Estimating Demand for New Cycling Facilities in New Zealand

Land Transport New Zealand
Research Report 340

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The research detailed in this report was commissioned by Land Transport New Zealand.

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Tony Spowart, Transit New Zealand (Steering Group member)
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Contents

Glossary

- Annual Average Daily Traffic (AADT) –The total yearly traffic volume in both directions divided by the number of days in the year, expressed as vehicles per day. This volume is usually calculated by adjusting short term counts with seasonal factors.
- Aggregate Behaviour Method – Aggregate behaviour studies or models attempt to predict mode split and/or other travel behaviour characteristics for an aggregate population, such as residents of a Census tract or metropolitan area. Prediction is based on characteristics of the population and of the area.
- Benefit Cost Ratio (BCR) – The present value of net benefits divided by the present value of net costs.
- Cycle Mode Share – the percentage of people who cycled to work during Census (i.e. trips to work divided by the total number of people that travelled to work). A measure of the popularity of cycling.
- Cycle Network and Route Planning Guide (CNRPG) – a best practice guide to the process of cycle network planning, with tools that may help cycle planners and communities. Published by the Land Transport Safety Authority, New Zealand, 2004.
- Debounce – a setting on traffic counters that compensates for the extra air pulses generated by a rubber hose rebounding on the pavement.
- Demand – the level of desire or need that exists for particular goods or services.
- Discrete Alternatives – completely separate possibilities or options.
- Geographic Information System (GIS) – a system for capturing, storing, analyzing and managing data and associated attributes which are spatially referenced to the earth.
- MetroCount –suppliers of automatic traffic counting equipment.
- Mode Share – The proportion of trips using a particular mode of transport such as cycle, motor vehicle, bus, walk etc.
- Multinomial Logit Models – a regression model which generalises logistic regression to where there can be more than two cases.
- Regression Analysis – examines the relation of a dependent variable (response variable) to specified independent variables (predictors). The mathematical model of their relationship is the regression equation. The dependent variable is modelled as a random variable because of uncertainty as to its value, given values of the independent variables. A regression equation contains estimates of one or more unknown regression parameters ("constants"), which quantitatively link the dependent and independent variables. The parameters are estimated from given realisations of the dependent and independent variables.
- Sensor-balance – the numbers of hits recorded by counter tube A divided by the number of hits recorded by counter tube B multiplied by 100 (%). A measure of the accuracy and reliability of the automatic count.

Executive Summary

Currently there is little guidance available for estimating demand on a new cycling facility. The purpose of the research was to develop a tool for estimating cycle demand on a new cycle facility that could be used for Land Transport New Zealand funding applications.

Existing methods in New Zealand and overseas were investigated as part of the research. A Steering Group was established to provide input and direction and to assist in the selection of ten cycle facility sites to be investigated further.

The sites were selected to provide a variety of geographic locations and facility types (five on-road and five off-road). The availability of historic count and funding application data were also considered in site selection. The ten sites chosen consisted of two from Auckland, one from Palmerston North, one from Porirua, two from Nelson, three from Christchurch and one from Dunedin.

Obtaining sites that had historical count data and/or funding application information was more difficult than expected and is probably indicative of a general lack of collection of cycle count data.

Pneumatic tube counters were used to carry out the cycle counts. Cycle counts were undertaken for a minimum of one week between February 2007 and May 2007. The tube counters are the same as those widely used for motor vehicle counts, but use a smaller diameter and softer rubber tube.

This research has achieved its objectives by establishing tools for estimating cycle traffic for both on-road and off-road facilities. The tools produce an estimate of the numbers of cyclists that would use a new facility and the annual growth rate in cycle traffic on the facility for use in Land Transport New Zealand's Simplified Procedures.

On-Road Cycle Demand Estimation Tool

The on-road tool assumes a "step function" model, where the number of new cyclists occurring on a new facility, such as a cycle lane, immediately on completion is estimated as 20% of the existing number of cyclists on the road being upgraded. The annual cycle traffic growth rate is estimated from the growth experience on the on-road cycle facilities studied in this research (8%) and the Census trip to work data in the area being considered.

1. Calculate the existing cycle AADT using the appropriate method in Appendix D of this report.

2. Calculate the number of new cyclists (*NC*), which is 20% of the existing cycle AADT as shown by Equation 4.

$$NC = CV_{BF} \times 0.2$$ *Equation 4*

CV_{BF} = the existing cycle volume before installation of a cycle facility.

3. Calculate the annual Cycle Growth Rate (*CGR*) by averaging the annual growth rate for the trip to work by cycle (calculated from the 2001 and 2006 Census data) and a default assumed annual growth rate of 8% due to the installation of a new cycle facility. The calculation is shown by Equation 8.

$$CGR = (BG + 8\%)/2$$ *Equation 8*

BG = the bike growth (or decline) based on Census trip to work by cycle data. Values for BG for different areas in New Zealand are listed in Appendix G.

Off-Road Cycle Demand Estimation Tool

The Off-Road Tool is intended to be used where an off-road facility runs parallel to an existing road. The off-road tool assumes that for an off-road path there are no existing cyclists and that the number of new cyclists can be estimated based on:

- The cycle AADT on the road parallel to the cycle path (where this exists).
- The Census data cycle mode share for the area being considered (percentage of people that cycled to work).
- The motor vehicle volume on the parallel road.
- The ratio of the NZ average trip length by cycles and motor vehicles (1:3.44, from the NZ Travel Survey).

The annual growth rate can be estimated from the growth experience at the off-road cycle facilities studied in this research and the Census trip to work by cycle data trends in the area.

1. For an off-road path existing cyclists = 0

2. Calculate the number of new cyclists (*NC*). This is an empirical formula based on analysis of the data collected but incorporating engineering judgement. The calculation is shown in Equation 22.

$$\therefore NC = 1.6 \times \sqrt{MS \times MV} + 0.5 \times PCV_{BF}$$ *Equation 22*

MS = the mode share (percentage of people that travel to work by bike) from Census data. Values for MS are listed in Appendix G.

MV = the motor vehicle volume on the road parallel to the off-road path.

PCV_{BF} = the existing cycle volume on the road parallel to the off-road path before the installation of the path.

3. Calculate the annual Cycle Growth Rate (*CGR*) by averaging the annual growth rate for those that biked to work (calculated from the 2001 and 2006 Census data) and the annual growth rate of 14% due to the installation of a new off-road path. The calculation is shown by Equation 24.

$$CGR = (BG + 14\%)/2 \qquad \textit{Equation 24}$$

BG = the bike growth based on Census trip to work by cycle data. Values for BG are listed in Appendix G.

Much more research is required before there is sufficient knowledge in this area. This research has developed an estimation method that can be applied in a consistent manner, has data requirements that are readily obtainable, that is simple to use and evaluate, making a much overdue start in achieving the goal of estimating cycle demand on new cycle facilities in New Zealand.

Based on the findings of this research the following recommendations are made:

1. That these cycle demand estimation tools be incorporated into the Economic Evaluation Manual.
2. That cycle counts, using the guidelines in Appendix B be undertaken as part of every application for funding through Land Transport NZ.
3. That a cycle facilities database be established to allow further research in this area.

Abstract

Funding for new cycling facilities is based on cost benefit ratios, which are dependent on the predicted future demand by cyclists. Currently there is no standard method to estimate future demand for a facility, and there is a danger that less worthy projects will get funding ahead of better projects due to the use of inconsistent methods of estimating cycling demand.

This research project compared cycle traffic flows after facilities have been built with predictions and with cycle traffic flows before construction. The aim of the project was to develop a tool to estimate demand for new facilities.

Ten sites (five off-road and five on-road) were studied and had cycle count surveys undertaken between November 2006 and May 2007. Analysis of the data has led to the following conclusions;

- A wide variety of methods has been used by different facility proponents to estimate cycle traffic on new facilities.
- The collection of cycle count data is in general minimal and is not consistent across road controlling authorities (RCAs).
- The amount of cycle traffic growth after a facility was installed varies considerably.
- More sites need to be studied to allow a more robust analysis.

Estimation tools have been developed for both on-road and off-road facilities based on “before” cycle counts, results of documented growth on NZ cycle facilities and Census travel to work data trends.

1. Introduction

1.1 Background

Currently, funding for new cycling facilities is based on calculated benefit cost ratios, which are in part dependent on the predicted future use of the facility. There are currently no guidelines for the estimation of future use on a cycling facility and there is a danger that less worthy projects will get funding due to inconsistent estimates of cycling demand. This is undesirable for the agency promoting the project as its other potential projects might be more worthwhile, and for Land Transport New Zealand (Land Transport NZ) which is trying to optimise its transport expenditure for the most cost effective projects.

With increasing policy support for cycling as a mode of transport combined with rising fuel costs, the demand for good cycle facilities is expected to increase. A standardised way of estimating the future use of cycle facilities is recommended to optimise the funding allocation.

This research is funded by Land Transport NZ and co-funded by ARTA, Dunedin City Council, Nelson City Council and Transit NZ.

1.2 Objective

This research project has compared cycle traffic flows after facilities have been built with predictions made before construction, and submitted as part of the Economic Evaluation Manual's Simplified Procedure No. 11 (SP11)[1] funding application process. There are many different methods for estimating future cycle volumes presently in use around New Zealand. This research aimed to investigate the current methods in use in New Zealand, evaluate methods being used in other countries and to carry out cycle counts at ten completed sites to compare the estimated future volumes with the actual future volumes. This information has been used to develop tools that will provide facility designers and planners with guidance to better estimate future cycle traffic volumes on new facilities.

1.3 Research team

Land Transport NZ engaged MWH New Zealand Ltd (MWH) to undertake this research in July 2006. MWH's lead researcher for the project, Andrew Macbeth left MWH in November 2006 and is now a director of ViaStrada Ltd. The subsequent team structure for the project included Andrew Macbeth (ViaStrada) and Andrew McDonald (MWH) as co-lead researchers, supported by David Mallett and Karisa Ribeiro of MWH. All researchers were based in Christchurch.

[1] Formally known as the Project Evaluation Manual's (PEM) Simplified Procedure No. 6 (SP6)

1.4 Steering group

A steering group was established, as shown in Table 1.1 to provide comment on the proposed methodology to discuss site selection.

Table 1.1 Steering Group Members (in alphabetical order).

Name	Organisation	Area
Andrew Gray	Porirua City Council (PCC)	Porirua
Ian Clark	Transit New Zealand (Transit)	Head Office – Wellington
Les Denia	Nelson City Council (NCC)	Nelson
Merijn Martens	Land Transport NZ	Wellington
Michael Ferigo	Christchurch City Council (CCC)	Christchurch
Ron Minnema	Dunedin City Council (DCC)	Dunedin
Sandi Morris	Palmerston North City Council (PNCC)	Palmerston North
Tricia Allen	Auckland Regional Transport Authority (ARTA)	Auckland
Tony Spowart	Transit New Zealand (Transit)	Christchurch

Steering group members recommended recently completed cycling projects from their area. Based on a range of criteria, including historic count data, available funding applications, geographical location and obtaining a broad spectrum of facility types, ten sites (listed in Section 4 of this report) were chosen to investigate more closely.

2. Literature Review

A literature review was undertaken to identify and analyse information related to cycle travel demand and forecasting (predicting future trends). This section aims to examine existing methods and models to evaluate the applicability in New Zealand. A wide variety of the methods which have been used to predict cycling demand for new and improved facilities were studied. Therefore, this section draws on and extends the literature review carried out by FHWA (1999a, 1999b), which has produced an extensive guideline report identifying and classifying the main methods and models for non-motorised vehicles. The Federal Highway Association (FHWA) guideline has been broadly adopted worldwide (United States of America, Canada, United Kingdom, and Australia). Based upon the review of various case studies throughout the world, the following section is a summary of models and techniques used to predict cycle demand.

2.1 Demand estimation methods and models

2.1.1 Comparison Study method

This method predicts travel on a cycle facility by comparing its use, surrounding population and the land use characteristics of other similar cycle facilities. There are two types of comparison methods: before and after studies which compare the usage levels before and after a change (such as a facility improvement); and studies that compare travel levels across facilities with similar characteristics (applicable for new facilities). The method is easy to apply and requires minimal inputs.

The major limitation of this method is that generally very few situations are compared and only a limited number of variables are examined. Often variables are proposed to explain differences in use, however it is not possible to establish whether those variables truly account for the differences and how much impact a variable actually has on the demand across only a couple of observations.

2.1.1.1 Central Massachusetts Rail Trail Bikeway, U.S.A.

An existing cycle/pedestrian facility and its surrounding population were compared with a proposed facility and its surrounding population to estimate potential cycling levels on the proposed facility (Lewis and James 1997). Cycle counts were conducted on an existing trail with similar characteristics. These counts were then factored based on the ratio of total population within the corridors surrounding the two facilities to predict total trips on the proposed facility.

2.1.1.2 Comparison of trails in Australia

The study compared the characteristics of users and the surrounding population on two existing facilities in Australia: Lower Yarra and Maribrynong trails. Trail users were surveyed regarding mode of access to the trail, access distance, and personal characteristics. Data on population in the surrounding area was also analysed. This was a relatively sophisticated comparison study using GIS databases to compare population characteristics adjacent to the two trails. The results indicate that the Lower Yarra trail attracts more users from a wider range of distances than the Lower Maribyrnong trail, despite similar levels of surrounding population. The study concluded that with better signs, improved linkages and promotional efforts for the Lower Maribyrnong facility, this trail could see higher cycling volumes, similar to the Lower Yarra trail. The model gives an estimate of the potential users of the Lower Maribyrnong trail (Wigan, et al. 1998).

2.1.1.3 The Hague and Tilburg in the Netherlands

Counts of cycle traffic were performed before and after the addition of cycle lanes at two locations in the Netherlands: The Hague and Tilburg (TRB, 1980) which were part of a trial study looking to improve cycling conditions and to promote the construction of new cycling facilities. Counts were performed on parallel facilities to attempt to estimate the diversion of cyclists verses new cyclists. In one location, cycle counts increased by 30 to 60 percent on the route with a slight increase on parallel routes. For a different location, cycle traffic on the route also increases but there is some decrease on parallel facilities; the authors conclude that roughly two-thirds of the increase in cycle traffic comes from parallel routes and one-third from new trips.

Table 2.1 Key aspects of the Comparison Study method.

<table>
<tr><th colspan="3">Comparison Method</th></tr>
<tr><td><u>Description</u></td><td colspan="2">Aggregate method which predict the travel on a facility by comparing it to usage and surrounding population and land use characteristics of other similar facilities.</td></tr>
<tr><td><u>NZ Context</u></td><td colspan="2">This method is easy to use with minimal data requirements and can be used with or without cycle count data. The ease of application has its benefits and is being used in NZ to some degree. Generally very few situations are compared (often only one). Proposed cycle facilities tend to be compared to the more successful cycle facilities, which may overstate the case. This method examines only a few variables. Applying this method in a consistent manner across RCAs in NZ would be difficult due to the subjective nature of the assessment.</td></tr>
<tr><td><u>Key Features</u>
• Relatively simple technique
• Wide range of applications
• Easy to misinterpret results</td><td><u>Data Requirements</u>
• Bicycle counts (but not always)
• Data on surrounding population
• Data on land use</td><td><u>Where Used</u>
• US: Massachusetts
• Netherlands
• Germany
• Australia</td></tr>
</table>

2.1.2 Aggregate Behaviour method

This method relates cycle travel to the characteristics of the local area through regression analysis and other statistical approaches (Parkin, J. et al. 2007).

