for preparing detailed advice. More background is available in the reference manuals/databases.

a New Zealand figures are based on 85% figures from available surveys. For most land uses there will be 1.05 to 1.15 above average. For retail uses the 85% trip generation may be 1.15 to 1.25 higher than the average.

b Above Australian retail figures are mean or average for group (ie on day of survey not necessarily adjusted to seasonal peaks)

c Above American and UK figures are mean or average for group (ie on day of survey for weekdays and not adjusted to seasonal peaks)

GFA = gross floor area, GLFA = gross leasable floor area, SA = site area

– = not available or applicable

Table 8.11 Comparison of New Zealand, Australian, American and United Kingdom parking generation rates 2010

Land use		New Zealand surveys		Australian parking requirements(a)	UK surveys(b)		US surveys(c)	
		Average	85%	85%	Average	85%	Average	85%
Churches		22.4/100m^2 GFA	33.9/100m^2 GFA	–	4.21/100m^2 GFA	6.61/100m^2 GFA	8.41/100m^2	14.84/100m^2
Dwelling houses		1.4/ unit	2.8/ unit	1 –2/ dwelling	(d)	(d)	1.83/ unit	2.14/ unit
Medium density residential		1.2/ unit	1.8/ unit	1.5/ unit	–	–	–	–
Retirement home		0.3/ bed	0.4/ bed	0.1/ bed (visitors) + 0.5/ employee	0.25/ resident	0.33/ resident	1.12/ 100m^2 0.9/ employee	1.65/ 100m^2 1.21/ employee
Retirement units		0.9/ unit	1/ unit	0.67/ unit (resident) + 0.2/ unit (visitor)	0.44/ dwelling	0.57/ dwelling	0.33/ unit	0.36/ unit
Motels(e)		0.7/100m^2 GFA 0.9/ occ unit	1.1/100m^2 GFA 1.4/ occ unit	1 for each unit + 1 per 2 employees	0.5/ room	0.72/ room	0.90/ room	1.02/ room
Commercial premises/offices		2.7/100m^2 GFA	3.2/100m^2 GFA	2.5/100m^2 GFA	3.05/100m^2 GFA	5.02/100m^2 GFA	3.06/100m^2	3.7/100m^2
Shopping centres	Small	3.6/100m^2 (<4,000m^2 GFA)	5.0/100m^2 GFA	<10,000 GLFA 1/100m^2	5.38/100m^2 GFA	7/100m^2 GFA	Mon–Thu 2.85/100m^2 GLA	3.6/100m^2
	Medium	3.3/100m^2 (4,000–10,000m^2 GFA)	4.9/100m^2 GFA	10,000–20,000 5.5/100m^2	5.64/100m^2 GFA	6.25/100m^2 GFA	Weekday: 3.25/ 100m^2	4.69/100m^2
	Large	2.7/100m^2 (>10,000 m^2 GFA)	3.7/100m^2 GFA	20,000–30,000 4.3/100m^2 >3000 4.1/100m^2	3.8/100m^2 GFA	5.0/100m^2 GFA	Sat: 3.2/100m^2	3.83/100m^2
Discount store		5.2/100m^2 GFA	6.5/100m^2 GFA	–	–	–	Sat noon Dec: 2.96 /100m^2	3.46/100m^2
Supermarkets(f)		4.2/100m^2 GFA	5.3/100m^2 GFA	4.2/100m^2 GLFA	5.4/100m^2 GFA	6.99/100m^2 GFA	4.69/100m^2	5.86/100m^2
Service stations		7.9/100m^2 GFA	9.1/100m^2 GFA	6/ work bay plus 5/100m^2 GFA of store	2.28/ filling bay	4.2/ filling bay	–	–
Roadside stalls		7.7/100m^2 GFA	8.5/100m^2 GFA	4/ stall	–	–	–	–
Drive-in liquor stores		1.7/100m^2 GFA	2.3/100m^2 GFA	-	–	–	–	–
Large format retail		1.6/100m^2	2.2/100m^2 GFA	2.5/100m^2 GLFA	--	–	–	–

Land use	**New Zealand surveys**		**Australian parking requirements**[(a)]	**UK surveys**[(b)]		**US surveys**[(c)]	
	Average	**85%**	**85%**	**Average**	**85%**	**Average**	**85%**
Drive-in fast food outlets	8/100m^2 GFA,	10.8/100m^2 GFA,	12/100m^2 GFA	5.28/100m^2 GFA	7.56/100m^2 GFA	weekday 10.66/ 100m^2 GFA	14.81/ 100m^2 GFA
	0.4/ seat	0.6/ seat				Sat 10.27/100m^2 GFA	14.62/100m^2 GFA
Restaurants	10.6/100m^2 GFA 5	13.2/100m^2 GFA	15/100m^2 GFA,	0.71/ seat	1.11/ seat	13.54/100m^2 GFA	18.96/100m^2 GFA
	0.5/ seat	0.6/ seat	1/3 seats			0.41/ seat	0.61/ seat
Bars & taverns	8/100m^2 GFA	10.9/100m^2 GFA	–	6.46/100m^2 GFA	9.66/100m^2 GFA		
Gymnasiums	4.5/100m^2	6/100m^2	3/100m^2 GFA	3.15/100m^2 GFA	3.92/100m^2 GFA	4.43/100m^2 GFA	6.83/100m^2 GFA
Warehouses[(g)]	0.9/100m^2 GFA	1.7/100m^2 GFA	1/300m^2 GFA	0.25/100m^2 GFA	0.38/100m^2 GFA	0.44/100m^2 GFA	0.67/100m^2
Manufacturing	1.1/100m^2 GFA	2.0/100m^2 GFA	1.3/100m^2 GFA	1.5/100m^2 GFA	2.14/100m^2 GFA	1.1/100m^2	1.27/100m^2
Stadiums	0.2/ spectator	0.2/ spectator	–	–	–	–	–
Plant nurseries	3.1/100m^2 GFA	6.1/100m^2 GFA	0.5 spaces/100m^2	–	–	–	–
			of site area	–	–	–	–
Medical centres	4.0/100m^2 GFA	6.0/100m^2 GFA	4/100m^2 GFA	3.01/100m^2 GFA	4.46/100m^2 GFA	4.77/100m^2 GFA	5.1/100m^2 GFA
	1.5/ prof staff	1.5/ prof staff					
Hospitals[(h)]	1.5/ bed	2.2/ bed	1.2/ bed	2.27/ bed	3.28/ bed	4.09/ bed	5.91/ bed
Preschools	0.2/ child	0.3/ child	0.25/ child	0.18/ child	0.28/ child	0.24/ student	0.34/ student
Primary schools	0.2/ pupil	0.3/ pupil	-	0.13/ pupil	0.19/ pupil	0.28/ student	0.36/ student

a Australian figures are assumed at 85% satisfaction

b All UK values are based on weekday surveys only

c American figures are based on surveyed average and estimated design for weekdays only

d TRICS parking demands are based on knowledge of arrivals, departures and number of parked vehicles pre survey - residential garaging prevents the number of pre-survey parked vehicles to be determined therefore no parking demand is available for this land use activity

e For the UK data motor lodge type facilities included within the hotel land use category has been selected as a comparative land use to motels

f UK values based on surveys that exclude sites that have on-site petrol filling stations

g UK sites based on non-retail (self storage) warehousing. GFA is based on internal and external areas within the site as appropriate

h UK sites based on general hospitals with a casualty department.

Note: This is a comparative chart for identifying the general similarities (and differences) shared by parking demand in these three countries. It is a summary table and should not be used alone as a basis for preparing advice. More background is available in the reference manuals.

9 Survey and forecasting practices

9.1 Sources of information

A full understanding of any proposed development is essential to predicting vehicle activity levels. The designer and planner must appreciate both the direct effect of the physical features of a site and the indirect factors such as catchment, competition and surrounding transportation systems. The likely catchment areas of the site affect the number of customers and visitors attracted, as well as determining the broad mode of travel characteristics. How the development is expected to interact with neighbouring activities, of a similar or complementary nature, will determine some of the patterns of vehicle activity, such as the duration of parking stay within a shared parking area.

One of the most important elements in determining the effects of traffic-generating activities is the collection of relevant data. In most situations where new developments are proposed, there will be only limited sources of information about the particular site or activity. While a major shopping centre, for example, will generate trip making and parking demand patterns similar to equivalent centres, there will always be modal split variations and catchment influences which surveys at other sites do not reveal.

The references section provides a useful resource for the designer and planner. The TRICS, RTA, TDB and ITE resources provide what the authors consider to be the most comparable and reliable reference data. The range of resources available is further complemented by information published electronically via the internet. Some of the documents listed in the references are available electronically, while further trip generation and parking demand studies can be readily accessed via search engines.

It is recommended any project requiring major investigation into trip generation or parking demand be referenced to existing survey information from the four databases discussed in the report. In addition some selected new site surveys of similar developments to that proposed will be of great assistance. The more information and supporting data that can be collected for a project, the more reliable the overall outcome in appropriate provision of traffic movement and parking facilities.

Practitioners should make a properly detailed assessment of the effects of the parking and trip making generated by a land-use development. Larger-scale developments will require quite detailed evaluation of travel characteristics that extends to the use of transportation models based on land use for estimating the site’s future level of vehicle trip generation.

The TDB *Database user guide November 2009* (TDB 2009) specifies the nature and quality of surveys and describes the format of the TDB database.

9.2 Need for multi-modal surveys

Following on from the discussion on the changing face of general transport activities in New Zealand (see section 1.5), any site trip generation and parking demand survey should include as much information as it is practicable to collect, including goods vehicles and the trips made by bus, cycle and walking as different modes of travel, rather than recording only vehicle-based activity. The increasing reference to the principles of ‘sustainable transport’ means survey design should incorporate increased awareness of the contribution to the total transport system of public transport, pedestrian and cycle trips, and the extent of car passenger travel as well as car drivers. This will require more on-site tally counts and interview surveys to fill the trip mode gap.