Aggregate models can be used for the following purposes:

- Identifying which factors influence overall levels of cycling in an area or individual facility.
- Predicting the change in levels of cycling caused by a change in one of these factors.

- Predicting the amount of cycling in other areas, based on data collected in one area.

Familiarity with regression analysis and other statistical concepts is required for useful application of this method.

2.1.2.1 Bicycle Journey-to-Work in the UK

In this study, Ashley and Banister (1989) used UK census and other data to (1) evaluate factors influencing cycling to work, (2) develop a model to predict the proportion of residents in a ward cycling to work, and (3) test the model. The authors used regression analysis to test the effects of various factors on the proportion of ward residents cycling to work. Factors tested included personal characteristics, trip distance, availability of cycling facilities, availability of other modes, traffic levels, and local climate and topography.

2.1.2.2 Bicycle mode split in U.S. cities

Nelson and Allen (1997) conducted a cross-sectional analysis of 18 U.S. cities to predict work trip bicycle mode split (from census data) based on weather, terrain, number of college students, and per capita miles of cycle facilities. A positive association was found between the presence of cycle facilities and the percent of cycle trips to work.

Table 2.1 Key aspects of the Aggregate Behaviour method.

Aggregate Behaviour method		
Description	Methods that relate bicycle travel to characteristics of the local area generally through regression analysis and other multivariate statistical approaches.	
NZ Context	This method has moderate data and technical knowledge requirements, but the cost and timeframe for analysis is still likely to be prohibitive for most RCAs. It requires statistical expertise which would likely need to be outsourced by most RCAs. However has the benefit of evaluating a variety of variables which would provide RCAs useful information.	
Key Features • Some statistical expertise required • Moderate data requirements • Can be used to identify importance of variables across different locations	Data Requirements • Bicycle counts • Facilities description • Census data • Land use data	Where Used • UK • US: Berkeley

2.1.3 Sketch Planning methods

This set of methods uses simple calculations, trip length rules of thumb. Mode shares, and other aspects of travel behaviour to predict the number of cyclists that will use a facility. These methods generally rely on data that already exists or that can be collected with relative ease (such as census and land use data), combined with behavioural assumptions derived from other studies. Sketch plan methods tend to vary widely in their specific approaches and in their level of sophistication (NCHRP, 2006).

The sketch plan methods tend to be relatively simple to understand and apply if the methods and data are selected carefully. The method may give reasonable estimates of the number of users on a proposed facility. These methods are best for developing rough estimates for planning purposes and for comparing potential cycling levels among facilities or areas to prioritise actions.

2.1.3.1 City of Seattle, U.S.A.

This is a research study conducted by Goldsmith (1997; referenced in NCHRP, 2006)) as part of the National Bicycle & Walking Study in Seattle, US. Proposed cycle lanes on Pine Street were used as the case study for the research. According to Goldsmith's projections, the potential cycle commuter mode share in Seattle for areas within reasonable distance of a regional cycleway system was about 8%.

Table 2.2 Key aspects of the Sketch Planning methods

<table>
<tr><th colspan="3">Sketch Planning methods</th></tr>
<tr><td><u>Description</u></td><td colspan="2">Predict use of a facility based on simple calculations and rules of thumb about trip lengths, mode shares, and other aspects of travel behaviour.</td></tr>
<tr><td><u>NZ Context</u></td><td colspan="2">This is a broad brush approach and has been applied in NZ. Is unlikely to achieve high accuracy but is a simple method to use. Applying this method in a consistent manner across RCAs in NZ would be difficult due to the subjective nature of the assessment.</td></tr>
<tr><td><u>Key Features</u>
• Relatively simple to construct predictive models
• Uses secondary data and parameters from previous research
• Likely to have significant errors but can run a series of “what ifs” for sensitivity analysis</td><td><u>Data Requirements</u>
• Bicycle counts (sometimes)
• Facilities description
• Census data
• Land use data</td><td><u>Where Used</u>
• Seattle (US)
• New York (US)
• Plattsburgh (US)
• Milwaukee (US)
• Montreal (Canada)</td></tr>
</table>

2.1.4 Discrete Choice models

Discrete Choice Models predict an individual’s travel decisions based on characteristics of the alternatives available to the user. The models can be estimated using “revealed preference” data (observed behaviour), “stated preference” data (where interview respondents are asked to indicate their travel preferences), or a combination of the two. This method has become widely used in economics, marketing research and transport planning.

Discrete choice models can provide insights into the major factors affecting a particular decision. Thus in a question of whether a cyclist would choose one route over another, various explanatory variables can be included in a model.

The model requires significant data especially in the case where estimation is based on revealed preference data. For the models to be estimated, data must be available on the chosen alternative (e.g. use of a particular mode or route) as well as the other alternatives. Generally this will require specialised data collection and rich data sets.

2.1.4.1 Transit Access mode choice in Chicago, U.S.A.

The Chicago Regional Transit Authority recently developed a set of discrete choice models to predict the impacts on public transport access mode of bicycle and pedestrian improvements to rail station areas in Chicago. Surveys to determine existing commuter's mode choice, station access distance and other characteristics were used in conjunction with surveys to estimate whether people would shift to non-motorised access modes as a result of various improvements on the facilities (Wilbur Smith Associates, 1997).

2.1.4.2 Australia study

In Australia, discrete choice methods have been widely applied and are used to provide some of the parameters for regional transport models. It has also been applied by transport consultants to derive patronage forecasts of various proposed transport projects such as the new Brisbane airport rail link. One Australian example of a discrete choice method being used to estimate cycle use is Austroads (2001). In that study, choice was modelled using a separate stated preference experiment that was specifically designed to estimate commuters' mode choices. The survey was administered to a small sample to test the suitability of the methodology. Important variables determining people's preference to cycle for commuting were trip distance, the proportion of the trip on a cycle path, and the existence of facilities such as showers, changing rooms and cycle parking. The study suggested that the provision of additional cycle paths will have a significant effect on the likelihood of people choosing to cycle for a specified trip.

Table 2.3 Key aspects of the Discrete Choice models.

<table>
<tr><th colspan="3">Discrete Choice Models</th></tr>
<tr><td>Description</td><td colspan="2">Disaggregate-level models which predict an individual's travel decisions based on characteristics of the alternatives available to them.</td></tr>
<tr><td>NZ Context</td><td colspan="2">The biggest disadvantage to RCAs for this method is the cost and due to the large data collection and analysis requirements. This method requires technical expertise, which would need to be outsourced by most RCAs. This is a time consuming method. However useful preference data can be obtained.</td></tr>
<tr><td>Key Features
• Well established theoretical basis
• Considerable technical skill required
• Can use revealed and stated preference data
• Wide range of applications (mode choice, route choice, vehicle choice etc.)</td><td>Data Requirements
Usually requires survey data collection specific to situation being analysed.</td><td>Where Used
• Wisconsin (US)
• Chicago (US)
• Raleigh (US)</td></tr>
</table>

2.1.5 Regional Travel models

Regional travel models use existing and future land use conditions and transportation network characteristics, in conjunction with models of human behaviour, to predict future travel patterns. Traditionally, they have been carried out in a four-stage process of Trip Generation, Trip Distribution, Mode Split and Network Assignment. It provides for the medium to long term planning of the transport network (Turner et al, 1997). It allows planners to predict traffic volumes, speeds and delays throughout the network. Using various assumptions, it can project the network's performance into the future at a relatively fine zonal level. It can also be used to examine network performance based on a number of others criteria (such as travel time, noise, travel cost, emissions). One of the principal uses of these models is to develop trip tables showing origin and destination pairs now and at some future point. These trip tables are then used for evaluating the quality of links (where links may be roads, public transport services or bicycle facilities) connecting these origins and destinations.

As Regional Travel models are such a powerful integrated planning tool, great reliance tends to be placed on them in evaluating proposed changes to the transport network. Data requirements for these sorts of models are extensive. Depending on the final structure of the model, the following sorts of information are required:

- socio-demographic data including population, employment, motor vehicle ownership and access;
- detailed information on workplace and residential locations;
- detailed information about the behavioural factors determining people's residential location choice, travel time choice, route choice, mode choice and other factors effecting their transport behaviour; and
- a well defined model of the physical transport network and public transport service overlay.

2.1.5.1 Edmonton Transport Analysis model, Canada

The Edmonton Transport Analysis Model recently developed for the Edmonton region in Canada was based on the Regional Travel models principal. It includes both walking and cycling as separate modes and also includes cycle network characteristics in determining mode choice. The cycle links in the network model can be coded in three ways: cycle path, cycle lane, or mixed traffic. The model has a number of other notable features, with trip generation, destination, time of day, and mode choice all based on multinomial logit models that were estimated using observations of individual travel behaviour and applied at aggregate (zonal) levels for 25 user groups and trip purposes. Therefore, improvements to the cycle network (i.e., addition of lanes or paths) can potentially affect total trip distribution and generation as well as mode choice. The model also estimates the composite utility of travel and therefore can be used to estimate the overall welfare benefits of an improvement to the cycle network (Hunt et al. 1998)

2.1.5.2 San Francisco Bay Area, U.S.A.

A number of U.S. cities have attempted to run regional transport models incorporating pedestrians and cyclists. For example, the Metropolitan Transportation Commission (MTC, 1990) developed a model for the San Francisco Bay Area that included both walking and cycling modes in their latest set of mode choice models. Walking and cycling facilities were based on travel time, employment density (for work trip models). Travel times were calculated using highway network distances and an assumed speed of 19.3 km/h for cyclists and 4.8 km/h for pedestrians. The MTC models are noteworthy for the variety of trip purposes modelled. Separate trip generation, distribution, and mode choice models were also developed for home-based work, home-based shop, home-based school (grade school, high school, and college), home-based social/recreation, and non-home-based trips.

2.1.5.3 Leicester Transport modelling, U.K.

British consultancy MVA (1995) has developed the TRIPS software that is widely used for transport modelling. It has also produced a cycle model as part of this package which has been applied in the city of Leicester. The primary purpose of the model is to distribute future bicycle trips given a network of existing and proposed roads and bicycle facilities, and to identify major points of conflict between potential bicycle flows and existing heavy traffic flows. In the Leicester model, it is possible to predict the likely bicycle flows on defined links in the system given new links or changes to the characteristic of the links, for example, reductions in road conflicts on a segregated bicycle path. It is also possible to forecast bicycle flows on particular links given an increase in the level of cycling at a future date.

Table 2.4 Key aspects of the Regional Travel models.

<table>
<tr><th colspan="3">Regional Travel models</th></tr>
<tr><td>Description</td><td colspan="2">Models that predict total trips by trip purpose, mode, and origin/destination and distribute these trips across a network of transportation facilities, based on land use characteristics such as population and employment and on characteristics of the transportation network.</td></tr>
<tr><td>NZ Context</td><td colspan="2">Requires technical expertise, is relatively expensive and may require specialised software. It is possible that several models may be required to model different trip purposes (e.g. work trip, shopping trips, recreational tips, etc). This method requires technical expertise, which would need to be outsourced by most RCAs. The cost and timeframe for analysis is likely to prohibitive for individual facilities for most RCAs.</td></tr>
<tr><td>Key Features
• Require considerable technical skills
• Models already exist for motor vehicles and transit in most major centres
• Scope for using these models as a basis for bicycle models in the future</td><td>Data Requirements
• Bicycle counts
• Facilities description
• Census data
• Land use data</td><td>Where Used
• Portland (US)
• Montgomery County (US)
• Sacramento (US)
• San Francisco (US)
• Edmonton (Canada)
• Leicester (UK)
• Netherlands</td></tr>
</table>

2.2 Summary

The literature review has shown that there are many methods and models available to aid in the prediction of cyclist demand. The methods vary from quick and simple approaches (such as the Comparison method) to complex and expensive approaches (such as the Regional Travel and Discrete Choice models). Comparison studies are mostly used, because of their relativity simplicity. Nevertheless, the main drawback of Comparison studies is that their results can be easily misinterpreted, as the quality of information and the ability to analyse the results can affect the outcomes of the method significantly. This potential for misinterpretation needs to be taken into account in practice. Overall, international experiences indicate that the choice of method will depend on the project objectives, data available, funds available and the level of detail and accuracy required.

Despite the widespread use of these above mentioned methods and models, the NCHRP (2006) report alerted to the fact that cycle demand models are derived from the standard motor vehicle methods and models. Hence, cycle demand models are not formulated taking into consideration specific cycle characteristics. Consequently, cycle travel demand estimates may be inaccurate if not considered in relation to the particular context to which a specific method or model is applied.

Therefore, an important finding from the review of international literature is that there is no standard way to estimate future use for a cycle facility worldwide. Despite the existence of reviewed methods and models and their allegedly successful performance, there is still the need to create, formulate and develop cycle demand models which are based on the particular characteristics of the cycle mode. In particular, there is a growing need to create models that consider New Zealand's characteristics.

3. Methodology

The research focused on 10 cycle facilities (5 off-road and 5 on-road), where historic cycle count data (before counts) would be compared with counts undertaken in 2007 (after counts) as part of this research.

In consultation with the Steering Group, ten sites as listed in Table 3.1 below were selected for further investigation and automatic cycle tube counts were undertaken. Cycle counts were for a minimum of one week and were carried out between February 2007 and May 2007.

Table 3.1 Cycle facilities studied.

Project	Area	Type of Project	Count start date
On-road facilities			
Centaurus Road	Christchurch	On-road cycle lanes	13 February 2007
Halswell Road	Christchurch	On-road cycle lanes	13 February 2007
Wakefield Quay	Nelson	On-road cycle lanes	26 April 2007
North Street	Dunedin	On-road cycle lanes	12 March 2007
George Bolt Memorial Drive	Manukau	On-road cycle lanes	6 March 2007
Off-road facilities			
Waterview Overbridge	Auckland	Off-road shared path (overbridge)	6 March 2007
Pioneer Path	Palmerston North	Off-road shared path	12 February 2007
Travis Road	Christchurch	Off-road shared path	21 February 2007
Atawhai Path	Nelson	Off-road shared path	26 April 2007
Harakeke Path	Porirua	Off-road shared path	20 March 2007

The use of MetroCount 5600 series counters with two soft bicycle counting tubes is now well established in New Zealand, although not widely used. An indicative cost for a one week cycle count was approximately $350. The tubes are typically placed 1 m apart and the counters are able to measure vehicle speed and thus wheel base. This allows them to classify vehicles into different sorts, such as bicycles, cars, buses and trucks of different axle configurations.

The tube counters were generally set out in accordance with the guidelines attached in Appendix A, however site specific constraints meant each situation required some judgement in the placement of the tube counters.

The automatic tube count data were analysed and checked for completeness. Part of the data validation process was to compare the automatic tube counts with manual counts.

From the automatic tube count data, estimates of the cycle AADTs were calculated. The method in Appendix 2 of the Land Transport Safety Authority, Cycle Network and Route Planning Guide (CNRPG) (LTSA 2004) was used to estimate the AADT for all sites except in Auckland and Manukau. For the Auckland region, the Auckland Regional Transport Authority (ARTA) commissioned the development of a tool, (ARTA 2007) see Appendix D, for scaling cycle counts based on the method in the CNRPG. This tool was used to estimate cycle AADTs from the traffic counts for the Auckland and Manukau sites.

The CNRPG and ARTA 2007 methods were also used to estimate the cycle AADT from historic count data obtained from RCAs. Using the same method to estimate the cycle AADT should provide a more consistent base for comparison than using the estimates provided by RCAs, where a variety of AADT estimation techniques were used.

The after cycle AADTs were compared with the before cycle AADTs. Where available, intermediate counts (counts undertaken after the construction of the facility but before the 2007 automatic tube counts) were also used to estimate an intermediate cycling AADT. This information was used to help gauge the number of new cyclists on the new facilities and the likely annual increase.

From this information a simple tool was developed that enables the number of new cyclists and the annual growth rate to be estimated. A method has also been developed to estimate the existing cycling AADT based on automatic tube counts. Tools such as the CNRPG and ARTA 2007 methods already exist for estimating the cycle AADT from manual counts.

Due to the limited availability of count data and the relatively small number of sites, it was necessary to apply some engineering judgement in the development of the Cycle Demand Tool in Section 6 of this report.

Although 10 sites is not a statistically large sample, it was felt that this research provides more guidance than currently exists, achieves the goal of providing a common technique and provides a good base for future research.

4. Summary of Site Descriptions

A summary description of the ten sites studied as part of the research is provided in this section. All sites had counters installed successfully. Installers who had previously only used motor vehicle counting tubes had no problems using the cycle counting tubes, and the installation practices for both tubes were similar. However variations and allowances were required on some sites due to particular site constraints.

Table 4.1 summarises attributes of each site in the vicinity of the automatic tubes counters. The table splits the sites into on-road and off-road facilities. A more detailed description of each site and site analysis is provided in Appendix A.

Table 4.1 Attributes of sites.

Location	Footpaths	Parking	Cycle Lanes	Traffic Lanes	Speed Limit	Median	Off-road Path	Motor Vehicle AADT (Parallel Rd)
On-road								
Centaurus Road (Christchurch)	2 x 1.6 m	-	2 x 1.6 m	2 x 3.5 m	50 km/h	-	-	10,500 (SH 75)
Halswell Road (Christchurch)	2 x 1.5 m	1 x 3.0 m	2 x 1.6 m	2 x 5.5 m	50 km/h	3.1 m	-	20,000
Wakefield Quay (Nelson)	2 x 1.5 m	1 x 1.9 m	2 x 1.2 m	2 x 3.2 m	50 km/h	-	-	26,000
North Road (Dunedin)	2 x 2.0 m	1 x 2.1 m	2 x 1.5 m	2 x 3.0 m	50 km/h	-	-	12,000
George Bolt Memorial Drive (Manukau)	-	-	1 x 1.8 m 1 x 2.6 m	4 x 3.5 m	100 km/h	1 m	-	32,000

Table 4.1 Attributes of sites (continued).

Location	Footpaths	Parking	Cycle Lanes	Traffic Lanes	Speed Limit	Median	Off-road Path	Motor Vehicle AADT (Parallel Rd)
Off-road								
Waterview Overbridge (Auckland)	-	-	-	-	50 km/h	-	3.1 m	95,000 (SH 16)
Pioneer Path (Palmerston North)	-	-	-	-	60 km/h	-	3.0 m	12,000 (SH 56)
Travis Road* (Christchurch)	1 x 1.5 m	1 x 1.9 m	2 x 1.4 m	2 x 3.6 m	50 km/h	2 m	2.5 m	10,200 (SH 74)
Atawhai Path (Nelson)	-	-	-	-	100 km/h	-	3.0 m	11,500 (SH 6)
Ara Harakeke Path (Porirua)	-	-	-	-	100 km/h	-	3.0 m	22,000 (SH 1)

* Travis Road has both an off-road and an on-road cycleway. The cycle counts were carried out on the off-road path.

5. Data Analysis

5.1 Historical data analysis

For the purposes of this report "historical data" are defined as any cycle counts or funding application information that were obtained prior to the cycle counts undertaken as part of this research project.

Obtaining sites to study that had historical count data and/or funding application information was more difficult than expected and is probably indicative of a general lack of collection of cycle count data in New Zealand. This is partly explained by the relatively low levels of interest among road controlling authorities in cycling until recent years and partly by uncertainty about suitable methods and reliability of counting cycle traffic. Both these aspects have changed, with most councils now reporting an interest in counting cycle traffic (Macbeth 2007) and increasing use being made of automatic cycle counters around the country.

It appears that half of the funding application estimates were based on cycle counts, with various different methods used to convert the counts to cycling AADT estimates. Some of the cycle facilities were installed prior to the SP11 funding procedure (or its predecessor, SP6) in which case cycle volume estimates were not required to obtain funding.

Generally there was no justification given for either the expected cycling growth rate or the estimate of new cyclists (or total numbers of cyclists expected to use the facility) in the funding applications.

For an on-road facility it is easy to count the number of existing cyclists prior to the installation of a cycle facility such as cycle lanes, but this is not so obvious for an off-road path where the facility hasn't been constructed. Counts can be undertaken prior to the installation of a path on the nearest road running parallel to the path. In some cases there will be a parallel road adjacent to a proposed path, but in others a path will be proposed through a park, alongside a railway line, river or coastline, or similar, in which case counting cyclists on the "existing facility" is more difficult. If the path is linking existing collinear paths, then the existing paths could be counted to estimate "existing" cycle demand. Counts of existing cycle traffic ("before" counts) appeared to be done in only two out of the five off-road sites studied. However the other three off-road sites had useful "after" counts (counts undertaken following the installation of the facility).

The off-road paths used in the research (see Table 4.1) had all been constructed between 2003 and 2006. During the short timeframe the paths showed a high growth rate, but it is too soon to tell whether this will be sustainable in the long term. Therefore an additional off-road site was studied to provide an estimate of the expected growth over a longer time frame. The Stoke Railway Reserve path in Nelson has cycle count data from 1999 to

2006. This was used to estimate the expected long term growth for off-road cycle facilities.

For on-road cycle facilities two sites (Centaurus Road and Halswell Road) had cycle counts before the installation of cycle facilities and two sites (Wakefield Quay and North Road) had counts shortly following the installation of cycle facilities. One site had neither cycle counts nor funding application information, but the site was in the Auckland region where it was desirable to have at least two study sites and no alternative with better data was found.

This research has identified that minimal cycle count data is currently being collected. While most RCAs have motor vehicle counting strategies, there would be benefits in developing cycle counting strategies that could cover aspects such as:

1. Frequency and location of counts.
2. Type of counts (automatic (both short term and long term) or manual).
3. Time of year. This is important for consistency. The school timetable is an important determinant of cycle traffic at many sites, as school students can be a significant component of cycle traffic. Also, winter counts are generally lower than summer counts. These aspects are covered in the *Cycle Network and Route Planning Guide.*
4. Weather. If undertaking manual cycle counts, some flexibility should be given to the day the count is actually undertaken so that the weather for each count is comparable. The weather is generally not as important a factor for automatic tube counters done for a week or more as over a longer period there will generally be a variety of conditions.

The recommendation section at the end of this report lists the type of data that would be beneficial to collect and that would assist further research.

The variation in the methods used to estimate existing cycling volumes, growth rates and the expected number of new cyclists, highlights the need for a standardised method. A standardised process will make funding applications more transparent and consistent and easier to compile and assess. This will help ensure that funding is directed where the most benefits will be achieved.

5.2 Automatic tube counter analysis

Once the cycle tube counts carried out at each site were obtained, a number of checks were performed (see Section 5.3 of this report) to verify the data (see Section 5.4 of this report). This enabled the identification of invalid count data and provided insight into the workings of the MetroCount counters. Once the data were verified, each count was converted to an Annual Average Daily Traffic volume (AADT). The methods outlined in the following two references were used;

1. Cycle Network and Route Planning Guide (LTSA 2004). Published by Land Transport Safety Authority, NZ, was used for all sites except those in Auckland and Manukau.
2. The ARTA 2007 method as discussed in Section 3 of this report was used for the Auckland and Manukau sites.

5.3 Tube counter verification

There are two components of an automatic tube counter, the road side counter and the pneumatic tubes. Therefore there are two types of faults that can occur when using an automatic tube counter:

- an error with the road-side unit causing data to not be counted; and
- an error with one or both of the tubes causing potential hits not to be recorded.

While the first error is easy to identify, as there will be no recorded counts for some or all of the count period, the second error will not be immediately obvious. There are two main checks using the MetroCount software (illustrated in graphical outputs) that can be carried out to determine the accuracy of the tube counts;

1. Sensor Balance; this graph records the number of axle hits per hour for each tube (tube A and tube B). The tubes are placed 1 m apart and should ideally record the same number of hits per hour (e.g. a perfect sensor balance would be 100%). An acceptable sensor balance figure is 95% to 105%. If the sensor balance is not within this range the graph can be investigated further to find the time period that the tubes were not recording equal hits per hour. If this time period is short then this period of counts can be removed from the analysis. If it is for a long period of time this may indicate more serious problems with the set-up or with one of the tubes. Some likely reasons for sensor imbalance are;
   i. A car stopping or parking on one of the tubes.
   ii. One or both tubes being damaged – either by vandalism or heavy vehicle impacts.
   iii. Flooding of the tubes.
   iv. One or both tubes becoming dislodged.
   v. The ends of the tubes becoming untied and therefore letting pulses escape.
   vi. A tube being wound or folded up so it does not allow the air pulses to get to the road-side unit.

2. Spectrum; this graph shows the time between axle hits. This needs to be checked to ensure the “debounce” has been set correctly. The debounce setting is a period of time, which was set to 10 milliseconds for all cycle counts undertaken. There are two pulses when a tyre hits the tubes – one when the tyre hits the tube, and one when the tube hits the road after sticking to the tyre. If the road-side unit records two pulses within the debounce time, it will only recognise one as a hit. Therefore the debounce accounts for the second pulse so that the counter does not interpret it as a new hit. The spectrum graph will generally show two peaks. The first is a sharp peak which is the time between the front and rear axles of the cycles recorded. This is usually a sharp peak because bike wheelbases do not vary much, so the time between the front and rear axle hits is fairly consistent. The second peak is the time between axle hits of different motor vehicles which have a greater range of wheelbases. Therefore the second peak has a greater spread and a flatter peak. The debounce setting is shown on this graph and this must be checked, because if the debounce time is too close to the first peak then it is likely that the roadside unit may have ignored some relevant tube hits, interpreting the pulse as a

tube sticking to the tyre, when actually it may have been caused by the rear axle of the same vehicle, or the preceding vehicle on a busy road or path.

The sensor balance graph uncovered several instances where the tubes had not counted correctly for certain periods of time. These had to be taken into account in the analysis. The most common problem appeared to be from cars parking on the tubes. The spectrum graph did not uncover any errors as a result of the debounce setting, which suggests that a debounce of 10 milliseconds is appropriate.

A summary of the site-specific verification findings is attached in Appendix C.

5.4 Count data verification

The automatic counts in Auckland were co-ordinated to coincide with manual counts being organised by ARTA. This allowed the automatic tube counts to be compared with the manual counts as a verification process. In addition to the Auckland and Manukau sites included in this project, three additional Auckland sites were studied (Te Atatu off ramp cycle link, Lake Road in Takapuna and Tamaki Drive). The analysis process, issues encountered and the results are described below.

The MetroCount software recognises groups of tube hits, and puts these groups into separate bins for different axle types. The bin classification system used was “ARX Cycles”. The software is also able to record the speed and direction of those vehicles. Where the pattern of hits does not match a known axle type the software will put the hits into an unknown category identified as class “???”, and where the counter records just a single hit, it will classify that hit as “Class 0”. The “Class 0” classification system became particularly significant with the cycle counts. The following issues were experienced;

i. On-road cycle counts were made difficult as many motor vehicles hit the tubes. In some cases this was because the tubes were extended into the traffic lane slightly in an attempt to capture all cyclists. It was thought that if the tubes stopped at the edge of the cycle lane some cyclists would cycle in the traffic lane to avoid the tubes. This however made it more likely that motor vehicles would hit the tubes. In other cases where general traffic lane widths were narrow, the tubes were not extended into the traffic lanes, however some motor vehicles encroached into the cycle lanes and hit the tubes.
ii. The software struggled to identify and classify groups of vehicles. This was a particularly significant concern as many cyclists, training and school cyclists especially, ride in groups. This often resulted in a group of cyclists being classified as a truck. This was obviously a mistake on the off-road paths, however for the on-road path counts the speed had to be analysed also to determine whether or not it was likely to be a truck. This problem is exacerbated on busy off-road paths where cyclists are likely to hit the tubes within close time intervals heading in opposite directions.

iii. Class 0 classifications were often a significant percentage of the overall vehicle count. These could have been a random pulse from the tube not cause by a vehicle, or a cyclist only riding or only being recorded over one tube.

iv. The tubes did not reliably record cyclists at speeds less than 10 km/h, however this would be considered slow for a cyclist.

v. It is possible that young children may not be recorded reliably using tube counters due to their light weight and slow speeds.

After close analysis of the MetroCount data and comparison between manual count results, it was found that the automatic counts undercounted the actual volume of cyclists. The reasons identified for this are;

i. Cyclists riding on the footpath and therefore missing the tubes.

ii. Cyclists swerving to avoid the tubes.

iii. Cyclists riding in bunches tend to confuse the counter resulting in incorrect classification, or the outside rider is forced wide of the tubes.

The off-road automatic counts were found to be more accurate, counting 85% of cyclists when compared with 62% of cyclists for on-road counts. This difference between the on-road and off-road counting percentage is primarily thought to be due to the “noise” in the data caused by motor vehicles hitting the tubes during the on-road counts. Some on-road counts appeared to be more successful than others, however, with accuracy rates varying between 52% and 100%.

5.5 AADT calculation from automatic tube counts

As discussed in Section 3 of this report the CNRPG and ARTA 2007 methods already exist for estimating cycling AADT from manual counts. The methods can also be adopted to estimate the cycling AADT from automatic tube counts. The main difference is the inclusion of an additional factor to allow for the undercounting of the automatic tube counters and the formula becomes:

$$AADT = Count \times \frac{1}{H} \times \frac{1}{D} \times \frac{W}{7} \times \frac{1}{R} \times \frac{1}{T} \qquad \text{Equation 1}$$

Where

Count = Result of count period
H = Scale factor for time of day (= 1 if count over a full day).
D = Scale factor for day of week (= 1 if count over a full week).
W = Week of the year.
R = Scale factor for a wet day. R = 64% (to be applied to individual days).
T = Scale factor to allow for the systemic undercounting of MetroCount counters.

The factors *H*, *D* and *W* are obtained from the CNRPG or from the ARTA 2007 methods, which have been included in Appendix D. If complete data for a whole week are available factors *H* and *D* can be ignored. This is because *H* = 1 as the count will be for a whole day and D = 1 as the count is for the whole week. However there will be occasions where the data is not valid for the whole week and these factors will be needed.

On average rain days reduce cycling numbers to 64% of a fine day. Therefore any week with one or more rain days will need to be calculated separately so that the whole week isn't affected by the rain day factor. Determining wet days was a subjective task based on the amount of rain, what time it rained, and the amount of rain on the preceding day.

For off-road paths T = 85%, for on-road facilities T = 64%.

Where more than a week's worth of data was collected, the counts were combined to form a virtual week. For example, if two Mondays were counted they were averaged to form a virtual Monday.