A good start for multi-modal surveys is to have employees/staff undertake self-administered questionnaires. This technique is cost effective and as well as defining the travel modes used by employees on their trips to/from work, other complementary information can be gleaned about home locations and trip distance and times. In addition household, sex, age and work types can be collected.

In New Zealand, there is a reliance on the five-yearly census and the New Zealand Household Travel Surveys for this type of information. However, these are both averaged within the census survey units for the destination premises and land uses. A site survey throughout a whole day together with personal interviews can add a considerable range of information for a full appraisal of the modes of travel to specific localities and individual retail and other premises. This is recommended for selected sites in the future.

There is more effort being applied to multi-modal surveys including recent NZTA research such as Pike (2011).

9.3 Site surveys

Traffic site surveys should be undertaken at appropriate times to ensure the assumptions and estimates made for a new development after opening have been realised, or to measure the consistency of performance of an existing facility. Studies after completion to see how developments perform and to compare this performance with the original estimates are desirable but seldom undertaken. In collecting surveys for the TDB database, the focus has been on identifying peak period trip generation to and from a site, together with the on-site parking accumulation at the busiest period. The quality of information collected by a site survey is closely related to the activity levels observed and recorded, and the explanatory factors and variables at the site. The standard survey summary sheet included in appendix E suggests the level of information that should be collected for a site and its activities.

Site surveys should ensure all of the particular traffic movement and parking accumulation activity of a site is fully covered, including on-site, off-site and on-street parking demands, particularly where overspill parking occurs or more convenient parking is located on the street. Survey organisers should visit and observe the site in question prior to designing any survey. This will allow an appropriate design for both the type of information collected and the period over which it will be most usefully collected. Frequently, not all the information listed in the survey forms is collected, and some surveys are of only limited coverage. The suggested priority for collection is:

1 essential information
  a dates and times
  b gross floor area
  c land-use activity
  d parking space supply (on-site and off-site)
  e short-term visitor parking, also employee/long-term car parking
  f parking demand at given time (peak hour)
  g trip generation (vehicles in + out) at (peak hour and daily)

2 desirable information:
  a arrivals by other modes (eg bus, bicycle, pedestrian)
  b goods vehicle trips and parking
  c arrivals/departures as passengers in vehicles
  d car passenger occupancy rates
  e visitor/customer head counts at intervals during survey
  f number of employees on the site
  g distribution (ie average stay at different time of day)
  h frontage road classification and passing traffic volumes
  i on/off site parking duration
3 useful information:
  a site size and percentage building coverage
  b trips (in + out) each hour throughout the day, all modes
  c population within catchment (up to at least 2km radius)
  d customers per year, per week, per day, per hour
  e seasonal turnover and trip generation characteristics
  f location relative to other land-use activities and floor areas within 200m
  g other variables (eg pupils, beds, congregation, spectators, pumps or filling positions)
  h distance of trip and location of origin of trip for visitors to the site
  i type of land use at origin of visitor trip (eg home, business, shops, recreation)
  j trip purpose (eg trips from home to shop, not home-based, to/from work)
  k trip types (eg primary, diverted, pass-by).

More mode split surveys should become the norm in the future. This follows from the discussion on the changing face of general transport activities in New Zealand (see section 1.5). Any site trip generation and parking demand survey should include as much information as it is practicable to collect, including goods vehicles and the different modes of travel, and in future should not rely solely on vehicle driver trips and parking demand. Chapter 8 covers this in more detail.

The current TDB survey form that is used as the basis for input to the TDB database is attached as appendix E. All surveys must be recorded on these summary forms to guarantee their quality and any necessary follow up.

The additional surveys required to fill the gaps and extend the TDB database will be more comprehensive and more expensive in the future. Additional sources of long-term funding from government, local government and industrial sponsors must be found to maintain a substantial programme of future surveys to provide the inputs for an increasing database.

9.4 Land-use descriptions

It is necessary to identify the type of land use on the survey site. It may also be necessary to describe the groups of activities or whether the site is isolated from other similar land uses.

For the purposes of this research, a simplified set of land uses has been established under the following nine principal groups:

1. assembly
2. commercial
3. educational
4. industrial
5. medical
6. recreational
7. residential
8. retail
9. rural

Within each group, supplementary definitions or key words have been provided in order to describe precisely the activity in appendix A. All sites surveyed in future should be described under their land use group and appropriate key words.

9.5 Adjusting to design hours

Any survey intended to provide design guidance for a particular land-use activity should be adjusted to a suitable design hour or agreed planned level of service (including constrained or unconstrained parking). This report suggests the 50th highest hour be adopted as an appropriate design level for trip generation and parking based on broadly all parking taking place on site and this is generally at a satisfaction level of 85%. Chapter 2 of this report gives guidance on applying seasonal, daily and hourly design factors in order to arrive at an appropriate design level that provides the necessary efficiency and convenience for parking and trip generation. This is most critical when considering high visitor generation land uses, in particular retail, audience entertainment and recreational land uses. This level recognises there is some inefficient use of resources if a traffic circulation or parking supply is designed to accommodate the peak demand in a year, and that in most retail and commercial activities the 50th highest hour approximates to the alternative industry standard of 85% satisfaction. The 85% satisfaction standard approximates to the 50th busiest hour for retail activities. By comparison, the 30th highest hour would approximate to 90% satisfaction, but this could be deemed a high standard for a site’s access and parking standard.

The methodology in chapter 2 and as set out in more detail in appendix B provides practitioners with a general approach to the selection of an appropriate design level, while also recognising local and regional information can be built into the design level assessment.

The planner of a trip generation or parking demand survey should take due cognisance of the time-related and seasonal effects through the course of trading or activity hours when extrapolating the survey data for facility design. Although the particular values and design factors presented in this report may be adjusted at the discretion of the transport planner or engineer, the basic methodology behind the application of seasonal, daily and hourly design factors should be consistent and clearly described.

9.6 Rational forecasting

Simple extrapolation of survey data from one site to another, or from one activity to another should be undertaken with caution. Discretion should be exercised when applying a set of surveyed trip generation or parking demand values to a new site or a site elsewhere in the country. In the absence of appropriate references, there is no option but to undertake more site-specific field surveys.

The prudent planner or engineer will seek out as much survey information as possible as well as drawing on published information that may be available. The more information relating to a particular planned development that can be collected, providing a range of possible trip generation and parking demand rates, the better the basis upon which to give advice, make forecasts and recommend designs suited to future needs.

In those regions where comprehensive transportation studies are based on home questionnaire surveys, regional four-step models and network assignments there may also be more confident long-term future forecasts available.

9.7 Census and other surveys

Many business research and household census-type surveys are made throughout communities. Fortunately, the national five-yearly census still includes the question on mode of travel for ‘trips to work’ and origin and destination..

Recent research on the NZHTS (Abley et al 2008) provides a description of travel and the variations in different sizes of community. The soon to be published NZTA research report ‘Travel profiling part B’ extends this work.

While some areas, such as retail and suburban residential land uses, are well represented in the TDB database, there are also some obvious gaps. These include:

- for trip generation:
    - goods movements (all land uses)
    - pedestrian movements (all land uses)
    - schools, secondary and primary
    - places of assembly and entertainment
    - restaurants large and small
    - offices both suburban and in CBD

  - industries and warehouses
  - gymnasiums and keep-fit classes
  - trips to work questionnaire surveys (all land uses)
  - hotel residential
  - multi-unit and apartment buildings
  - transfer nodes, eg rail, bus stations and airports
- for parking demand:
  - schools, on-site and street
  - recreation stadiums and arenas, sports fields and courts
  - offices separating short-term and commuter demands
  - gymnasiums and keep-fit classes
  - goods vehicles (all uses)
  - places of assembly and entertainment
  - restaurants large and small
  - multi-unit and apartment buildings.
  - parking at transfer nodes, eg rail, bus stations and airports.

These should be surveyed and added to the database as opportunity permits.

The above ‘gaps’ point to the need for many more multi-modal surveys over a wider range of land uses and sites in the future.

10 Comparison of four trip rate and parking demand international databases

10.1 Introduction

A review of four trip rate and parking demand databases was undertaken. The New Zealand database reviewed was from the New Zealand Trips, Parking Database Bureau which is now called the TDB. The international databases reviewed were the Trip Rate Information Computer System (TRICS) from the UK, Roads and Traffic Authority (RTA) of Australia and Institute of Transportation Engineers (ITE) Trip Generation of the United States. A fifth reference, *NZTA research report 374* (Milne et al 2009) compares New Zealand and UK trips and parking rates.

10.2 Style of the databases

10.2.1 TDB database

The computer database developed in 2001 by the TDB has been in use by traffic engineers and planners for 10 years and has been extended to 700 New Zealand and 300 Australian sites. The TDB database was first published in 2001 as *Transfund NZ research report 210* 'Trips and parking related to land use. Volume 2: Trip and parking surveys database'. This report has been superseded by regular releases and upgrades of the database and should no longer be referred to.

The current TDB database (version July 2007 – June 2008) contains approximately 693 New Zealand sites and 192 Australian sites from the RTA. The information is retained at individual site by site levels. The database is supplied to members as a Microsoft Excel spreadsheet on CD which is updated annually. Other TDB research documents, survey methodology, technical notes and similar aids to the understanding of the database are available on request as well as the website – www.tdbonline.org.

10.2.2 TRICS database

TRICS is a database that contains traffic count information for over 3199 individual sites, 5746 days of survey counts and 110 land-use sub-categories. The database was formed in 1989 and had 301 organisations holding licences when TRICS 2008(b) was issued.

TRICS is the most comprehensive database available.

TRICS now has two database versions available. Members of TRICS can search the database on a site-by-site basis via an online version that can be accessed via the TRICS website www.trics.org and an offline version that can also be downloaded via the TRICS website. Individual site details stored in either version can be imported into Microsoft Excel spreadsheet for further data manipulation. New Zealand and Australian members of the TDB have 'inquiry access' to these TRICS databases through nominated representatives in each of the main cities.