- Where less than a full week's data were obtained, each day's data was scaled up as per Equation 1. The cycle AADT calculated from each day's count was then averaged to give a cycle AADT for that site.
- For on-road sites a counter was set up on each side of the road. The cycle AADT was calculated for each side of the road and was then combined to give a total cycle AADT for that road.
- Worked examples of cycle AADT calculations are contained in Appendix F.

The cycle AADT results obtained for the ten sites are:

Table 5.1 Cycle AADT for the ten test sites.

Site	Location	Cycle AADT
On-Road		
Centaurus Road	Christchurch	702
Halswell Road	Christchurch	548
Wakefield Quay	Nelson	455
North Road	Dunedin	347
George Bolt Memorial Drive	Manukau	100
Off-Road		
Waterview Overbridge	Auckland	260
Pioneer Path	Palmerston North	120
Travis Road Path	Christchurch	76
Atawhai Path	Nelson	74
Harakeke Path	Porirua	43

6. Cycle Traffic Estimation Tool

6.1 Introduction

As discussed in Section 5.1 of this report, in New Zealand it appears that minimal cycle count information is collected on new cycle facilities, either before or after installation. It is felt that every new facility should have cycle counts (both before and after installation). The technology exists, and the cost of counts is a very small part of overall project costs.

To use a cycle traffic estimation tool for funding applications, it needs to provide an estimate for:

1. the existing cycle traffic AADT,
2. the number of new cyclists, and
3. the annual growth rate.

Each of the three pieces of information above are required as part of the EEM SP11 economic analysis.

With five on-road and five off-road sites and the difficulty obtaining comprehensive historical data, assumptions based on the experience and engineering judgement of the research team were incorporated into the development of the model. Where assumptions have been made, they are clearly stated in the sections on the tool development.

From the analysis of the data it became obvious that on-road and off-road facilities would require different models. Therefore a separate tool for on-road and off-road facilities has been developed.

Based on experience the researchers assumed that a jump in cycling numbers would occur following the installation of a cycle facility due to suppressed demand and marketing and promotion associated with a new facility. This “step function” is consistent with the EEM SP11 simplified procedures and corresponds to the number of new cyclists. Before the installation of a cycle facility there will be a cycle volume, CV_{BF} at time Y_{BF}. Once the facility is installed in year Y_0 there will be a jump in the cycle volume to CV_0, which is assumed to occur instantaneously. In reality, the jump in cycling numbers would occur over a few months, which in terms of the 25 year evaluation period of the EEM SP11 is relatively short. The cycle volume on that facility is assumed to grow over the following 25 years (year Y_{25}) to volume CV_{25}. A graphical representation of the assumed model is shown in Figure 6.1.

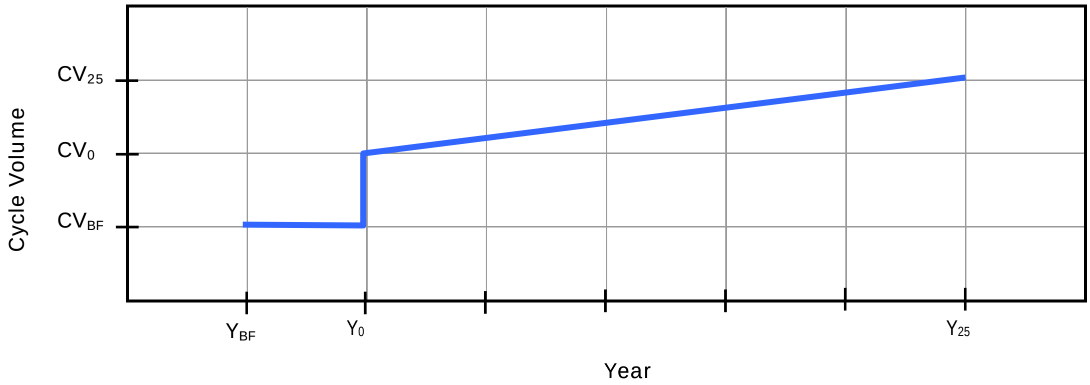

Figure 6.1 Step function model for cycle traffic volumes.

Neither the on-road nor off-road tools have been validated. This is primarily due to the limited amount of data available. All the available data has been used in the development of the tool. As more data becomes available it is anticipated that a validation process will occur and the model will be refined.

6.2 On-road tool development

This method assumes that cycle counts collected before the installation of a cycle facility can be used to estimate existing and future cycling volumes. It is also assumed that existing trends observed in the Census travel to work data can be used to predict the cycle traffic growth rate.

The following steps describe the procedures to develop the cycle demand estimation tool for on-road facilities.

Step 1: Extract relevant Census data for the most recent year (Y_n) and the previous set of Census data (Y_{n-1}). The Census data used in this research is from 2001 and 2006, which is available in Appendix G.

Step 2: For each year of Census data, obtain the number of people who biked to work in year Y_n (CB_{Yn}) and Y_{n-1} (CB_{Yn-1}). For years 2001 and 2006 the *CB* values are listed in Appendix G. Census data for different years can be used if it is known (and can be documented) that 2001 or 2006 had some anomalies associated with them (for example, wet weather on Census day in the particular region being considered).

Step 3: From the Census data, compute the time series growth for people who biked to work (BG) using the standard arithmetic growth formula as shown in Equation 2;

$$BG = \left(\frac{CB_{Y_n}}{CB_{Y_{n-1}}}\right)^{\left(\frac{1}{Y_n - Y_{n-1}}\right)} - 1 \qquad \text{Equation 2}$$

Census data in New Zealand is collected every five years and the 2001 and 2006 Census data has been used in the tool, therefore Equation 2 becomes;

$$BG = \left(\frac{CB_{2006}}{CB_{2001}}\right)^{\left(\frac{1}{5}\right)} - 1 \qquad \text{Equation 3}$$

Appendix G lists the calculated BG values for each council.

Step 4: Before the installation of the cycle facility gather cycle counts (CC_{BF}) and after the installation of the cycle facility in a given year (*Y*) gather cycle counts (CC_Y). For after cycle counts undertaken in 2007 as part of this research this would become CC_{2007}. Other historical after cycle counts were also available. The before cycle counts CC_{BF} and the after cycle counts CC_Y are used to estimate the before cycling volumes CV_{BF} and after cycling volumes CV_Y using the AADT estimation methods discussed in Section 5.5 of this report.

Step 5: Based on the assumed model discussed in Section 6 of this report an assumption was made on the size of the step function that would represent the number of new cyclists due to suppressed demand. It was assumed that the step function should be a percentage of the existing cycling numbers. Using the cycle count data, the higher the step function the lower the growth rate. A sensitivity analysis was carried out using 10%, 20% and 30% step functions. The researchers assumed a step function of 20% as this was a reasonable fit with the data and was considered appropriate in the opinions of the researchers.

Compute the number of new cyclists (*NC*) using the cycle facility as shown in Equation 4:

$$NC = CV_{BF} \times 0.2 \qquad \text{Equation 4}$$

The model assumes that the number of new cyclists using the facility occurs instantaneously. Therefore at the installation of the new facility at time (Y_0), the total cycle volume (CV_0) is:

$$CV_0 = CV_{BF} + NC \qquad \text{Equation 5}$$

Step 6: Compute the annual percentage growth (*AG*) as shown in Equation 6:

$$AG = \left(\frac{CV_Y}{CV_0}\right)^{\left(\frac{1}{\eta}\right)} - 1 \qquad \text{Equation 6}$$

Where η is the number of years between installation of the cycle facility and the last count following construction of the cycle facility.

Step 7: Based on the 20% step function the cycling AADT at the time of installation can be estimated.

The cycling AADTs for the four on-road locations are shown below in Table 6.1.

Table 6.1 Summary of AADTs and growth rates.

Locations	AADT at Installation	AADT (2007)	Years Facility Installed	Annual Growth
Centaurus Road, Christchurch	508[2]	702	3	11.4%
Halswell Road, Christchurch	565[2]	548	3	-1.0%
Wakefield Quay, Nelson	357	455	8	3.1%
North Road, Dunedin	242	347	2	19.9%
Average of Annual Growth				8.3%
Weighted Average of Annual Growth				7.7%

With the AADT estimates in Table 6.1, the growth can be estimated using Equation 6. A straight average of the growth rate on individual sites gives an average annual growth of 8.3%, whereas a weighted average (by cycling volume) gives an average annual growth of 7.7%. Rounding to the nearest percentage gives an annual growth rate due to the installation of a new facility of *AG* = 8%.

Step 8: The growth rate of 8% calculated in Step 7 above needs to reflect the current regional cycling trends. Therefore the annual cycle to work growth (*BG*), as calculated from the Census data in Equation 2 is added to the annual growth (*AG*) from the installation of a facility. It is anticipated that the 8% growth calculated in Step 7 overstates the expected growth. This will in part be due to the fact that the facilities studied were generally recent installations and growth is expected to be higher during the initial years following installation. Therefore for the purpose of the tool it is suggested that the annual growth rate be halved. Since *AG* was halved, *BG* should also be halved, otherwise *BG* will dominate the equation. Therefore the annual Cycle Growth Rate (*CGR*) used in the tool is calculated as shown in Equation 7.

$$CGR = (BG + AG)/2 \qquad \text{Equation 7}$$

Where AG = 8%, Equation 7 becomes:

$$CGR = (BG + 8\%)/2 \qquad \text{Equation 8}$$

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[2] Calculated based on the 20% step function discussed in Step 5.

6.3 On-road tool

The on-road cycle demand estimation tool required two pieces of information:

1. "Before" cycle counts CC_{BF} to estimate the existing cycle AADT, CV_{BF}.
2. The Census growth rate for people that biked to work in the appropriate district or city, *BG* (see Appendix G).

The procedure for the tool is:

1. Calculate the existing cycle AADT, CV_{BF}. The existing cycle AADT, CV_{BF}, is calculated using the methods in Appendix D or as discussed in Section 5.5 of this report.
2. Calculate the number of new cyclists, *NC* using Equation 4. $NC = CV_{BF} \times 0.2$.
3. Calculate the annual Cycle Growth Rate, *CGR* using Equation 8. $CGR = (BG + 8\%)/2$.

These are the three pieces of information required for the EEM SP11 simplified procedures for on-road facilities.

6.4 On-road tool worked example

Assume that the site is in Hamilton.

1. Based on cycle count data collected before the installation of the cycle facility, assume the estimated cycle AADT, $CV_{BF} = 300$.
2. The number of new cyclists, $NC = 300 \times 0.2 = 60$.
3. From Appendix G, Hamilton has a Census biked to work growth rate, $BG = -4.0\%$. Therefore the cycling annual growth rate, $CAG = (-4.0\% + 8\%)/2 = 2.0\%$.

6.5 Off-road tool development

The main difference between the on-road and off-road tool is that existing cycle volumes cannot generally be counted for off-road paths before they are installed. Therefore the step function starts from zero. Without existing counts on which to base the step function, an alternative method for estimating the step function was required.

The off-road tool is intended to be used where an off-road facility is to be installed adjacent to an existing road. This is believed to represent the most common scenario.

The model developed for the off-road paths is an empirical model based on the data obtained from the sites and engineering judgement. It was assumed that the Census cycling mode share for the particular city or district, multiplied by the motor vehicle AADT on the nearest adjacent road should be able to form the basis for an off-road path cycle volume estimate. The average trip length for motor vehicles is higher than for cycles, therefore a factor was introduced to allow for this. Empirical factors were then applied to align results from the model with the data obtained from the off-road sites studied.

This method calculates the number of new cyclists and the growth rate for an off-road path. The number of existing cyclists is always zero for an off-road path that hasn't been constructed.

This method formalises the analytical steps and mathematical formulation to estimate cycle demand for off-road facilities. This method assumes that same step function model shown in Figure 6.1.

Step 1: Gather the latest Census data for the study area. Obtain the number of people who biked to work (CB_Y) and the total number of people that travelled to work (CTT_Y) in that year. Note that the total travelled to work (CTT_Y) is the total number of journeys to work and excludes people that did not work, that worked at home and that didn't specify a mode of travel to work. The tool uses Census data from Y = 2006.

Step 2: From the Census data, compute the cycling mode share (*MS*) as shown in Equation 9;

$$MS = \frac{CB_Y}{CCT_Y} \times 100 \qquad \text{Equation 9}$$

The Census mode share for each council is provided in Appendix G.

Step 3: Obtain the motor vehicle AADT (*MV*) for the current year for the road running parallel to the proposed off-road path. Motor vehicle AADTs from earlier years may need to be adjusted to the current year. If a road is not immediately parallel to the off-road path, use the motor vehicle AADT from the road that cyclists would need to take in the absence of the off-road path. In some cases this may not be possible, however this method is expected to address the majority of situations.

Step 4: Compute the cycle to motor vehicle trip length ratio (*CTR*).

$$CTR = \frac{\text{Average motor vehicle trip length (AMVTL)}}{\text{Average cycle trip length (ACTL)}} \qquad \text{Equation 10}$$

For the analysis, the *CTR* was calculated from the number of cycle and motor vehicle driver trips and the length of those trips based on figures from the New Zealand Road Safety Trust (1999) New Zealand Travel Survey and the (MOT2007) Household Travel Surveys.

From Tables TR2 and TR3 of the New Zealand Road Safety Trust (1999) New Zealand Travel Survey:
Vehicle Driver Trips, VDT_{1999} = 414.4 million
Vehicle Driver Distance Travelled, VDD_{1999} = 4390 million kilometres
Cycle Trips, CT_{1999} = 13.6 million
Cycle Distance Travelled, CD_{1999} = 40 million kilometres

$$AMVTL_{1999} = \frac{VDD_{1999}}{VDT_{1999}} = \frac{4390M}{414.4M} = 10.59 \qquad \text{Equation 11}$$

$$ACTL_{1999} = \frac{CD_{1999}}{CT_{1999}} = \frac{40M}{13.6M} = 2.94$$ Equation 12

$$\therefore CTR_{1999} = \frac{AMVTL_{1999}}{ACTL_{1999}} = \frac{10.59}{2.94} = 3.60$$ Equation 13

From Table 1 of the Ministry of Transport (2007) Household Travel Surveys v1.2 Comparing Travel Modes:
Vehicle Driver Trips, VDT_{2007} = 3,467 million
Vehicle Driver Distance Travelled, VDD_{2007} = 31,592 million kilometres
Cycle Trips, CT_{2007} = 89 million
Cycle Distance Travelled, CD_{2007} = 247 million kilometres

$$AMVTL_{2007} = \frac{VDD_{2007}}{VDT_{2007}} = \frac{31592M}{3467M} = 9.11$$ Equation 14

$$ACTL_{2007} = \frac{CD_{2007}}{CT_{2007}} = \frac{247M}{89M} = 2.78$$ Equation 15

$$\therefore CTR_{2007} = \frac{AMVTL_{2007}}{ACTL_{2007}} = \frac{9.11}{2.78} = 3.28$$ Equation 16

Data from both the 1999 and 2007 travel surveys have merit. The 1999 data is older but is confined to work trips (as is the cycle mode share data) and has a larger data set. The 2007 data is more current but aggregates all trip purposes and is a smaller data set. The cycle to motor vehicle trip length ratio is similar for both sets of data, with each data set having merit it seemed reasonable to average the results from each. Therefore the *CTR* used in the analysis is calculated as shown by Equation 17.

$$CTR = \frac{CTR_{1999} + CTR_{2007}}{2} = \frac{3.60 + 3.28}{2} = 3.44$$ Equation 17

Step 5: The before cycle counts, PCC_{BF} on the road parallel to the off-road facility are used to estimate the cycle volume, PCV_{BF} using the estimation methods in Appendix D or as discussed in Section 5.5 of this report.