10.2.3 ITE database

ITE (2008) *Trip generation,* 8th edition, consists of two data volumes with land-use descriptions, trip generation rates, equations and data plots. Data is included from more than 4800 sites and 162 land uses. The survey information is merged and analysed together for land-use groups rather than being retained at an individual site-by-site level. The ITE database is produced in book format and there is also a software version available. Trip Generation by Microtrans software (www.tripgeneration.com) calculates traffic generation on the basis of the ITE database and has been updated with each new edition of the ITE report.

In addition, the ITE (2004) *Parking generation,* 3rd edition, has 91 land uses represented and includes parking demand data by hour of day.

10.2.4 RTA database

The RTA database is a published document that contains vehicle trip rates and parking rates information for nine main land uses. The document only provides an average trip or parking rate by grouped land-use activities. Site-by-site details of each land use activity are not included within this document. Much of the trip and parking rates are based on surveyed data from the 1990s; however, surveys of large format retail stores and senior housing have been added in 2009.

10.2.5 Summary

A comparison of the national and the international databases by database style is shown in table 10.1.

Table 10.1 Summary of databases by style

Database style	TDB	TRICS	ITE	RTA
Microsoft Excel spreadsheet format	Yes	No	No	No
Computer database	No	Yes	Yes	No
Online version	No	Yes	No	No
Hardcopy	No	No	Yes	Yes
Site by site level	Yes	Yes	No	No

10.3 Database parameters

10.3.1 TDB database

Trip rates and parking rates can be calculated using a variety of parameters or data fields. The most common is the rate per 100m² of gross floor area (GFA). This parameter is normally surveyed and trips and parking rates for all surveyed sites are calculated on this basis initially. The following six parameter fields are included in the database as being common to a large proportion of land-use groups and wherever possible all six should be observed and recorded: gross floor area (GFA), site area (SA), employees (emp), residential units (h/h), people or occupants (pp) and car parks (p).

10.3.2 TRICS database

Most land-use categories will have one to four variables, or parameters, by which trip rates can be calculated. GFA, employee numbers, parking spaces and site area are extensively applied to a wide range of land uses when calculating trip or parking rates. The most common parameter fields in the TRICS database are GFA, parking spaces and site area. Some more recent sites within the database include a ‘GFA not in use’ figure, which represents GFA as defined within the TRICS Help section that was not in use at the time the survey was undertaken.

10.3.3 ITE database

For the purposes of estimating trip generation, an independent variable is defined as a physical, measurable and predictable unit describing the study site or trip generator (eg GFA, employees, seats, dwelling units). It is important the analyst understands the definition of each potential independent variable for a particular land use. When the user has a choice of independent variable, it is best to use one that produces a rate/equation with the ‘best fit’ of data. The most commonly used parameters in the ITE database are gross floor area (GFA), gross leasable area (GLA), number of seats, number of employees and dwelling units.

10.3.4 RTA database

The RTA database provides average trip or parking rates for nine main land uses: residential, casual accommodation, office and commercial, retail, refreshments, recreational and tourist facilities, road transport facilities, industry and health and community services. The most commonly used parameters for the RTA database are gross floor area (GFA) and dwelling units. Gross floor leasable area (GFLA) is generally used for retail, which provides a better indication of trip generation than gross floor area.

10.4 Multi-modal survey data

10.4.1 TDB database

The most up-to-date TDB database (version Nov 2009) contains a moderate number of multi-modal survey data, approximately 90 New Zealand data sets, that show the percentage split of total trip generation by travel modes. The TDB multi-modal survey data is available for 12 land-use activities. A pilot study has now been published as *NZTA research report 439* (Pike 2011), which aims to establish data required and develop survey techniques to enable calculation of trip rates for walking, cycling and public transport trips to a variety of activities.

10.4.2 TRICS database

The TRICS (2009) database v6.4.2 contains approximately 600 multi-modal survey data for over 15 land uses. The survey data indicates trip generation of developments by six different modes by hourly intervals. To ensure multi-modal surveys are prepared and undertaken appropriately, JMP Consultants Ltd has prepared a multi-modal survey methodology. This document sets out how to undertake multi-modal surveys, from the initial site visit through to the production of a detailed survey specification, and can be used as guidance for practitioners wishing to undertake multi-modal or traffic surveys that are compatible with TRICS.

10.4.3 ITE database

ITE *Trip generation* (2008) contains more than 4800 survey data (vehicles only) for 162 land uses. Truck trip generation rates information is also available in the ITE (2004) *Trip generation handbook* 2nd edition. The handbook summarises heavy goods trip rates for approximately 12 different land uses. Trip rates for trucks by axle configurations are also included in the handbook. However, ITE points out these truck trip rates should be used with discretion as some data is more than 35 years old and there are inconsistent definitions of trucks and truck trips between the earlier and more recent surveys.

10.4.4 RTA database

The RTA has published a series of trip generation analysis reports for different land-use activities. The survey data contained in these reports is now summarised and included in the TDB database as 'RTA database 2009'. The RTA database 2009 contains 109 surveys that show the percentage split of total trip generation by travel modes. The multi-modal survey data is only available for five different land-use activities.

10.4.5 Summary

A comparison of the four databases by multi-modal information is shown in table 10.2.

Table 10.2 Summary of databases by multi-modal information

Database content	TDB	TRICS	ITE	RTA
Multi-modal data available	Yes	Yes	Light and heavy vehicle trip rates only.	Yes – now contained in the TDB database version Nov 2009.
Number of multi-modal survey data	90 (692 surveys)	600 (3199 surveys)	Nil (4800 surveys)	109 (192 surveys)
Formal multi-modal survey methodology	No	Yes	No	No
Surveyed modes	Car driver, car passenger, goods driver, goods passenger, pedestrian, cyclist, bus passenger	Vehicles, pedestrians, public transport users, cyclists, occupants, public service vehicles, goods vehicles, taxis	Vehicles and trucks	Car driver, car passenger, goods driver, goods passenger, pedestrian, cyclist, public transport
No. of surveyed activities (multi-modal)	12	84	Nil	5

10.5 Seasonal/daily/hourly variations

10.5.1 TDB database

Report 209 set out hour of day, day of week, and seasonal factors for retail activities. The hour of day factors were derived using pedestrian foot counts at a shopping centre and hourly parking building occupancy counts for two major urban centres. Data from several of the NZTA's continuous count stations in larger metropolitan areas were also analysed over a full year.

The day of week factors were derived by using the daily pedestrian activity pattern recorded at a major suburban shopping centre (>20,000m² GFA) over a seven-day trading week, a holiday week and a busy December trading week.

The seasonal factors were derived by using 16 of the NZTA's continuous on-road SH count stations throughout the country to indicate the pattern and scale of general traffic activity levels within the major road network of metropolitan, urban and tourist centres.

10.5.2 TRICS database

JMP Consultants published a TRICS seasonality research document in 2002 (TRICS 2002). The objective of this research was to assist TRICS practitioners in identifying typical profiles of vehicle trip making throughout the course of a year for different types of land use. The research illustrated how traffic activity varied for different land uses by time of day, day of week and month of year.

The research considered eight sites in total, from five main land-use activities. These were: retail (three sites), employment (one site), health (one site), residential (two sites) and golf (one site). Automatic traffic counter loops were positioned at the main vehicle entrance of the sites to identify all vehicle movements over 24-hour periods for 12 months. Mean am and pm peak-hour, 12-hour and 24-hour traffic flows are tabulated, by month of year and day of week, for each site. The time at which the am and pm peak-hour flows occurred are tabulated, by month of year and day of week, for each site. Graphs showing hourly flow by time of day for each site are also included in the report.

To assist practitioners on when to undertake surveys for the above land use, the report identifies the months with less than 5% variation in mean weekday 24-hour flow and the days with less than 5% variation in mean 24-hour flow. The peak two-hour periods by day of week and land use are also tabulated.

10.5.3 ITE database

The *Trip generation handbook* 2nd edition (ITE 2003b) includes data on time of day, day of week and seasonal variations for shopping centres only. The hourly variation in shopping centre traffic as a proportion of the 24 hour entering and exiting traffic for an average weekday, Saturday and Sunday are shown in section 2 of the handbook in a tabular form. The daily variation in shopping centre traffic as a percentage of weekday volume and the monthly variation in shopping centre traffic as a percentage of average month volume are also presented in tabular forms in section 2 of the handbook.

ITE recommends exercising caution when using the summary data on time of day, day of week and seasonal variations as the number of studies providing this data is limited.

10.5.4 RTA database

The *Land use traffic generation data and analysis report* (RTA 1995) sets out daily and seasonal variations for shopping centres. Automatic traffic counters were installed at the entry and exit points of the selected shopping centres. These provided data on vehicle arrival and departure patterns as well as demand for car parking.

The report summarises the variation of daily traffic flow factors based on four sites over the months June to September in a tabular form. The monthly variation in daily traffic flow factors is also summarised in a tabular form inside the report, although RTA only observed the traffic flows at one shopping centre over four years from 1989 to 1991.

10.5.5 Summary

A comparison of the national and the international databases by seasonal/daily/hourly information is shown in table 10.3.

Table 10.3 Summary of databases by seasonal/daily/hourly information

Factors		TDB	TRICS	ITE	RTA
Hour of day	Availability	Yes	Yes	Yes	No
	Data source	• Pedestrian counts at a shopping centre • Hourly parking building occupancy counts • SH continuous traffic count data	• Automatic traffic counter	Unknown	Whole week 12-hour daily counts
Day of week	Availability	Yes	Yes	Yes	Yes
	Data source	• Pedestrian counts at a shopping centre	• Automatic traffic counter	Unknown	• Automatic traffic counter
Seasonal	Availability	Yes	Yes	Yes	Yes
	Data source	• SH continuous traffic count data	• Automatic traffic counter	Unknown	• Automatic traffic counter
Relevant activities		Retail	• Retail • Employment • Health • Residential • Golf	Shopping centres	Shopping centres

10.6 Trip types

10.6.1 TDB database

The TDB does not, at present, contain trip type information describing ‘primary’, ‘pass-by’ and ‘diverted’ trips.