Step 6: None of the off-road sites studied had counts within the first few months of installation. The earliest was Pioneer Path, which was approximately six months following construction. However knowing the recent growth and 2007 cycle AADT on some of the sites the researchers could extrapolate backwards to estimate the number of new cyclists on those sites. However with little data to go on the researchers needed to develop a method based on readily available data that made good engineering sense. The researchers thought that the number of new cyclists (*NC*) could be derived from the Census cycling mode share (*MS*) for the particular city or district, multiplied by the motor vehicle AADT (*MV*) on the nearest adjacent road, all divided by the ratio of the cycle to motor vehicle trip length (*CTR*) as shown by Equation 18.

$$NC = \frac{MS \times MV}{CTR} \qquad \text{Equation 18}$$

However the model did not fit the count data from the sites, particularly where the parallel road had a high motor vehicle AADT. Therefore the initial model was modified using empirical factors to provide a good fit with the data as shown by Equation 19.

$$NC = 6 \times \sqrt{\frac{MS \times MV}{CTR}} \qquad \text{Equation 19}$$

An aspect missing from Equation 19 is a cycle count, which is considered an important factor that will reflect the popularity of a particular route (e.g. directness, how it links with other roads etc) as well as regional differences. With no data available to estimate how the cycle volume on a particular road correlates with predicted new cyclists on a parallel path, the researchers made the following assumptions:

1. 50% of the existing cyclists on the parallel road would transfer to the off-road path.
2. An additional 50% of cyclists would be generated from suppressed demand.

Therefore the number of cyclists on the parallel road (PCV_{BF}) is equal to the number of cyclists expected on the new off-road path.

Therefore the number of new cyclists is an average of the empirical formula (Equation 19) and the existing cycle AADT on the road parallel (PCV_{BF}) to the off-road path as shown by Equation 20. Averaging the two methods provides a buffering effect so that one method doesn't dominate.

$$NC = \frac{\left(6 \times \sqrt{\frac{MS \times MV}{CTR}} + PCV_{BF}\right)}{2} \qquad \text{Equation 20}$$

Where *CTR* = 3.44 as calculated in Equation 17;

$$\therefore NC = \frac{\left(6 \times \sqrt{\frac{MS \times MV}{3.44}} + PCV_{BF}\right)}{2} \qquad \text{Equation 21}$$

Dividing through by the denominators Equation 21 simplifies to;

$$\therefore NC = 1.6 \times \sqrt{MS \times MV} + 0.5 \times PCV_{BF} \qquad \text{Equation 22}$$

Step 7: Use the Census data to compute the annual growth in the number of people who biked to work (*BG*) as per Step 1 to Step 3 of the on-road method. Appendix G lists the calculated *BG* values for each council.

Step 8: The annual growth rate calculated on the off-road facilities studied was very high. The concern is that the facilities studied were all constructed within the last four years and therefore were likely to be experiencing their strongest growth, which was not expected to be indicative of growth over a 25 year period. Therefore the Stoke Railway Reserve path in Nelson, which has cycle count data from 1999 to 2006, was used to estimate the expected cycle growth rate. The linear trend line has an annual cycle growth, *AG* = 14% over the eight year period.

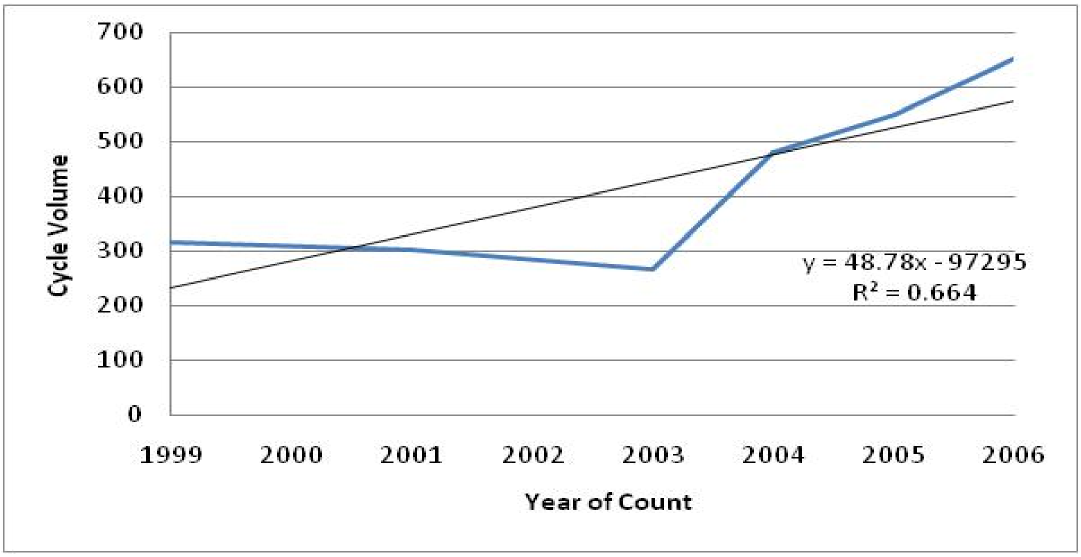


Figure 6.2 Cycle volumes on Stoke Reserve Cycle Path in Nelson.

Step 9: The growth rate of 14% calculated in Step 8 above needs to reflect the current regional cycling trends. Therefore the annual cycle to work growth (*BG*), as calculated from the Census data in Step 7 (and listed in Appendix G) is added to the annual growth (*AG*) from the installation of a facility.

The growth rate of 14% over an eight year period is likely to overstate the growth over a 25 year period, therefore for the purpose of the tool it is suggested that the annual growth rate, *AG*, be halved. Since *AG* was halved, the Census Bike Growth, BG, should also be halved, otherwise *BG* will dominate the equation. This is consistent with on-road methodology.

Therefore the cycling annual growth rate (*CGR*) used in the tool is calculated as shown in Equation 23.

$$CGR = (BG + AG)/2 \qquad \text{Equation 23}$$

Where *AG* = 14%, Equation 24 becomes:

$$CGR = (BG + 14\%)/2 \qquad \text{Equation 24}$$

6.6 Off-road tool

The off-road cycle demand estimation tool requires four pieces of information:

1. The cycling mode share for the appropriate city or district, *MS* (see Appendix G).
2. The motor vehicle AADT, *MV*, on the road parallel to the off-road path.
3. Cycle counts CC_{BF} on the road parallel to the off road path to estimate the existing cycle AADT, CV_{BF} on the road parallel to the off road path.
4. The Census growth rate for people that biked to work for the city or district, *BG* (see Appendix G).

The procedure for the tool is:

1. Count cycle traffic and then estimate the existing cycle AADT, PCV_{BF} on the road parallel to the off-road path using the methods in Appendix D or as discussed in Section 5.5 of this report.
2. Calculate the number of new cyclists using Equation 22.
$$\therefore NC = 1.6 \times \sqrt{MS \times MV} + 0.5 \times PCV_{BF}$$
3. Calculate the cycling annual growth rate, *CGR* using Equation 24.
$$CGR = (BG + 14\%)/2$$

These are the two pieces of information required for the EEM SP11 simplified procedures for off-road paths.

6.7 Off-road tool worked example

Assume the site is in Napier.

1. Based on cycle count data collected before the installation of the cycle facility, assume the estimated cycle AADT, CV_{BF} = 150 cycles per day.
2. The motor vehicle AADT on the parallel road is 10,000 vpd, the mode share for Napier is 4.0%. Therefore the number of new cyclists is:

$$\therefore NC = 1.6 \times \sqrt{MS \times MV} + 0.5 \times PCV_{BF}$$
$$= 1.6 \times \sqrt{0.04 \times 10000} + 75 = 107$$

4. From Appendix G, Napier has a Census biked to work growth rate, *BG* = 0.8%. Therefore the cycling annual growth rate, *CGR* = (0.8% + 14%)/2 = 7.4%.

7. Conclusions

The research, Estimating Cycle Demand for New Facilities has achieved the objectives set out in the proposal by establishing a tool for the estimation of cycle volumes on new facilities, the number of new cyclists and the growth rate. In addition to the original objectives the project also achieved the following:

1. Developed awareness amongst RCAs that automatic tube counters can be used for collecting cycle data to estimate cycle AADTs.
2. Developed guidelines for the set out of automatic tube counters for the purposes of collecting cycle count data.
3. Developed awareness and skills among vehicle counting contractors for the use of automatic tube counters to collect cycle count data. Many contractors had not used standard counters to count cycles and were not aware that different tubes were available for this purpose.
4. Contributed to the development of a technique for converting automatic tube counts to an estimate of the cycling AADT.

Land Transport NZ funded (co-funded by ARTA, Dunedin City Council, Nelson City Council and Transit NZ) research of ten cycle facilities sites. Automatic tube counts were carried out over at least a week at each site between February and May 2007, and the results of these counts were analysed and converted into AADT volumes using the procedures discussed in Section 5.5 of this report. The resulting AADTs were then compared with AADT estimates before the facilities were installed, and the predictions made regarding the cycling growth.

A literature review was undertaken, and uncovered many methods that are in use globally to predict cycle volumes and relative popularities of facilities. Depending on the results and accuracy desired and the data available, these methods varied in complexity from the simple Comparison methods to the complex and expensive Regional Travel and Discrete Choice models.

No consistent method was used to make predictions used in funding applications. This highlights the need for a consistent method to be developed to aid practitioners in predicting future cycle volumes and growth on new facilities.

Much more research is required before there is sufficient knowledge in this area. However an estimation method has been developed that can be applied in a consistent manner, has data requirements that are readily obtainable, that is simple to use and evaluate, making a much overdue start in achieving the goal of estimating cycle demand on new cycle facilities in New Zealand. The tool can be refined as more “before” and “after” data come to hand.

8. Recommendations

Based on the findings of this research the following recommendations are made:

1. That these cycle demand estimation tools be incorporated into the Economic Evaluation Manual.
2. That cycle counts, using the guidelines in Appendix B be undertaken as part of every application for funding through Land Transport NZ.
3. That a cycle facilities database be established to allow further research in this area.

9. References

Ashley, C., & Banister, C. 1989. *Bicycling to Work from Wards in a Metropolitan Area, Traffic Engineering and Control, Vol. 30*. 6-8pp.

Auckland Regional Transport Authority (ARTA). 2007. *Development of a Cycle Traffic AADT Tool*. Christchurch, New Zealand. 14pp.

Austroads, 2001. *Forecasting Demand for Cycling Facilities*. Sydney: Austroads Incorporated. 32pp.

Christchurch City Council. 2003. *Economic Evaluation of Cycling Projects.* Christchurch, New Zealand. 59pp.

FHWA. 1999a. *Guidebook on Methods to Estimate Non-Motorized Travel: Overview of Methods.* U.S. Dept. of Transportation's Federal Highway Administration - Research, Development, & Technology.

FHWA, 1999b. *Guidebook on Methods to Estimate Non-Motorized Travel: Supporting Documentation.* U.S. Dept. of Transportation's Federal Highway Administration - Research, Development, & Technology.

Goldsmith, S. 1997. *Draft: Estimating the Effect of Bicycle Facilities on VMT and Emissions, Seattle Engineering Department*. www.ci.seattle.wa.us

Hunt, J.D., Brownlee A.T., & Doblanko L.P. 1998. *Design and Calibration of the Edmonton Transport Analysis Model*. Presented at the 1998 Transportation Research Board Annual Meeting, Paper #981076.

Lewis, C., James E. 1997. *Central Massachusetts Rail Trail Feasibility Study*. Central Transportation Planning Staff, Boston, MA, April.

Land Transport Safety Authority (LTSA) 2004. *Cycle Network and Route Planning Guide*. Wellington, New Zealand. 88pp.

Macbeth, A. G. 2007. *Cycle Counting in New Zealand*. Land Transport New Zealand.

MOT 2007. *Household Travel Surveys v1.2 Comparing Travel Modes.* Wellington, New Zealand. 13pp.

MTC. 1990. *Metropolitan Transportation Commission, San Francisco Bay Area. Travel Model Development Project: Compilation of Technical Memoranda (Volumes II-VI).* Oakland, CA, 1995-1997.

MVA. 1995. *Leicester Bicycle Model Study, Final Report, prepared for Leicestershire County Council*. Contract No. 02/C/1428.

NCHRP. 2006. *Guidelines for Analysis of Investments in Bicycle Facilities.* National Cooperative Highway Research Program, Report. 552pp.

Nelson, A.C., & Allen, D. 1997. *If You Build Them, Commuters Will Use Them: Cross-Sectional Analysis of Commuters and Bicycle Facilities.* Presented at the Transportation Research Board, 76th Annual Meeting, Washington, DC.

New Zealand Road Safety Trust 1999. *New Zealand Travel Survey.* Wellington, New Zealand.139pp.

Parkin, J., Wardman, M., & Page, M. 2007. *Estimation of the determinants of bicycle mode share for the journey to work using census data*. Transportation Journal.

TRB. 1980. *Cycle Routes in the Hague and Tilburg.* Crowthorne, U.K.. Published in Cycling as a Mode of Transport: Proceedings of a Symposium held at the Transport and Road Research Laboratory, (TRRL Supplementary Report 540).

Turner S., Aaron H., & Gordon S. 1997, Bicycle and Pedestrian Travel Demand Forecasting: Literature Review. Texas Department of Transportation, Research and Technology Transfer Office.

Wigan, M., Anthony., Paris B. 1998. Simplified Estimation of Demand for Non-motorized Trails Using GIS, Transportation Research Board.

Wilbur Smith Associates. 1997. *Non-Motorized Access to Transit: Final Report. Prepared for Regional Transportation Authority*. Chicago, IL.

Appendices

Appendix A

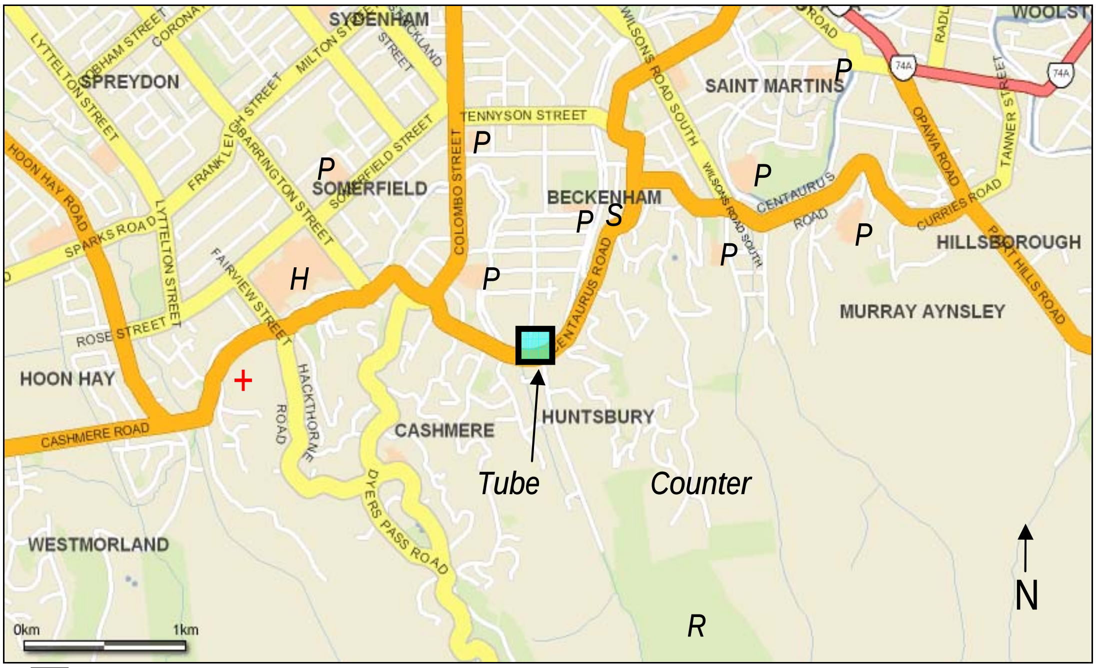
Descriptions and Analysis of Sites Studied

Appendix A: Descriptions and Analysis of Sites Studied

AA.1 Centaurus Road (Christchurch)

AA.1.1 Site description

Centaurus Road runs along the Heathcote River around the foot of the Port Hills in Christchurch and is a flat but windy road. It serves a variety of cyclists, from commuters and school students, to sports recreational cyclists accessing the Port Hills mountainbike tracks via Dyers Pass Road or Port Hills Road. The route is also used by "road" cyclists (racing cyclists) on training rides. The Christchurch CBD is approximately 5 km north of Centaurus Road via Colombo Street. There are also three schools, a block of shops and a hospital in the immediate vicinity that are likely to contribute to the volume of cyclists using Centaurus Road. A map of the general area is shown in FigureAA.1.1 below.



Tube count location

Hospital

S Shops

Schools (***U*** = University, ***H*** = High School, ***I*** = Intermediate, ***P*** = Primary, ***O*** = Other)

Recreational Areas (***R*** = Recreational Parks, ***F*** = Sports Fields, ***G*** = Golf Course)

Figure AA.1.1 Centaurus Road - map of facility and surroundings.

Cycle lanes are provided on both sides of Centaurus Road as shown in Figure AA.1.2. The physical attributes and motor vehicle volumes are summarised in Table AA.1.1.

Table AA.1.1 Centaurus Road - summary of infrastructure and traffic data.

Cycle Lane Width	Cycle Lane Length	Cycle Facility Installation	Traffic Lanes	Parking	Footpaths	Motor Vehicle AADT	Speed Limit (km/h)
2 x 1.6 m	2.5 km	2004	2 x 3.5 m	None	2 x 1.6 m	10,500	50

Figure AA.1.2 Typical section of Centaurus Road.

AA.1.2 Tube counter setup

The tubes were placed between Bowenvale Avenue and Landsdowne Terrace, 90 m west of Bowenvale Avenue and operated between 13 February 2007 and 21 February 2007. The tubes were extended 400 mm into the traffic lane to catch the majority of cyclists, however eastbound cars on this inside bend were observed hitting the tubes more than on the outside of the bend. While the counter can generally distinguish between cars and cycles, if a car and a cycle hit the tubes at almost the same time, counting errors may occur.

Manual cycle counts were undertaken at this site between 3:00 and 4:00 pm on 20 February 2007. It was observed that 14 cyclists (25%) missed the tubes. The majority of these cyclists were riding on the footpath; 10 of those riders were observed to be school aged cyclists. Other instances where cyclists missed the tubes occurred when cyclists were riding side by side with the outside cyclist riding in the general traffic lane. No cyclists were observed swerving to avoid the tubes.

AA.1.3 Original estimate of cycling AADT

The original estimate for the funding application was based on a weighted average of several counts along the route. For the section that corresponds to the tube count location the cycling AADT estimated was 220 cycles per day based on a range of counts from 1998 to 2002.

Christchurch City Council assumed a zero growth. The following is from Section 3.3.3 – 'Cycle growth', (Christchurch City Council, 2003); *"….. cycle counts shows that numbers have remained static for the last two years…. The Council expects that the implementation of new and improved cycling facilities around the city will ensure that at the very least, the current numbers of cyclists are maintained. Hence, no increase in cyclist numbers has been assumed for economic evaluation purposes. This conservative approach ensures that the benefits of new facilities will not be overestimated."* This statement applies to the two Christchurch City Council cycling projects studied.

AA.1.4 Findings

Based on the automatic tube counts, the estimated 2007 cycling AADT on Centaurus Road is 728 cyclists per day.

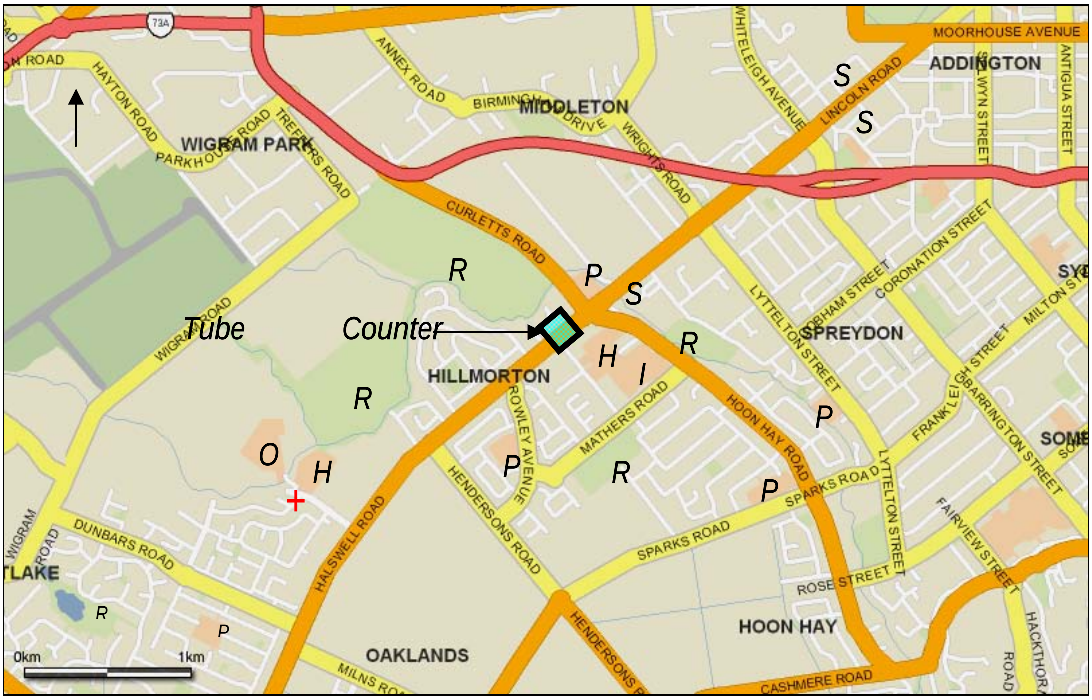
The count data indicate that the weekend cycling volumes are 27% higher than the weekday volumes, indicating that it is popular recreationally as well as for weekday use by students and commuters.

A 2006 manual count between 7:30 am and 9:00 am recorded that 38% of the cyclists on Centaurus Road were school students.

AA.2 Halswell Road (Christchurch)

AA.2.1 Site Description

Halswell Road (SH75) is a main route into the Christchurch CBD from the South-west. There are many schools in the area, as well as a hospital. The Halswell Domain, aquatic centre and shopping centre are 3 km south of the count site. The CBD is 5 km north-east of the count site. As might be expected with a main road, there are some major intersections along this route. A map of the general area is shown in Figure AA.2.1 below.



Tube count location

Hospital

S Shops

Schools (***U*** = University, ***H*** = High School, ***I*** = Intermediate, ***P*** = Primary, ***O*** = Other)

Recreational Areas (***R*** = Recreational Parks, ***F*** = Sports Fields, ***G*** = Golf Course)

Figure AA.2.1 Halswell Road - map of facility and surroundings.

Cycle lanes have been marked on both sides of Halswell Road. The photo in FigureAA.2.2 shows the general layout. The physical attributes and motor vehicle volumes are summarised in Table AA.2.1.

Table AA.2.1 Halswell Road - summary of infrastructure and traffic data.

Cycle Lane Width	Cycle Lane Length	Year of Installation	Traffic Lanes	Parking	Footpaths	Motor Vehicle AADT	Speed Limit (km/h)
2 x 1.6 m	5.8 km	2004	2 x 5.5 m	1 x 3 m	2 x 1.5 m	20,000	50

FigureAA.2.2 Count location on Halswell Road with the Hoon Hay/Curletts Road intersection in the distance.

AA.2.2 Tube Counter setup

The tubes were placed approximately 150 m southwest of the Hoon Hay Road/Curletts Road intersection and operated between 13 February 2007 and 21 February 2007.

The tubes on the western side were extended 400 mm into the traffic lane. Given the wide motor vehicle lane widths, cars were unlikely to drive over the tubes. The tubes on the eastern side were not extended into the traffic lane as the parking demand here was low and cyclists were usually able to use the parking area to cycle. The section over the parking lane had hatching painted in an attempt to deter people parking on the tubes, as shown in Figure AA.2.2.

Traffic flow was observed after the tubes were installed and only a small proportion of vehicles hit the tubes. All cyclists observed cycled over the tubes and were correctly recorded by the counter. The parking on the eastern side was not used at anytime during the counter setup.

AA.2.3 Original estimate of cycling AADT

For the section of road where the count was located, the original AADT estimate used as part of Transit New Zealand's funding application was 212 cycles per day with zero growth.

AA.2.4 Findings

Based on the automatic tube counts, the estimated 2007 cycling AADT on Halswell Road is 548 cyclists per day.

The count data indicate that the weekend cycling volumes are 41% of the weekday volumes, indicating this facility is primarily used by commuters and school students, although road training cyclists are known to use the route, particularly further south along Halswell Road towards Halswell.

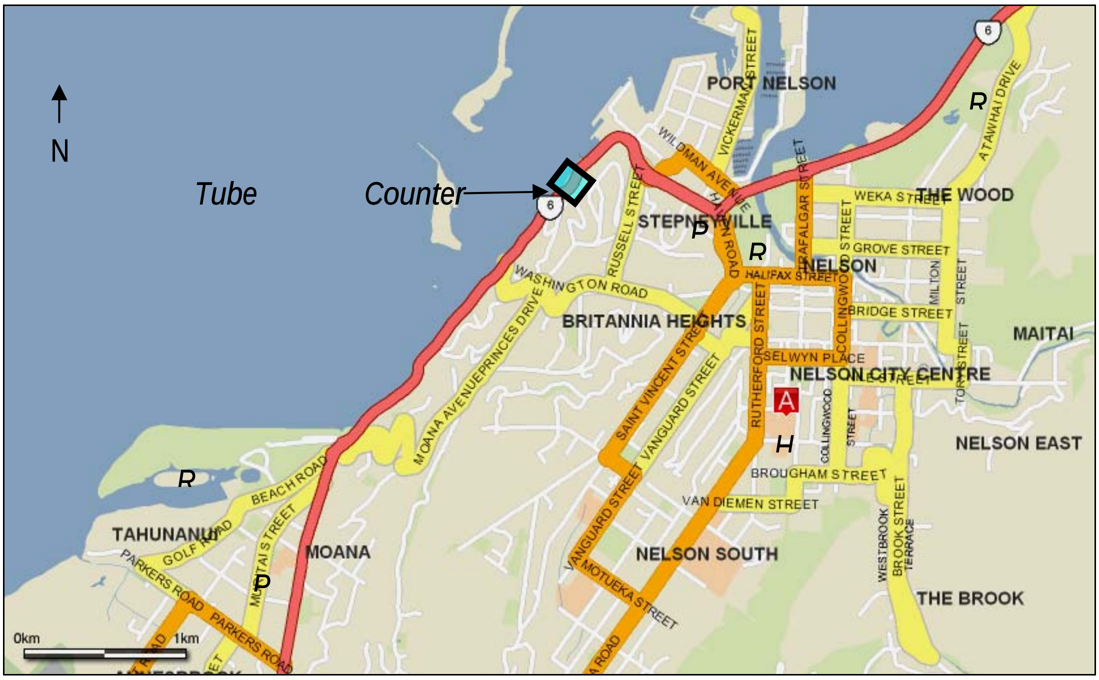
During a manual count in 2005 between 7:30 am and 9:00 am, school students made up 38% of all cyclists.

AA.3 Wakefield Quay (Nelson)

AA.3.1 Site description

Wakefield Quay (SH6) is one of two routes into the Nelson CBD from the south, and the flat coastal route serves as the main route for cyclists commuting to work from the southern suburbs such as Richmond and Stoke (12 km and 8 km respectively south of the Nelson CBD). The other route goes over the top of a hill and hence is not as attractive for commuting cyclists. Nelson airport (6 km) and Tahunanui beach and an accommodation park (4 km) are also to the south of the Nelson CBD, providing attractions for recreational cyclists and tourists, particularly in the summer.

There is a high volume of motor vehicle traffic, including a high percentage of heavy vehicles. A map of the general area is shown below in Figure AA.3.1.



Tube count location

Hospital

Shops

Schools (***U*** = University, ***H*** = High School, ***I*** = Intermediate, ***P*** = Primary, ***O*** = Other)

Recreational Areas (***R*** = Recreational Parks, ***F*** = Sports Fields, ***G*** = Golf Course)

Figure AA.3.1 Wakefield Quay - map of facility and surroundings.

Cycle lanes are marked on both sides of Wakefield Quay which follows the waterfront, making it an attractive continuous route as shown in FigureAA.3.2. The physical attributes and motor vehicle volumes are summarised in Table AA.3.1.

Table AA.3.1 Wakefield Quay - summary of infrastructure and traffic data.

Cycle Lane Width	Cycle Lane Length	Year of Installation	Traffic Lanes	Parking	Footpaths	Motor Vehicle AADT	Speed Limit (km/h)
2 x 1.2 m	3.4 km	1998	2 x 3.2 m	1 x 1.9 m	2 x 1.5 m	26,000	50

Figure AA.3.2 Typical section of Wakefield Quay showing narrow cycle lane and carriageway widths.

AA.3.2 Tube Counter setup

The tubes were placed 50 m north of Victoria Road and operated between 26 March 2007 and 8 May 2007.

On the east side the tubes were placed in a tow-away area outside a group of garages. It was felt this would minimise the chance of people parking on the tubes. The tubes extended the width of the cycle lane but did not extend into the traffic lane, given the high volume of traffic and the narrow lane widths. All cyclists observed while on site cycled well within the cycle lane. Tubes on the west side were placed in a no-parking section and extended 100 mm outside the cycle lane as the cycle lane was narrow at this point. The majority of motor vehicle traffic observed missed the tubes despite the narrow motor vehicle lane, and all cyclists observed cycled within the cycle lane and thus over the tubes.

AA3.3 Original estimate of cycling AADT

No information regarding before counts or estimates of future volumes was available as these facilities predate the EEM SP11 procedures, however good historical count information following construction was available. After installation in 1998, counts were undertaken and a cycling AADT of 356 cyclists per day was estimated from manual counts in 1999.

AA.3.4 Findings

Based on the automatic tube counts, the estimated 2007 cycling AADT on Wakefield Quay is 425 cyclists per day.