10.6.2 TRICS database

The TRICS database does not contain trip type information. However JMP Consultants have published *TRICS research report 95/2* ‘Pass by and diverted traffic – a resume’ (TRICS 1995).

10.6.3 ITE database

The *Trip generation handbook* 2nd edition (ITE 2003b) includes information on the proportions of primary, pass-by and diverted linked trips for different land use activities listed in table 10.4

Table 10.4 ITE land-use activities with primary, pass-by and diverted trip data

Land-use activity	Day of the week/period	No. of surveys
Free-standing discount superstore	Weekday, pm peak period	8
Free-standing discount store	Weekday, pm peak period	31
Hardware/paint store	Weekday, peak period	2
Shopping centre	Weekday, pm peak period	100
Automobile parts sales	Weekday, pm peak period	1
Tyre store	Weekday, pm peak period	3
Supermarket	Weekday, pm peak period	9
Convenience market (24 hours)	Weekday, pm peak period	11
Convenience market with gasoline pumps	Weekday, am & pm peak periods	24
Discount supermarket	Weekday, pm peak period	10
Home improvement superstore	Weekday, pm peak period	3
Electronics superstore	Weekday, pm peak period	1
Pharmacy/drugstore without drive-through window	Weekday, pm peak period	6
Pharmacy/drugstore with drive-through window	Weekday, pm peak period	3
Furniture store	Weekday, pm peak period	3
Drive-in bank	Weekday, pm peak period	6
Quality restaurant	Weekday, pm peak period	4
High-turnover (sit-down) restaurant	Weekday, pm peak period	12
Fast-food restaurant with drive-through window	Weekday, am & pm peak periods	24
Fast-food restaurant without drive-through window	Weekday	4
Gasoline/service station	Weekday, am & pm peak periods	9
Gasoline/service station with convenience market	Weekday, am & pm peak periods	19

10.6.4 RTA database

There is no formal information of trip types contained in the RTA 'Guide to traffic generating developments' report. However RTA has published a series of trip generation and parking generation technical reports for different land use activities. Table 10.5 presents a list of land-use activities RTA has studied that contains trip type information.

Table 10.5 RTA land-use activities with trip type data

Land-use activity	Day of the week/period	Trip types	No. of survey data
Housing for seniors	Weekdays and weekends	Primary, pass-by and multi-purpose trips	10
Large format goods/hardware stores	Weekdays and weekends	Primary, pass-by and multi-purpose trips	11
Drive-through restaurants	Friday and Saturday	Percentage of pass-by trips only	8
Shopping centres	Thursday 5.30pm–7.30pm Saturday 10.00am–12.00 noon Friday all day	Percentage of linked trips only	42

10.7 Survey results and transfer to the New Zealand database

Having captured the on-site survey information it is essential the survey phase is completed by forwarding the information to the TDB. Completing the summary survey sheet attached as appendix E is the first step in this process. The survey sheet is also a convenient means of checking all the necessary vital information has been collected and recorded.

The *Database user guide* (TDB 2009) sets out in section 5 'Site survey summary sheet guideline' what should be included on the survey summary sheet and also the definitions of the information to be included.

The information contains the level of detail regarding trips and parking generation associated with the defined land-use activity. Any organisation undertaking such traffic surveys should use this form for their initial analysis of the raw information. The sheet matches the specific data requirements to be entered into the TDB database.

The TDB is the only point of entry for the new data and the manager of the database must check the adequacy of the information and confirm the survey results forwarded are reliable and can be entered into the database. The confirmation of the quality and reliability of the surveyed information is made at that point. Following entry it is possible to instantly compare the newly entered results with those already captured and proceed to make comparisons.

In 2009, the UK TRICS consortium agreed to have a special arrangement with the New Zealand TDB. This enables up to six New Zealand and six Australian subsequent licences to be available for access to TRICS on TDB membership enquiry.

The present arrangement for accessing the TRICS database in New Zealand, on enquiry, is through six New Zealand consultant offices and this service, provided by the Database Advisory Group, is under continual review. It is hoped New Zealand and Australian members will make greater use of this service.

The necessary improvements required to move the TDB database to website access and distribution are in hand. But it is considered this will only be feasible and economic with a larger Australasian membership and better quality of data. Before this occurs it will be desirable to gather a lot more survey data for a wider range of uses so the database will be carrying a greater volume of data for comparison and selection of comparable sites.

11 Conclusion and recommendations

As well as revising Report 209, this report compares recent New Zealand, Australia, UK and USA information on trip and parking related to land use, and reviews current trip generation survey and data manuals from these four countries.

Report 209 found total traffic in the community had increased by a factor of 2.2 during the previous 40 years. However, the intensity of traffic activity at the individual site level changed little during the same period. The growth in demand was largely met by an increase in the number of establishments matched to the community's needs. That earlier research has now been complemented by this research covering the results of surveys on many land uses in New Zealand between 1998 and 2009.

This revised version also includes a consideration of seasonal factors and recommends using the 50th highest design hour and the 85% parking satisfaction level (for unconstrained parking), as well as undertaking more surveys of multi-modal transport and land use and trip generation and parking demand. The full trip and parking surveys database is now included in the Trips Database Bureau's annual CD database with an increasing coverage of both New Zealand and Australian surveys.

The research indicated a general consistency in the travel trends seen in New Zealand with those reported in UK, US and Australian research and publications.

The appendices which follow cover:

A Land use and site location relevant to the database

B Seasonal factors and design hours

C Current trip generation and parking demand rates at 15%, 50% and 85% satisfaction

D Trip databases, practitioners questions and responses

E Site survey summary sheet.

This report covers a wider range of issues than Report 209 including modal split, trip purposes, a detailed comparison of New Zealand, the UK and US trip rates and parking demand associated with retail centres and some other selected land uses.

It is to be hoped the TDB trip database will be maintained and extended in the future and enable this report to be revised and extended in 2020 for use in the following decades.

11.1 Recommendations

1. That the TDB database is extended as a cooperative public/private service with increasing emphasis on multi-modal trip data.
2. That the joint New Zealand and Australian memberships are increased and a mixture of voluntary and contracted surveys undertaken to add significantly to the number and variety of sites included in the TDB database.

3 That the TDB database is placed on a website platform to improve its utility and ease of update and maintenance.

4 That liaison is continued with TRICS (UK) with a view to continued sharing of survey results, database definitions and database programmes.

5 That the NZ Transport Agency is encouraged to continue their support for increasing knowledge in the area of integrating transport and land use and the collection of data to give a better understanding of travel by all modes to individual land uses.

6 That the TDB site survey summary sheet is updated and note if other factors may have affected the survey results including the use of an operative travel plan and if congestion and/or parking restraint may have affected the survey results.

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Appendix A: Land-use and site location characteristics

A.1 Introduction

The database is categorised into nine land-use groups. The land-use groups are based on the typical definitions used by town planners in developing zones for district plans. Within the individual land-use groups there are further subdivisions which are defined as land-use activities in the database. These activities are recognisable town planning, employment and visitor attracting activities. At this level the difference in traffic generating characteristics becomes part of the reason for such definition.

Any practitioner investigating a particular land use will need to study a certain range of data categories as well as individual sites in order to select the appropriate description for the activity in question.

Additional categories of land-use groups and land-use activities may be required as specific and measurably different parking and traffic characteristics develop. TDB maintains and updates the land-use groups and land-use activities as necessary.

A.1.1 Land-use groups

Primary land-use groups generally coincide with land-use descriptions used in district plans. The following primary land-use groups are used to classify sites within the database.

- assembly
- commercial
- education
- industry
- medical
- recreation
- residential
- retail
- rural.

A.1.2 Land-use activities and descriptions

Surveyed sites are first categorised by land-use groups, as detailed above, then sub-categorised by land-use activity (column G of the database). The groupings are general in nature and more detailed site information is where necessary included in site descriptions (column H of the database). These descriptions should include whether the establishment has any exceptional features, eg post boxes at a shop, or service station at a supermarket etc. The land-use groups and land-use activities are listed in table A.1.

Table A.1 Land-use groups and land-use activities

Land-use group	Land-use activity
1. Assembly	**Church** – traditional church buildings as well as other religious and spiritual meeting places. The actual building may fall within another activity grouping, eg community centre/hall, but at certain times of the week caters for church-based activities.
	Cinema – including traditional single-screen, stand-alone facilities and multi-screen, multiplex cinemas.
	Community centre/hall – providing generally for the assembly of the public and community groups. These may also involve other ancillary activities, eg Citizens' Advice Bureau.
	Conference – venues, either separate or part of a hotel or other complex.
	Gallery – all public and private art and exhibition spaces.
	Museum – public and private facilities displaying items of general and specific interest, ranging from small community facilities through to the national museum.
	Theatre – places of live performance and which may also have café/bar facilities on-site.
	Visitor – tourist attractions – indoor visitor attractions with a variety of display and entertainment activities.
2. Commercial	**Banks** – including financial institutions and mail centres with direct service to the public.
	Business park – collection of office buildings in a free standing location, with a variety of organisations sharing access and services.
	Office – government and corporate administrative and professional services.
	Services – office operations where personal services such as insurance, accounting and real estate and other personal professional services (excluding medical) are provided.
3. Education	**Campus** – extensive military camps, training establishments, business schools, outward bound, health and recreation camps in rural and urban settings.
	Community – independent specialist education activities such as WEA offices, career training consultants and other training facilities.
	Library – libraries public and institutes including University archives, research library also research laboratories.
	Pre-school – including kindergartens, nursery schools, crèches, kohanga reo and Montessori facilities.
	Primary – state and independent schools including intermediate schools, catering for Years 1 to 9.
	Integrated – catering for Years 1 to 14.
	Secondary – catering for Years 10 to 14.
	Tertiary – university and polytechnic institutions as well as the increasing range of 'education providers' offering Qualifications Authority approved tertiary courses.
4. Industry	**Commercial** – light industrial activities generally associated with industrial parks. May include industrial offices and research laboratories.
	Contractor – activities where a range of construction and manual services are undertaken off-site.
	Industrial park – collection of industrial sites in a free-standing location.
	Manufacturing – production sites where raw materials, goods and services are further processed and then distributed.
	Storage – including warehousing, container storage, repacking and storage facilities for consolidation for forward transport (eg containers, couriers, mail centres, storage units).

Land-use group	Land-use activity
	Transport – activities where vehicles for the transport of people goods are based but the site itself is not used for the storage or processing. This includes terminal for road, rail, ports and airports.
5. Medical	**Centre** – broad category of general and specialist medical facilities, further defined according to the number of medical professionals engaged within the centre.
	Clinics – specialist chambers, free standing or associated with a hospital and may include minor routines and x-ray.
	Hospital – all public and private hospital facilities providing both day and overnight surgery and care. Could be further defined by size and functions in the third field.
	Veterinary – facilities dedicated to the care and treatment of animals, and involving the sale of pet and animal-related products.
6. Recreation	**Aquatic** – the range of facilities from stand-alone swimming pools to the modern aquatic centre providing water-based activities of many kinds and catering for a wide age range.
	Courses – facilities such as golf courses, and possibly polo fields or similar also driving ranges.
	Gymnasium – facilities for sports and fitness training, either as stand-alone commercial operations or attached to other facilities such as a university or school.
	Indoor courts – including the traditional range of racquet and ball sports.
	Marina – uses involving the berthing, launching, repair and storage of boats, and associated social activities.
	Outdoor courts – for sporting activities generally requiring a hard surface, including netball and tennis.
	Ski fields – maintain locations of commercial and club fields. Also ice-skating rinks.
	Sports fields – outdoor sporting facilities with primarily grass or artificial turf surfaces for summer and winter team sports but not associated with major audience stands and facilities.
	Stadium – indoor or outdoor seated venues catering for both sporting and cultural events.
	Tourist – outdoor tourist attractions, mazes, bungy jumping, historic villages
7. Residential	**Backpacker** – budget travellers accommodation, generally shared communal living facilities.
	Dwelling – traditional detached dwelling-houses, with one household units per site.
	Hostel – communal residential facilities catering for eg students, institutional workers such as nurses or project construction workers also prisons and other residential institutions.
	Hotel – travellers' accommodation facilities which include restaurant and bar facilities on-site and sometimes also catering and conference facilities such as seminar rooms.
	Motel – travellers' self contained kitchen and bathroom accommodation catering for vehicle-based travel and typically without on-site drinking or restaurant facilities.
	Multi-unit – residential units attached and grouped together and numbering more than 10 individual household units collectively.
	Retirement home – the range of residential and care facilities for the elderly and other age-groups, sometimes providing on-call and full-time medical and hospital care.
	Retirement unit – An individual apartment for retirement purposes generally provided as part of a wider retirement complex or village.
	Townhouse – groups of attached and semi-detached households generally one or two storeys high, and with 10 or fewer units per site.
8. Retail	**Automobile** – new sales, parts, service centre, second hand sales, tyres and rental cars.
	Bar – a wide range of drinking places, from small licensed café/wine bars to the more traditional taverns and pubs.

Land-use group	Land-use activity
	Large format retail – a recent addition to the range of New Zealand retailing facilities, covering large retail activities selling bulky goods including whiteware and home furnishings.
	Car sales – Car sales yards, showrooms, auctions and rental cars.
	Fast food – activities involving the preparation and sale of food with/without restaurant, sometimes with drive-through and pick-up.
	Garden centre – typically an indoor storage and display area in conjunction with an outdoor area, sometimes including other on-site facilities such as a café.
	Hardware – full range of building materials, households and garden hardware, DIY stores, such as Placemakers, Mitre 10, Bunnings etc.
	Market – an area either formally or informally arranged to provide for the wholesale or direct selling of fruit, vegetables and other items, eg wholesale fruit and vegetable market/auctions, as well as community markets held in parks, public squares and at schools.
	Motor vehicle – car sales display areas, building and yards.
	Produce – stand alone retail outlet specialising in the sale of fresh produce
	Restaurant – eat-in, sit-down restaurant facilities (excluding fast-food and takeaway outlets).
	Roadside sales – primary product roadside food stalls and other fruit and vegetable retailers.
	Service station – a site providing primarily for the sale of petrol and other fuels, often including other motoring accessories and services such as car grooming and car washes. On-site food and other retail facilities are also expected from most modern service stations.
	Shop – because of the wide range of individual retail outlets, this category has been left relatively broad and further description should be provided within the data record (H) itself.
	Shopping centre – collection of retail shops and services where joint facilities are shared, such as parking and access. Typically including grocery, pharmacist, hairdressers, bookshops, fruiterers, tailors, dress shops, furniture stores etc which may be surveyed together or separately.
	Supermarket – An establishment with a wide range of food and other retailing operations, ranging from the larger convenience store (eg Star Shop) to the grocery warehouse (eg Pak'nSave) and including discount operators such as The Warehouse, K-Mart and Briscoes.
9. Rural	**Factory** – Farming sites where stock and poultry are housed and managed in factory-farm facilities.
	Farming – primary production includes extensive grazing, raising of livestock, agriculture, growing of field crops for animals or human consumption.
	Horticulture – orchards, market gardens and intensive agriculture including glass houses and hydroponics.
	Primary processing – primary production yards, timber mills, cheese factories, milk-processing plants, fertilizer plants, winery, packing sheds etc.
	Stalls – see Retail
	Vineyards – where grapes are grown and processed, often also providing wine sales, tasting and sometimes restaurant facilities normally including winery.

A.2 Site location characteristics

A.2.1 Location environment

The location environment (column I of the TDB database) of a site is affected by the size of the community in which it is placed and also the relative position to the city centre, suburbs, outer edge of a city or in the rural area. The following main location environment groups are used to classify sites within the database:

- outer rural
- inner rural
- outer suburb
- inner suburb
- town centre.

A.2.2 Urban, rural and road situation

Columns N-P of the TDB database have been included to enable the total population of the city or locality involved and also to report the residential population within 1km and 5km radius from the site. This information is obtained from census information when results are being processed.

A.2.3 Frontage road hierarchy and daily traffic volume

The surveyed site's frontage road hierarchy and its daily traffic volume also provide further insights into the site location data. The major frontage road of the site is categorised in the following four broad groupings (columns J – M of the TDB database):

- major arterial road
- minor arterial road
- collector road
- local road.

Other factors such as location on the road network, the frontage environment, passing traffic volumes and proximity to adjacent intersections are also relevant. These factors may be identified in the survey comments and notes and reflected in the database information.

The daily traffic volume of the site's frontage road is recorded and the preferred recorded value is the annual average daily traffic (AADT). Alternatively vehicles per day (vpd) as collected and recorded on the survey day could be used.

A.2.4 Pedestrian activity and public transport accessibility

An indication of pedestrian activity on the frontage road/s and accessibility of the site to public transport is recorded in columns Q and R of the TDB database. These fields are specified as one of five categories ranging from 'nil' to 'very high'. See tables 5.1 and 5.2 of the TDB (2009) *Database user guide* for a guide to the level of activity corresponding to each of the five categories.

Appendix B: Seasonal factors and design hours – practice note

B.1 Selecting the 50th highest design hour

This appendix supports the summary given in chapter 2 and complements the procedure set out in *NZTA research report 422* 'Integrated transport assessment guidelines' (Abley et al 2010).

The data shows that throughout a full year there are significant changes in trips and parking activity levels associated with a wide range of land uses especially in retail centres. This points to a recommended parking design level to cater for all but the very busiest seasonal peak activity periods.

The detailed analyses and ranking calculations undertaken as part of the 2001 research indicated a 'reasonable' design parking demand for general retail and associated customer generating activity is one of the busy weeks in a holiday period or in early December.

For parking, the 50th highest hour is a useful starting point and coincides with the:

- 10th busiest week of the year
- 30th busiest day, and provides
- 85% satisfaction of the highest expected level of parking.

The investigations of activity levels at larger retail centres have revealed that it is prudent, at locations with particular operational factors (such as limited on-street public parking or low turnover of off-street parking lots), for developers and traffic planners to provide greater levels of available parking. In such situations, on-site parking to satisfy perhaps the demands of the 30th highest hour may be necessary. The 30th highest hour in the year will be about the 90% parking demand satisfaction but not all high trip generating sites would require that level of supply.

Using the 30th highest hour, a particular facility would provide more adequately for the very busiest hours or days of the retail trading year. However, it is then accepted that for a greater proportion of the trading year sections of the parking facility will be under-utilised.

The range of data available to practitioners on annual trading or activity patterns is often limited, and selecting the 50th highest hour or any other chosen design level requires experience and judgement. While arranging for data to be collected, for example, on a busy Thursday evening during the last week in November would provide close to a recommended 50th highest hour level, such situations and timing may be neither available nor convenient. As a means of converting any selected survey period (hour, day or week), the following sections provide a basis for converting raw survey information from surveys undertaken at other times of the year to a design activity level.

By applying seasonal, daily and hourly design factors to raw survey results, a better estimate of the design level (eg 50th highest hour, 30th busiest day, 10th busiest week yielding an 85% satisfaction) can be obtained. The formula to calculate the selected design hour from survey data is:

Design hour (D50)	=	Survey figure (S)	x	Hour of day factor (H)	x	Day of week factor (W)	x	Year (seasonal) factor (Y)

Such an equation can be used to calculate trip rates at say T30 hour and parking rates at the chosen P50 hour.

B.2 Hour of day factors (H)

To establish appropriate guidelines for the design of traffic and parking facilities associated with retail activities, it was decided to review the average weekday patterns of on-road traffic volumes generated by retail centre activity by making foot counts at a shopping centre and hourly parking building occupancy counts for two major urban centres. Data from several of the NZTA's continuous count stations in larger metropolitan areas were also analysed throughout typical weekdays averaged over a full year. In this way, on-road traffic, pedestrian activity and parking occupancy patterns could be compared. In section 2 there is more description of the seasonal variations.

Figure 2.3 illustrates the general pattern of hourly total person trips activity to a major retail centre recorded over a typical seven-day week.