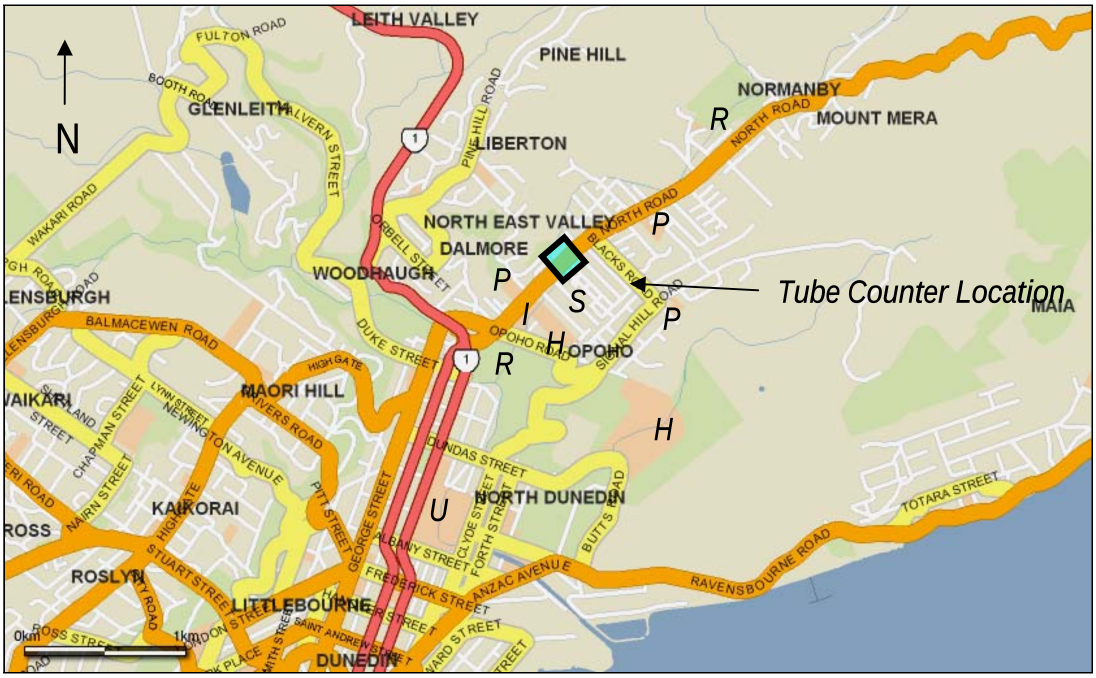
The automatic tube count data indicates that cycling numbers at the weekends are 11% higher than weekday volumes, indicating that it is a popular recreational route, but also well used by commuters.

AA.4 North Road (Dunedin)

AA.4.1 Site description

North Road is the main route into Dunedin from the north-eastern suburbs. Two schools have frontages onto North Road, Dunedin North Intermediate and Sacred Heart. The count site is 4 km from the Dunedin CBD and 2 km from Otago University. New cycle lanes have been installed on both sides of the road for 2.2 km between Antrim Street and Pine Hill Road (SH 1).

The eastern side of North Road in the vicinity of the tube placement has short term (P10) parking and a bus stop 20 m to the north. The short term parking serves a day-care centre and a dairy on the corner of North Road and Chambers Street. This parking was observed to have medium use throughout the day. The western side also had short term (P10) parking to the north and long term parking to the south. The short term parking on the western side was heavily used. A map of the general area is shown in Figure AA.4.1.



Tube count location

+ Hospital

S Shops

Schools (***U*** = University, ***H*** = High School, ***I*** = Intermediate, ***P*** = Primary, ***O*** = Other)

Recreational Areas (***R*** = Recreational Parks, ***F*** = Sports Fields, ***G*** = Golf Course)

Figure AA.4.1 North Road - map of facility and surroundings.

As shown in Figure AA.4.2, the traffic lanes on North Road are narrow, however there is a 300 mm buffer strip between the parking tee and the cycle lane. Motor vehicles were observed frequently encroaching into the cycle lanes. The physical attributes and motor vehicle volumes are summarised in Table AA.4.1.

Table AA.4.1 North Road - summary of infrastructure and traffic data.

Cycle Lane Width	Cycle Lane Length	Year of Installation	Traffic Lanes	Parking	Footpaths	Motor Vehicle AADT	Speed Limit km/h
2 x 1.5 m	3.4 km	2005	2 x 3 m	1 x 2.1 m	2 x 3 m	12,000	50

The dimensions above exclude the buffer between the parking tee and the cycles lane.

Figure AA.4.2 Typical section of North Road.

AA.4.2 Tube Counter setup

The tube counters were installed between Chambers and Craigleith Streets and operated between 12 March 2007 and 20 March 2007. This is a straight, flat, mid-block section of the road. On the eastern side, the tubes were placed between the short term parking. Where parking bays are marked, the tube layout shown in Figure AA.4.2 above helps to minimise the risk of cars parking on the tubes. On the western side the tubes were placed at a kerb build-out where parking was prohibited.

The tubes were placed across the width of the cycle lane, extending 100 mm into the traffic lane as above. This was reduced from the recommended 400 mm due to the narrow motor vehicle lane width and the high traffic volumes to avoid the tubes being damaged by motor vehicles and to reduce the “noise” in the data set.

Only one cyclist was observed swerving to avoid the tubes, and one cyclist missed the tubes as the outside rider riding two-abreast. Cars were observed to generally miss the tubes, however cars accessing the parking and a few buses had to drive over the tubes to access their stops. Due to the narrowness of the traffic lanes large cars and heavy vehicles often hit the end of the tubes, however this could not be avoided and would often have been the case even if the tubes were stopped at the limit of the cycle lane. This generally would not be a problem for data quality, as the counters can distinguish between cycles and motor vehicles, except when two vehicles (a cycle and a motor vehicle, or two cycles) hit the tubes at almost the same time.

AA.4.3 Original estimate of cycling AADT

The funding application estimated the existing cycle volumes at 130 cyclists per day with an estimated 3 new cyclists and a predicted annual growth rate of 2%. There is no explanation for the predicted number of new cyclists; it is assumed that 130 has been multiplied by the growth rate. There is no explanation of the predicted growth rate.

AA.4.4 Findings

Based on the automatic tube counts, the estimated 2007 cycling AADT on North Road is 347 cyclists per day.

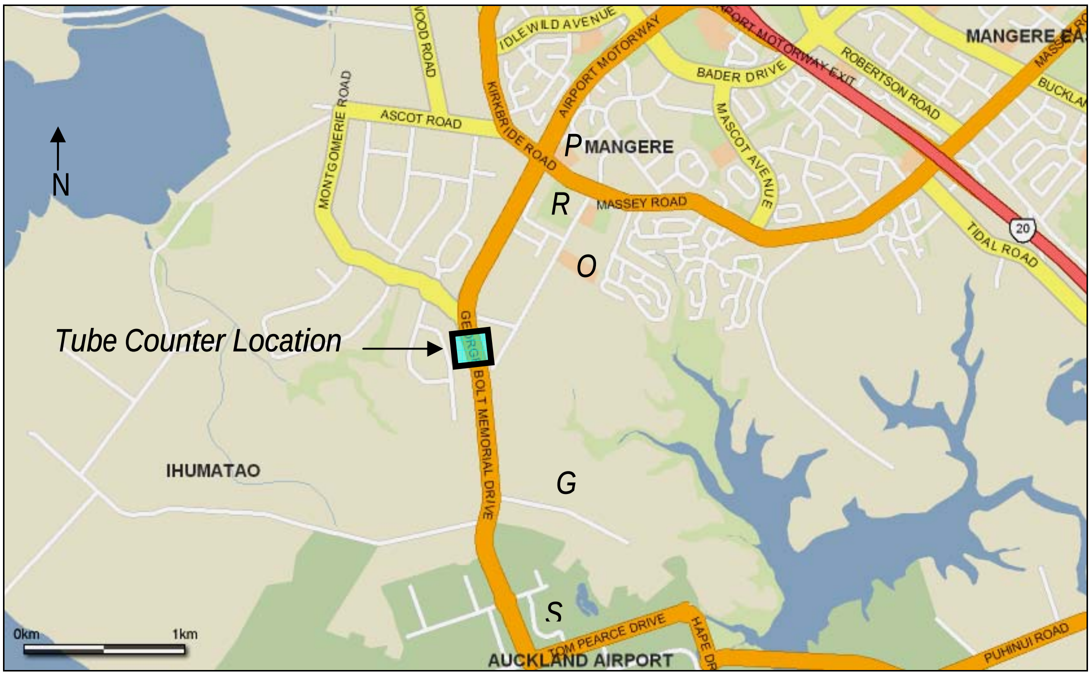
The count data indicate that the weekend cycling volumes are 72% of the weekday volumes, indicating that the facility is primarily used for commuting and school cyclists although it experiences moderate use by recreational cyclists in the weekends.

AA.5 George Bolt Memorial Drive (Manukau)

AA.5.1 Site description

George Bolt Memorial Drive (SH 20A) is the main route to Auckland International Airport. There are two motor vehicle lanes in each direction, separated by a median strip with a wire rope barrier in the middle. A cycle lane is provided on each side of the road.

Auckland International Airport and the commercial businesses that have built up around it are likely to be the main generators of cycle traffic. Although there are some schools to the north and a recreational park in the vicinity, these are unlikely to generate significant cycle traffic. A map of the general area is shown in Figure AA.5.1.



Tube count location

Hospital

S Shops

Schools (**U** = University, **H** = High School, **I** = Intermediate, **P** = Primary, **O** = Other)

Recreational Areas (**R** = Recreational Parks, **F** = Sports Fields, **G** = Golf Course)

Figure AA. 5.1 George Bolt Memorial Drive - map of facility and surroundings.

Figure AA.5.2 illustrates the site, showing the counter installation on the northbound roadway. The generous northbound cycle lane width of 2.6 m is used by sports cyclists which was confirmed by observations of road cyclists travelling in groups and using this as a training route. The physical attributes and motor vehicle volumes are summarised in Table AA.5.1.

Table AA.5.1 George Bolt Memorial Drive - summary of infrastructure and traffic data.

Cycle Lane Widths	Cycle Lane Length	Year of Installation	Traffic Lane Widths	Parking	Footpaths	Motor Vehicle AADT	Speed Limit (km/h)
1 x 1.8 m 1 x 2.6 m	3.2 km	Mid 1990s	4 x 3.5 m	No	No	32,000	100

Figure AA.5.2 George Bolt Memorial Drive - typical section of George Bolt Memorial Drive.

AA.5.2 Tube Counter setup

The tube counters were placed approximately 200 m south of Montgomerie Road and operated between 6 March 2007 and 17 March 2007. The northbound side has a 2.6 m kerb side cycle lane, while the southbound side has a 1.8 m cycle lane with no kerb. The tubes were placed across the width of the cycle lane, extending 200 mm into the traffic lane. This was reduced from the recommended 400 mm due to the high traffic volumes and the proportion of heavy vehicles to reduce the risk of the tubes being damaged by motor vehicles and to reduce the “noise” in the data set. Despite only extending the tubes 200 mm into the traffic lane the northbound tube was damaged after four days and no further data were collected.

AA.5.3 Original estimate of cycling AADT

No funding application or “before” cycle counts were available for this project.

AA.5.4 Findings

Based on the automatic tube counts, the estimated 2007 cycling AADT on George Bolt Memorial Drive is 97 cyclists per day.

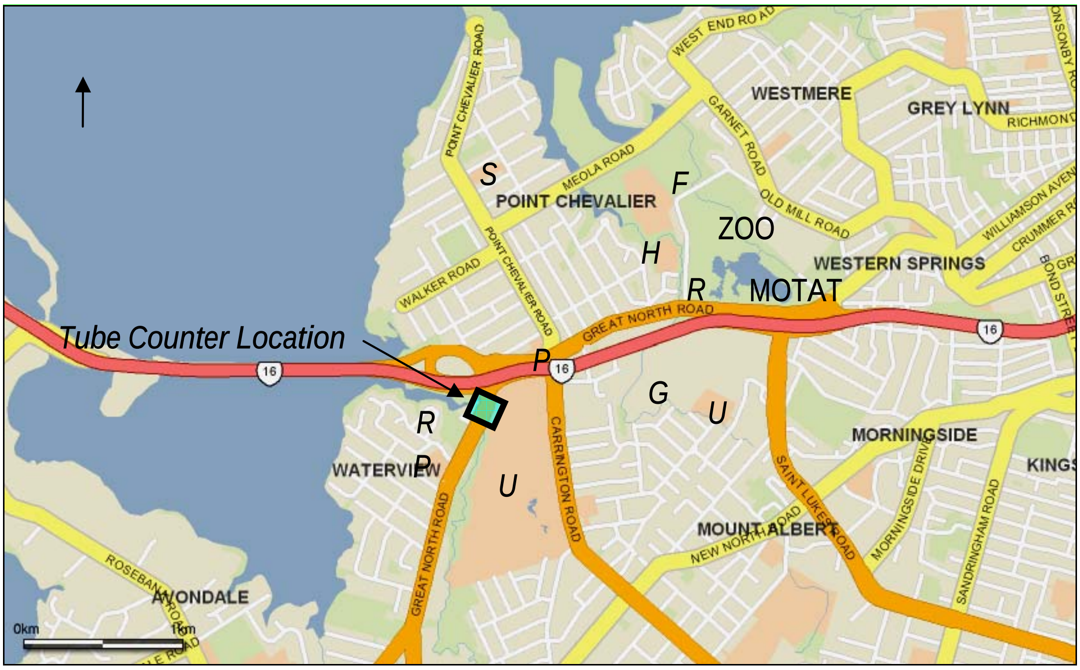
The results from the tube count showed little difference between the weekend and weekday cycle volumes. Commuters and sports training cyclists appear to be the dominant users of this cycle facility.

AA.6 Waterview Overbridge (Auckland)

AA.6.1 Site description

The Waterview Overbridge provides a link between the North Western Motorway interchange at Waterview and the Central City. This also connects with a new off-road link to Unitec (Auckland Institute of Technology), providing continuity for the approximately 18 km long dedicated cycleway between Auckland City's CBD and the Lincoln Road area in Waitakere City. The Unitec, Waterview Primary School, Point Chevalier shopping centre, the Auckland Zoo and the Museum of Transport and Technology (MOTAT) are likely generators of cycle traffic.

The cycling and pedestrian overbridge crosses Great North Road which has a motor vehicle AADT of 50,000 vehicles per day (vpd) and runs parallel to SH 16 with approximately 95,000 vpd. A map of the general area is shown in Figure AA.6.1 below.



Tube count location

S Shops

Schools (*U* = University, *H* = High School, *I* = Intermediate, *P* = Primary, *O* = Other)

Recreational Areas (*R* = Recreational Parks, *F* = Sports Fields, *G* = Golf Course)

Figure AA.6.1 Waterview Overbridge - map of facility and surroundings.

The shared cycling and pedestrian Waterview overbridge is shown in Figure AA.6.2 with key facility and motor vehicle volume information summarised in Table Table AA.6.1.

Table AA.6.1 Waterview Overbridge - summary of facility information and traffic data.