Figure 2.4 shows the recommended scale factor pattern for factoring hourly trips related to a typical weekday.

From an appreciation of general retail activity, the 'recommended' scale factors have been selected to reflect the various time-dependent influences of both on-road traffic flows and site-generated pedestrian activity. This relates the hour of survey to the design hour which works for retail 11am–12 noon weekday or 1pm–2pm Saturday. Groups of weekly variations for a shopping centre are illustrated in figures 2.1 for person trips and 2.2 for parking.

Table B.1 Hourly design factors for retail (H)

Hour of survey (hour ending)	Scale factor		
	Weekday (non-late night)	Weekday late nights	Weekend
9.00am	1.83		
10.00am	1.36		1.82
11.00am	1.16		1.28
12.00 noon	1.00		1.09
1.00pm	1.01		1.05
2.00pm	1.10		1.00
3.00pm	1.14		1.08
4.00pm	1.10		1.29
5.00pm	1.20	1.15	
6.00pm	1.50	1.36	
7.00pm		1.38	
8.00pm		1.56	

☐ denotes design hour

B.3 Day of week factors (W)

Over the past decade there has been a general spreading of visitor parking activity through all seven days of the week and a move away from the traditional and earlier activity patterns of employment and shopping during weekdays culminating with Friday. The weekends now dominate the recreation, shopping and trips for entertainment. Retail activity, especially, is now more dispersed across the entire week. Figures 2.3, 2.4 and 2.5 illustrate the pattern of total daily pedestrian activity recorded at a major suburban shopping centre (>20,000m² GFA) on an hourly % basis over each day of a seven day trading week.

B.4 Seasonal or yearly factors (Y)

The only comprehensive and continuous traffic counts throughout the year are state highway (SH) road traffic volumes.

The 16 continuous count sites selected for this analysis were divided into three broad groups:

- Metropolitan locations – group 1- the major metropolitan sites close to the centre of cities, which display little holiday and special event traffic (eg Auckland Harbour Bridge and SH1/2 at Ngauranga Gorge, Wellington).
- Suburban areas and provincial centres – group 2 - sites on the periphery or within the urban areas of main and provincial centres where low to moderate effects of holiday traffic activity can be discerned (eg SH2 at Belmont, SH1 at Timaru).
- Seasonal holiday traffic – group 3 - beyond the main urban areas are sites along the main SH routes, often close to popular recreational areas, where strong seasonal and holiday traffic patterns are experienced (eg SH2 at Rimutaka, SH1 at Hallets Bay, Lake Taupo).

Figures 2.6, 2.7 and 2.8 show the seasonal variations. Table B.2 tabulates the corresponding weekly scale factor for converting a measured count during any week into the annual average, or the 5th busiest, design week.

The columns for the group 1 and 2 sites, relating to the major city and peripheral metropolitan areas, show relatively little variation in scale factor. During January and December both groups display higher scale factors, related to the dropping away of commuter and business traffic volumes through the quieter summer months around Christmas and New Year. In group 2, some small influence of increased holiday period activity (such as at Easter, Queen’s Birthday and Labour Weekend) is evident in the reduced scale factors at these times.

For the group 3 sites, illustrated in figure 2.6, there are definite and significant periods of holiday-related traffic where scale factors become essential in establishing any coordinated design traffic level. The chart clearly shows the effects of:

- January summer holidays
- Waitangi weekend (February)
- Easter and school holidays (April)
- Queen’s Birthday (first weekend in June)

- mid-term school holidays and busy period for skiing recreation (July)
- September school holidays
- Labour weekend (late October)
- Christmas and summer holidays.

These group 3 patterns are expected to be appropriate for many retail and recreational land-use activities associated with small-centre locations relying on recreational tourism and associated service centres alongside the inter-regional SH routes.

These seasonal fluctuations are set out numerically by weeks throughout the year in table B.2 as design factors for all sites. This table is derived to enable the factoring of surveys taken at any point in the year so as to be able to derive the average and the 5th busiest week, ie the 30th highest hour, for traffic and trips. These are based on the seasonal variations in travel illustrated in figures 2.6, 2.7 and 2.8 in section 2 of this report. If the designer seeks to relate a particular survey situation to the 10th busiest week and the 50th highest hour this can be interpolated from these graphs where the 10th highest week is identified.

Table B.2 Weekly design factors based on SH seasonal traffic counts by group

Week	for calendar year 1998	Group 1 Sites (metropolitan sites not subject to holiday extremes)		Group 2 Sites (peripheral metropolitan and provincial centres, holiday effects recognisable)		Group 3 Sites (small centres and those subject to holiday extremes)	
		Scale Factor to Obtain Annual Average Week	Scale Factor to Obtain 5th Busiest Week	Scale Factor to Obtain Annual Average Week	Scale Factor to Obtain 5th Busiest Week	Scale Factor to Obtain Annual Average Week	Scale Factor to Obtain 5th Busiest Week
1	04 Jan	1.57	1.65	1.29	1.37	1.71	0.73
2	11 Jan	1.15	1.20	1.08	1.14	1.31	0.96
3	18 Jan	1.05	1.10	1.06	1.12	1.18	1.06
4	25 Jan	1.02	1.07	1.00	1.06	1.15	1.09
5	01 Feb	**1.00**	1.05	0.99	1.05	1.03	1.21
6	08 Feb	1.03	1.08	1.02	1.08	1.25	**1.00**
7	15 Feb	0.96	1.01	0.98	1.04	1.08	1.16
8	22 Feb	0.96	1.01	0.96	1.02	1.08	1.16
9	01 Mar	0.95	**1.00**	0.96	1.02	1.05	1.19
10	08 Mar	0.97	1.02	0.98	1.04	1.02	1.23
11	15 Mar	1.01	1.07	**1.00**	1.06	0.95	1.32
12	22 Mar	0.97	1.02	0.97	1.03	0.97	1.30
13	29 Mar	0.99	1.04	0.98	1.04	0.91	1.38
14	05 Apr	0.99	1.04	0.98	1.04	0.87	1.45
15	12 Apr	1.06	1.11	0.98	1.04	1.22	1.02
16	19 Apr	1.04	1.09	0.99	1.05	1.27	0.99
17	26 Apr	0.98	1.03	0.95	1.01	1.05	1.20
18	03 May	0.99	1.04	1.01	1.07	0.86	1.46
19	10 May	0.99	1.04	**1.00**	1.07	0.84	1.50
20	17 May	0.99	1.04	1.01	1.08	0.82	1.53
21	24 May	**1.00**	1.05	1.03	1.09	0.81	1.55
22	31 May	**1.00**	1.05	1.01	1.07	0.91	1.37
23	07 Jun	1.03	1.08	1.05	1.12	0.87	1.44
24	14 Jun	1.01	1.06	1.03	1.09	0.77	1.63
25	21 Jun	1.01	1.07	1.04	1.10	0.80	1.56
26	28 Jun	1.04	1.09	1.05	1.11	0.80	1.56
27	05 Jul	1.02	1.07	1.05	1.11	0.86	1.46
28	12 Jul	1.01	1.06	1.03	1.09	0.99	1.26
29	19 Jul	**1.00**	1.06	1.04	1.11	0.98	1.28
30	26 Jul	0.99	1.04	1.10	1.17	0.80	1.57
31	02 Aug	0.99	1.04	1.09	1.15	0.80	1.57
32	09 Aug	0.99	1.04	1.06	1.13	0.82	1.54
33	16 Aug	**1.00**	1.05	1.04	1.10	0.81	1.54
34	23 Aug	0.99	1.04	1.03	1.09	0.83	1.51
35	30 Aug	**1.00**	1.05	1.04	1.10	0.81	1.55
36	06 Sep	0.99	1.04	1.02	1.08	0.86	1.46
37	13 Sep	0.99	1.04	1.02	1.09	0.88	1.43
38	20 Sep	0.99	1.04	1.02	1.08	0.87	1.43
39	27 Sep	0.99	1.04	1.01	1.07	0.92	1.36
40	04 Oct	0.98	1.03	0.99	1.05	1.07	1.17
41	11 Oct	0.99	1.04	0.98	1.04	1.05	1.19
42	18 Oct	0.98	1.03	1.01	1.08	0.88	1.42
43	25 Oct	1.01	1.06	0.97	1.03	1.07	1.17
44	01 Nov	1.04	1.10	**1.00**	1.06	1.06	1.18
45	08 Nov	0.97	1.02	0.97	1.03	0.96	1.30
46	15 Nov	0.99	1.04	0.95	1.01	1.06	1.18
47	22 Nov	0.95	**1.00**	0.95	1.01	**1.00**	1.25
48	29 Nov	0.95	**1.00**	0.94	**1.00**	1.01	1.24
49	06 Dec	0.94	0.98	0.94	**1.00**	0.99	1.27
50	13 Dec	0.92	0.97	0.92	0.97	1.00	1.26
51	20 Dec	0.92	0.96	0.92	0.98	1.04	1.21
52	27 Dec	1.07	1.12	0.91	0.97	1.41	0.89

☐ denotes equivalent design week(s) in series

B.5 Application of scale factors

As discussed in sections 2.5 and 2.6, the derivation of these weekly, daily and hourly scale factors has been based on the data available throughout the course of a year for pedestrian activity at a shopping centre in a major suburban centre, car-parking turnover and from a series of SH continuous count sites. It is recommended that the 30th highest hour and the 5th busiest week are the most appropriate trip generation design standards for retail and high visitor-attracting land uses while for most parking situation experience shows the 50th highest hour and the 10th busiest week yields an 85% satisfaction at the highest peak parking demands. As shown already, the five busiest weeks of the year also generally include the 30 highest trading hours of the year.

Table B.3 is a worksheet showing how all those scale factors contribute to determining suitable design hour Trips and Parking estimates. This procedure has been identified in Abley et al (2010, appendix D Practice note ITA PN 10/02).

Table B.3 Example of application of scale factors

LOCATION OF SURVEY Shopping Centre (size 3240 m^2 GFA)
High Street
SMALLSVILLE

SIZE AND POSITION 3240 m^2 GFA, frontage to urban arterial - 8000 vpd

DATE/TIME OF SURVEY Tuesday 9 May 2000
2:00 - 6:00pm

SURVEYED TRAFFIC AND PARKING RATES

peak trip generation :	131 vph (in)
(4:30-5:30pm)	<u>119 vph (out)</u>
	250 vph (in+out)

peak parking demand:	115 vehicles on-site
(5:15pm)	<u>12 vehicles off-site</u>
	127 vehicles total

surveyed trip generation rate (T)
250vph / 3240m^2 *100 = **T = 7.7 vph per 100m^2 GFA**

surveyed parking demand rate (P)
127 veh / 3240 m^2 * 100 = **P = 3.9 veh per 100m^2 GFA**

DETERMINE SCALE FACTORS

1. Identify the Hour of Day Factor (Table 2.1 for the time of peak survey or if the survey has been of sufficent length to isolate the peak period, use H = 1.0
   - peak activity 4.30 - 5.30pm, from Table 2.1, H=1.2
   - the survey established a peak activity in this hour and so a scale factor of H=1.0 to 1.2 is appropriate

   H = 1.1

2. Identify the Day of Week Factor (Table 2.2) for the survey day
   - in this case the survey day was a Tuesday and the scale factor from the table is :

   W = 1.38

3. Identify the Week of Year or Seasonal Factor (Table B.2) for the survey week
   - the example survey was conducted in the second week of May so from the table, a scale factor for a minor urban centre falling in Group 2, and having already decided to cater for the 5th busiest week is :

   Y = 1.07

4. The design trips and parking demand figures are then calculated as follows:

T_{30} = T x H x W x Y
= 7.7 x 1.1 x 1.38 x 1.07
<u>design trip generation = 12.5 vph/100 m^2 GFA</u>

P_{30} = P x H x W x Y
= 3.9 x 1.1 x 1.38 x 1.07
<u>design parking demand = 6.3 veh/100m^2 GFA</u>

Appendix C: Current New Zealand trip generation and parking demand

Table C.1 includes the 15%, 50% and 85% trips and parking demand rates.

Table C.1 New Zealand trip generation and parking demand

LAND USE CATEGORIES		No. of Sites Surveyed			Survey Results by Percentile									
						15%			50%			85%		
		Parking	Peak Hour Trips	Daily Trips	Units per...	Parking Demand	Peak Hour Trips	Daily Trips	Parking Demand	Peak Hour Trips	Daily Trips	Parking Demand	Peak Hour Trips	Daily Trips
1. ASSEMBLY	1.1 Church	6	3	0	Congregation	0.4	0.9	-	0.4	1.0	-	0.5	1.1	-
2. COMMERCIAL	2.1 Office	6	12	4	100m² GFA	2.4	0.9	13.5	2.7	1.6	19.6	3.2	2.5	26.1
3. EDUCATION	3.1 Preschool	25	26	6	Pupil	0.1	0.7	3.3	0.2	1.1	3.7	0.3	1.4	4.1
	3.2 Primary	4	6	3	Pupil	0.1	0.4	1.3	0.2	0.6	1.4	0.3	0.7	1.6
	3.3 Secondary	5	2	2	Pupil	0	0.1	0.3	0.1	0.1	0.3	0.1	0.1	0.4
	3.4 Tertiary	6	4	2	Pupil	0.1	0.1	0.8	0.3	0.2	1.1	0.3	0.2	1.4
		3	2	2	100m² GFA	0.9	0.5	3.4	2.7	1.1	7.3	4.4	1.7	11.3
4. INDUSTRY	4.1 Warehousing	13	21	2	100m² GFA	0.3	0.2	1.9	0.9	0.9	2.1	1.7	1.0	2.4
	4.2 Contractor	7	7	0	100m² GFA	0.8	0.4	-	2.8	2.8	-	5.1	6.2	-
	4.4 Manufacture	17	18	6	100m² GFA	0.4	0.5	7.6	1.1	1.4	17	2.0	2.7	30.0
5. MEDICAL	5.1 Centre	1	4	5	Professional	1.5	8.0	38.5	1.5	9.9	59.8	1.5	11.6	79.4
	5.2.1 Hospital (Small)	5	3	1	Bed	0.8	0.7	-	1.6	1.8	-	2.3	3.0	13.5
	5.2.1 Hospital (Large)	4	1	1	Bed	0.9	-	-	1.5	-	-	2.1	-	3.1
6. RECREATION	6.1 Stadium	6	0	0	Spectator	0.2	-	-	0.2	-	-	0.2	-	-
7. RESIDENTIAL	7.1 Inner City (Multi Unit)	1	2	0	Unit	-	0.2	-	-	0.3	-	-	0.3	-
	7.2.1 Dwelling (Inner Suburban)	0	14	38	Unit	-	0.9	7.8	-	1.1	9.5	-	1.2	10.9
	7.2.2 Dwelling (Outer Suburban)	0	1	6	Unit	-	-	5.4	-	-	6.9	-	0.9	8.2
	7.3 Dwelling (Rural)	0	4	4	Unit	-	0.9	6.9	-	1.1	8.5	-	1.4	10.1
	7.4.1 Retirement Home	5	4	4	Bed	0.3	0.2	1.9	0.3	0.3	2.1	0.4	0.4	2.4
	7.4.2 Retirement Units	4	1	1	Unit	0.8	-	-	0.9	-	-	1.0	0.3	2.6
	7.5 Hostel	5	1	1	Bed	0.2	-	-	0.3	-	-	0.4	0.6	2.5
	7.6 Motel	17	21	17	Occ. unit	0.4	0.3	0.6	0.9	0.8	1.7	1.4	1.4	3.0
	7.7 Hotel	4	3	3	Room	0.6	0.4	3.2	1.2	0.8	4.8	1.8	1.2	6.4
8. RETAIL	8.1 Shop	9	11	6	100m² GFA	1.7	10.4	47.0	4.3	26.2	93.4	9.5	42.5	129
	8.2.1 Shopping Centre (Small)	79	54	13	100m² GFA	1.7	9.5	33.9	3.6	14.6	92.0	5.0	18.9	141
	8.2.1 Shopping Centre (Medium)	39	23	5	100m² GFA	2.0	9.0	53.5	3.3	12.2	77.3	4.9	17.2	101
	8.2.1 Shopping Centre (Large)	40	19	3	100m² GFA	1.5	3.8	43.0	2.7	7.1	62.4	3.7	9.9	83.7
	8.2.1 Shopping Centre (CBD)	8	2	1	100m² GFA	1.0	4.8	-	1.7	6.6	-	2.9	8.5	55.9
	8.3 Garden Centre	4	7	7	100m² GFA	0.5	1.9	12.2	3.1	14.1	82.2	6.1	27.8	147
	8.4 Discount	6	6	1	100m² GFA	3.2	4.5	-	5.2	11.2	-	6.5	15.3	100
	8.5 Supermarket	12	11	3	100m² GFA	3.0	13.5	73.6	4.2	15.8	102	5.3	17.9	129
	8.6 Bulk	17	20	7	100m² GFA	0.8	1.0	13.5	1.6	4.0	29.4	2.2	5.6	44.8
	8.7 Restaurant	7	9	5	Seat	0.2	0.2	1.3	0.5	0.6	3.7	0.6	0.5	6.1
	8.8 Fast Food	5	5	4	100m² GFA	4.5	15.9	169	8.0	36	266	10.8	52.2	362
	8.9 Bar	19	10	3	100m² GFA	5.9	4.1	35.2	8.0	10.3	63.5	10.9	15.6	92.1
	8.10 Service Station	3	11	4	100m² GFA	6.6	36.2	209	7.9	65.1	449	9.1	100.9	718
	8.11 Market	3	2	3	100m² GFA	1.6	1.2	10.6	2.4	1.8	16.6	3.3	2.4	22.4
	8.12 Produce	3	2	2	100m² GFA	5.9	48.3	439	6.3	58.6	463	6.7	68.8	487

Appendix D: Trip databases: practitioner questions and responses

As part of the process of informing this research, revising Report 209 and indicating directions for the future of the TDB, a series of questions were asked by those who attended the Seminar in Auckland on 10 September 2009. The 24 returns reflected the practitioner interests and functions and their professional roles were spread between:-

Directors	6 – major interests in network planning and strategic matters
Modellers	5 – major interests in modelling and planning
Transportation engineers	6 – major interest in transportation assessments/surveys
Town planners	4 – interests in land use planning and transport assessments
Research and technicians	3 – major interests in safety/pedestrian/cycle facilities

The questions asked and the responses emerging from this research are as follows:

Table D.1 Practitioners' questions and answers

Policy issues	Response
P1: How can TDB best envisage its condition and status in five and 10 years time?	P1: So far TDB growth has been through a cooperative professional concern. The anticipated increased costs of surveys and the wider use of the information requires a big step up in funding. The Australian involvement is essential.
P2: When surveys are undertaken and processed, who owns the resulting data?	P2: It is in the wider professional and public interest for the information to be published and shared. Very few clients make a point of retaining it as 'their' property. In those cases obviously we cannot place it in the database. It is proposed to have an approval form for future surveys so the client agrees to forego ownership of the raw survey material. The interpretations, judgements and recommendations are, of course, the clients.
P3: Should a National Environment Standard be developed to ensure consistency?	P3: National standards could be used but we are dealing with infinite variations over innumerable sites. Experience shows that ongoing exchange of factual information is preferable to rigid adherence to a pre-selected group of average national standards. This is one of the reasons we note the 50% and the 85% data so practitioners and administrators must think about it.
P4: Is there a case for archiving and distribution of ITAs and reported data?	P4: There is a good case for archive availability but it seems impossible to do it in a national way. It is best to ring and talk to colleagues and take advantage of their recall, the published references and cumulative wisdom. Getting a report on equivalent sites already reported is a nice idea but they seldom cover what you need being tailored to the particular problem at hand.
P5: Is New Zealand big enough to support TDB or should we push Australia to take the lead?	P5 & P6: We have the TDB and it is now Australasian. There is a long journey ahead to gain membership, strong professional support and funding. Obviously government/state part funding is desirable in New Zealand and Australia through the state road authorities. The national database is best seen as a public good. There will be some consultants specialising in the area but they can see the benefits from a willing exchange of survey data with the Bureau. It does not matter whether it is run from Christchurch or Melbourne it must be a combined Australasian database of site by site information.
P6: Is it intended that a combined Australian/NZ database be established?	

P7: Will NZTA and TDB be allocating funding for specific projects for data collection?	P7: Some specific funding for research, eg this report, has been provided both from members and the NZTA (LTSA, Transfund, NRB). The big funding crunch is ahead. This is the cost of commissioned and focused surveys to add new sites to the database. TRICS spend $5M a year on surveys. RTA and others know the costs. Some mechanism must be put in place to subsidise members and consultants to undertake more comprehensive multi-modal surveys so as to extend the database.
P8: How can we make this information more accessible and useable to the different professions to achieve other purposes, eg urban design, access, energy use?	P8: The NZTA runs seminars and makes its research reports freely available. The TDB runs multi disciplinary workshops. Membership of TDB is not confined to transportation engineers and includes planning and economists as members. In the end if the work has the quality and the utility and all supporting it are heading in the same direction it will be used by others for a variety of purposes.
P9: Are there steps underway at TDB to produce a national survey methodology?	P9: The national survey methodology is an important and ongoing evolution. The TDB *Database user guide* is a good start. The recent report on integrated transportation assessments includes in its Part 3 provision for the preparation of practice notes and this is a very suitable place to publish a national survey methodology.
Travel plans, ITAs, reports	**Response**
T1: Will travel plans become a part of plan changes/resource consents under RMA?	T1: The integrated transport assessment (ITA) report provides a clear framework for the quality and extent of assessments related to the scale of a resource consent. There are clear occasions when an application must be subject to an appropriate assessment and district plans should recognise this when considering the status of any application.
T2: What criteria should be required by TLAs when processing consent applications?	T2: These criteria are now set out in the recent report as part of the framework for ITAs. All district plans should include in their policies for defining the status of applications and their zone rules suitable guidance as to when ITAs are required and their scale.
T3: There is a plethora of technical reports forming part of council agendas – parts of consent applications-- could these be captured and stored under key topic headings?	T3: As mentioned above (P4) this is easier said than done especially since we now have user pay arrangements on reports to council on applications etc. It is an additional function added on to the tail end of the council decision-making process and in this user-pay environment tends to be overlooked. However the principle should be explored by some of the lead councils and might be formally addressed by ARTA and the new Auckland Greater Council.
T4: What is the panel's view of the ITAs and travel plans becoming potential dust gatherers after their preparation at great expense to both developers and the community?	T4: There is a real risk that at needless excess of effort is made at the outset and then the reports are filed and forgotten. There is much effort beforehand to gain the decision and most often very little after observation to monitor or even measure the performance of the site or project after it is in operation.
T5: Do you think that we will get to the situation where there will be a standardised, national mandated ITA manual including methodology, format, applicability etc?	T5: As mentioned above (P9) there could be a move to establish a national standard. However the TDB subscribes to developing and improving professional practice for a self regulating profession. The NZTA report, including the publication of the recent ITA research help the profession more than a national standard would. However some council's and some developers do not have access to adequate professional advice and some 'model' ITAs and Rules might well be prepared to advantage.
T6: Travel plans - how do you get companies in the same industrial area to combine?	T6: Briefly there is a need for community collaboration and this involves the councils. Regrettably the larger the council the more formal the need for manuals to set out to secure these negotiation patterns.
Database form	**Response**
D1: (The most asked question) Is TDB going towards a web-based TRICS-like database?	D1, D2: Yes the TDB wishes to move, in a year or so, from its present CD Excel spread sheet database to a web-based system. Discussions will be held with TRICS and it is hoped an equally useful and flexible system can be introduced. However

D2: Is there the potential to move to a more user-friendly database front-end, like TRICS?	with only 100 members it is doubted whether the present membership can afford the shift. Also the quality of survey information has to be improved to justify that platform. It is something to strive for.
D3. Why use paper input to database-webpage data entry would surely be more useful?	D3: We wish to go to website upgrades but at the end of the day there must be strict control of the quality of information entered into the database. So users willing to add information must still first send it to the TDB manager to guarantee the consistency of the database. While users can extract the data and manipulate it they must not be able to corrupt it. This is essentially the CD Excel situation which already exists.
D4: Do we need a more disaggregate database on the influencing parameter variables?	D4: TDB would like to use a wider range of parameters and has introduced others, eg beds, seats, employees, etc which can be accessed through the 'drop down 'boxes. However if those sending the surveys in have not surveyed that information the gaps will not be filled.
D5: We are now collecting data (albeit limited in range) on modal split, how can this be applied to other establishments?	D5: The issue of surveying all modes at future survey sites is singly the most important hurdle to cover immediately. Research is being applied on multi modal surveys at this time. There is experience already available from selected consultants. As with all TDB sites once the individual site is clearly defined then by analogy from a similar site where modal surveys were undertaken some sensible judgement can give a reasoned answer.
Survey data	**Response**
S1: Should the bureau start to collecting questionnaire survey information on trip types and purposes (eg primary, diverted, pass-by) and also (HW,HS,HO and NHB etc) ?	S1: Again this range of data derived from questionnaire and footpath interviews provide useful information related to basic understanding of travel patterns. However the first obligation of TDB is to get a larger database on trip generation by all modes. These more sophisticated surveys are probably best done as focused site interview surveys or as part of comprehensive metropolitan transportation studies.
S2: Does the bureau give consideration to additional trips, not entering site (eg off-site office parking) when accepting data?	S2: This is an important aspect of surveys already being undertaken and TDB tries to ensure that all parking on and off the site are included. It is essential that sites are selected that have all the trips contained in an off-street surveyable area. Sites with a lot of street parking, and around the corner trip making are avoided for this reason.
S3: Will the use of TRICS in New Zealand be limited to the few land uses where a direct comparison of site characteristics can be made against New Zealand data?	S3: TRICS should not be used on its own. It is an invaluable tool to swell your data from the start point which must be a New Zealand or Australian survey. If there is no site in the TDB database then you are off to an equivalent New Zealand site to survey. After that by all means invigilate the TRICS database to find individual sites which are of the same land use and location characteristics so as to improve your range of information and judgment.
S4: Will we publish conversion factors for ITE/TRICS for use as a New Zealand specific adjustment?	S4: It is not proposed to calculate any conversion factors. Some detailed research has been made looking for ratios and the only variable which has emerged is the car parking demand where UK experience consistently demands about 1.5 car park spaces more than New Zealand equivalents. As a general rule the practitioner should be comparing like sites not looking for an average over a class or group of sites.
S5: What measures are being implemented to promote the collection of multimodal data?	S5 & S6: There are many interesting aspects of modal split and gaps in our knowledge. The mobility scooters are one of them. At this time there are no specific surveys in the database yielding data on motor scooters, motor bikes, bicycles, walking and only passing reference to car passengers. These will require new surveys and collection of information from a variety of sources in the future.
S6: Modal split – have you considered the aging population and the increased use of mobility scooters?	

Appendix E: Site survey summary sheet

Survey Period Date & Time		Day	Date	Time Start	Time Finish
	☐ Extended Data Collection (Several Days)		Date Start		Date End

A.	Activity Name	**Results & Comments**				
	Land Use Description					
	Territorial Local Authority					
	Street Address & Suburb					
	Survey Site General Location	OuterRur ☐	InnerRur ☐	OuterSub ☐	Inner Sub ☐	Town Ctr ☐
	Pedestrian Activity	Nil ☐	Low ☐	Moderate ☐	High ☐	V High ☐
	Public Transport Opportunities	Nil ☐	Low ☐	Moderate ☐	High ☐	V High ☐
SITE DATA	Highest Classification of Frontage Road/s		Major Arterial ☐	Minor Arterial ☐	Collector ☐	Local ☐
			Traffic aadt =		SH/TLA/Other Rd (state)	
	Occupied Site Area (Ha or m^2)					
	Gross Floor Area (GFA m^2)					
	Employees (during survey)					
	Other Size (please specify value and units eg seats, rooms, beds, pupils)					

B.	Parking Spaces Provided On-site (Inc Staff)	Total		
	Other Parking Spaces Available On-street Off-site	Total		
PARKING	Staff Parking Spaces Provided On-site	Total		☐ Not Relevant
	Staff Parking Spaces On-street and Off-site	Total		☐ Not Surveyed ☐ Estimated
	Peak Parking Demand	Time	Total (Inc Staff)	Staff (number)
	Peak Parking Demand During Survey	total / 100m^2 GFA	total / other unit (state unit)	staff / 100m^2 GFA

C.	SITE SURVEYED ARRIVAL/DEPARTURE FLOW	AM Peak (veh/hr)	TIME	start	end	Comments
			IN	trips	IN + OUT	
			OUT	trips		
TRIP GENERATION		PM Peak (veh/hr)	TIME	start	end	
			IN	trips	IN + OUT	
			OUT	trips		
		Daily (veh/day)	TIME	start	end	
			TOTAL IN+OUT	trips		
	Peak Trip Rate per 100m^2 or other unit (state)		AM Hr	/ 100m^2 GFA / hr		/ other unit (state) / hr
			PM Hr	/ 100m^2 GFA / hr		/ other unit (state) / hr
			DAILY	/ 100m2 GFA / day		/ other unit (state) / day

GENERAL COMMENTS AND NOTES

eg. Site location characteristics, parking durations, weather and other special aspects (school holidays, public holidays)

Modal Split	**Number**	**%**
Car Drivers		
Car Passengers		
Goods Drivers		
Goods Passengers		
Pedestrians		
Cyclists		
Bus Passengers		
Total		**100%**

Survey undertaken by (org): **Surveyor Contact (ph):**

Survey undertaken by (surveyor): **email:**

For inclusion in the TDB database fax to 03 377 4702, email to admin@tdbonline.org or post to PO Box 28105, Christchurch 8242