Cycle Path Width	Cycle Path Length	Year of Installation	Motor Vehicle AADT of Parallel Road (SH 16)	Speed Limit of Parallel Road (SH 16)
3.1 m	1 km	2003	95,000	100 km/h

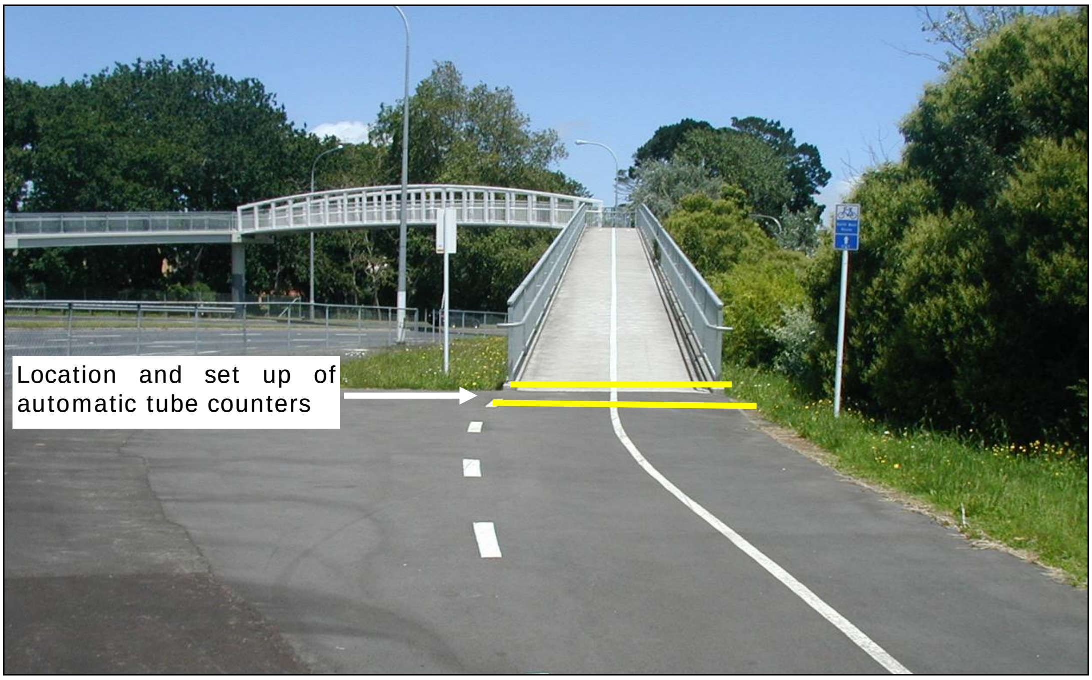


Figure AA.6.2 The Waterview Overbridge.

AA.6.2 Tube Counter setup

The tube counters were placed across the width of the overbridge at the western end and operated between 6 March 2007 and 15 March 2007. The tubes were positioned to pick up all cycle traffic using the bridge to cross Great North Road. Testing carried out on the tubes shows that pedestrians are generally not recorded as a bike.

The set out of the tubes was undertaken during the early hours of the morning hence no cyclists were observed.

AA.6.3 Original estimate of cycling AADT

The funding application was not available. It is believed that the Waterview overbridge was constructed as part of a package and it is not known whether an SP11 evaluation was carried out. However cycle count data following the construction of the bridge was available for analysis.

AA.6.4 Findings

Based on the automatic tube counts, the estimated 2007 cycling AADT on the Waterview overbridge is 260 cyclists per day.

Data from the tube counts estimate the weekend cycling volumes to be 74% of weekday use, indicating that the facility is primarily used for commuting and school cyclists, although it experiences moderate use by recreational cyclists at weekends.

AA.7 Pioneer Path (Palmerston North)

AA.7.1 Site description

Pioneer Highway (State Highway 56) extends south-west from the Palmerston North City Centre, heading towards Levin. It is the main route to Levin from Palmerston North, also connecting the suburbs of Awapuni and Highbury to the city centre.

The Pioneer Path is a shared cycling and pedestrian path that runs along the northern side of Pioneer Highway. A map of the general area is shown in Figure AA.7.1.

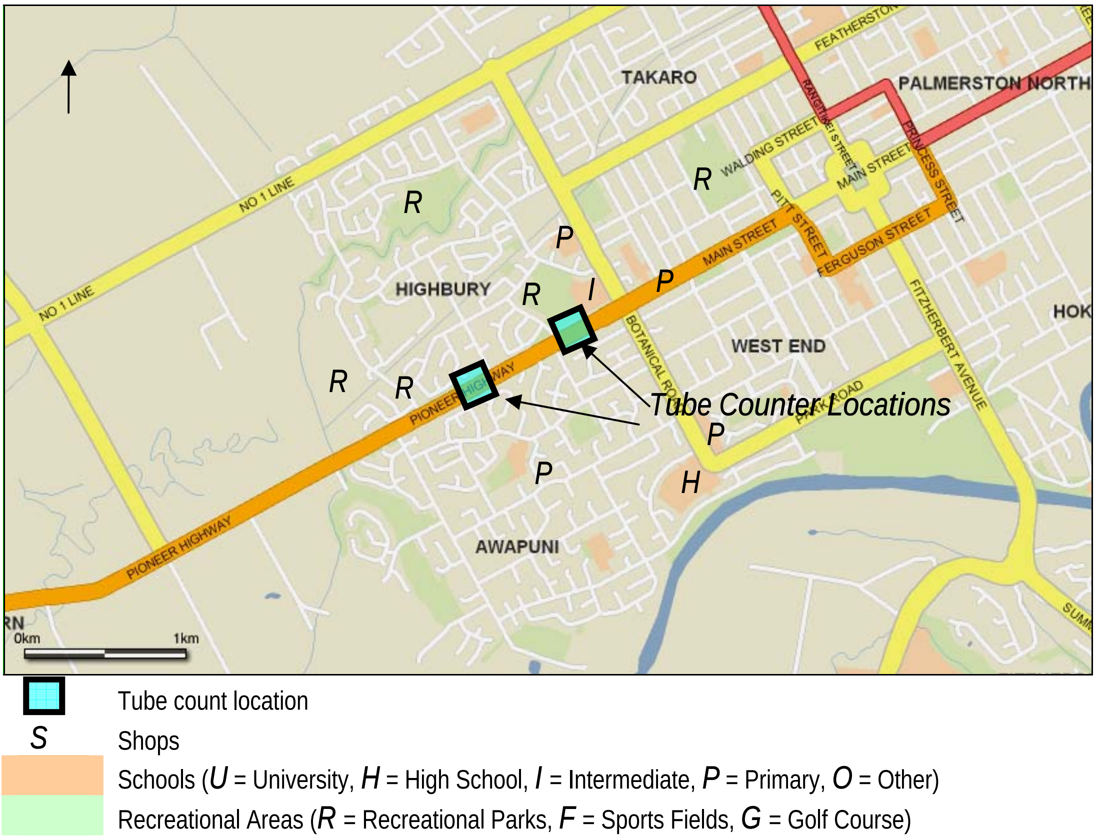


Figure AA.7.1 Pioneer Path - map of facility and surroundings.

As shown in Figure AA.7.2, Pioneer Path provides a scenic route through the Chippendale Reserve. Key facility information and motor vehicle volume information is summarised in Table AA.7.1.

Table AA.7.1 Pioneer Path - Summary of infrastructure and traffic data.

Cycle Path Width	Cycle Path Length	Year of Installation	Motor Vehicle AADT of Parallel Road (Pioneer Highway)	Speed Limit of Parallel Road (Pioneer Highway)
3.0 m	1.8 km	2006	12,000	60 km/h

Figure AA.7.2 Pioneer Path

AA.7.2 Tube Counter setup

Tube counters were placed across the width of the path in two locations and operated between 12 February 2007 and 19 February 2007. Counts in July 2006 and November 2006 were also carried out and analysed.

Two sets of tubes were set up approximately 700 m apart, one approximately 60 m west of Cavendish Crescent and the other approximately 30 m east of Mariner Street. This was consistent with previous counts collected by the Palmerston North City Council.

AA.7.3 Original estimate of cycling AADT

The funding application estimated existing cycle/pedestrian volumes (the funding application did not differentiate between cyclists and pedestrians) at 306 and the number of new cyclists/pedestrians was estimated at 194. There was no documented method used to arrive at these numbers. A growth rate of 2% was assumed and an expected reduction in car trips of 20 trips per day was also noted. This resulted in a BC of 4.6.

AA.7.4 Findings

Based on the automatic tube counts, the estimated 2007 cycling AADT on Pioneer Path is 120 cyclists per day. Count data indicate that the weekend volumes are 56% of the weekday volumes, suggesting that mostly commuter and school cyclists use this facility.

AA.8 Travis Road (Christchurch)

AA.8.1 Site description

Travis Road (SH 74) forms part of a State highway ring road running around Christchurch. Travis Road is a two lane road between Queen Elizabeth II (QEII) Drive and Rookwood Avenue. The section of Travis Road from QEII Drive to Anzac Drive forms part of SH 74.

Travis Road has both an off-road path and on-road cycle lanes that run in parallel (separated by approximately 20 m) between Burwood Road and Frosts Road. The off-road path was the facility studied as part of this research.

One of the major recreational facilities in the area is QEII Park which has an aquatic centre, a golf course and athletics facilities. Travis Road leads directly to QEII Drive, forming a direct route to Waimairi Beach and North New Brighton suburbs. There are many schools in the area and the Christchurch CBD is approximately 8 km away to the south west. A map of the general area is shown in Figure AA.8.1.

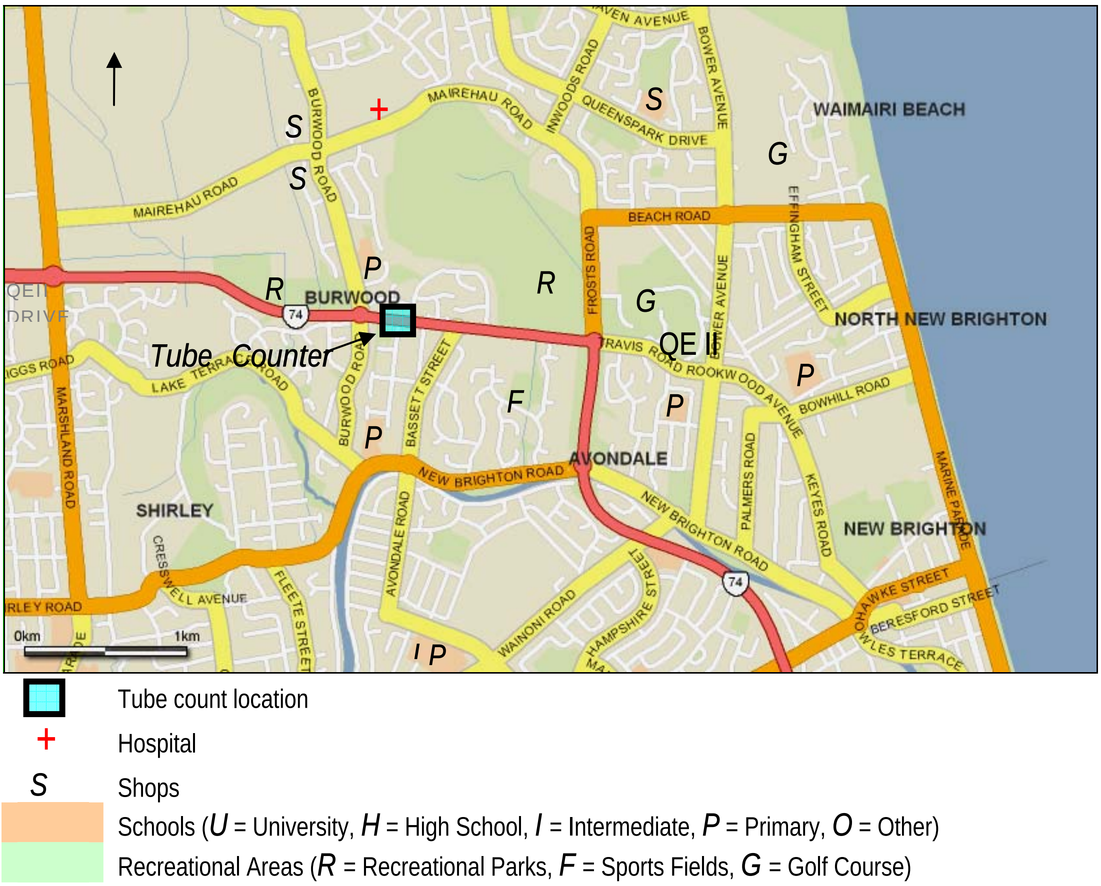


Figure AA.8.1 Travis Road Path - map of facility and surroundings.

The shared walking and cycling path is shown in Figure AA.8.2 with key facility and motor vehicle volume information summarised in Table AA.8.1.

Table AA.8.1 Travis Road Path - Summary of infrastructure and traffic data.

Cycle Path Width	Cycle Path Length	Year of Installation	Motor Vehicle AADT of Parallel Road (SH 74)	Speed Limit of Parallel Road (SH 74)
2.5 m	2.1 km	2004	10,200	50 km/h

Figure AA.8.2 The Travis Road Path (left) with Travis Road and on-road cycle lanes (right).

AA.8.2 Tube Counter setup

The tube counters were placed across the width of the path approximately 80 m east of Burwood Road and operated between 21 February 2007 and 2 March 2007.

While setting up the tubes, all cyclists observed on the shared path went over the tubes and were recorded correctly by the counter. A mother walking a pram was also observed crossing the tubes, but the tubes did not record any hits. This is due to the low speed and light weight of the pram and baby.

AA.8.3 Original estimate of cycling AADT

For the section of road where the count was located, the original AADT estimate used as part of the funding application was 90 cycles per day. This is based on an on-road cycling AADT estimate of 180 cycles per day, where the path was estimated to achieve 50% of the off-road path. A zero growth rate was used as described for Centaurus Road, (see section AA.1.3 of this report).

AA.8.4 Findings

Based on the automatic tube counts, the estimated 2007 cycling AADT on Travis Rd Path is 76 cyclists per day.

Count data indicate that the weekend volumes are 88% of the weekday volumes, suggesting that this facility is used by both commuters and school students during the week and recreational cyclists at weekends.

AA.9 Atawhai Path (Nelson)

AA.9.1 Site description

The Atawhai Path runs parallel to SH 6. This path feeds the northern suburbs of Brooklands (3 km north), Atawhai (5 km north) and Marybank (7 km north). There are large sports fields to the east of Atawhai Path providing an attraction for recreational riders on the weekends. A map of the general area is shown in Figure AA.9.1.

Tube count location

S Shopping centre

Schools (*U* = University, *H* = High School, *I* = Intermediate, *P* = Primary, *O* = Other)

Recreational Areas (*R* = Recreational Parks, *F* = Sports Fields, *G* = Golf Course)

Figure AA.9.1 Atawhai Path - map of facility and surroundings.

The shared walking and cycling path is shown in Figure AA.9.2with key facility and motor vehicle volume information summarised in Table AA.9.1.

Table AA.9.1 Atawhai Path - Summary of infrastructure and traffic data.

Cycle Path	Cycle Path Length	Year of Installation	Motor Vehicle AADT of Parallel Road (SH 6)	Speed Limit of Parallel Road (SH 6)
3.0m	1.6 km	2005	11,500	100 km/h

Figure AA.9.2 The Atawhai Path with SH 6 to the right over the railway tracks.

AA.9.2 Tube Counter setup

The tube counters were placed across the width of the path approximately 50 m south of the cycleway link from North Road (on the east side of the railway line) and operated between 26 April 2007 and 8 May 2007.

The short grass on either side of the track would allow cyclists to avoid the tubes if they wanted to; however the number of cyclists that would do this was not expected to be significant. No cyclists were observed using the facility during the set up of the counter.

AA.9.3 Original estimate of cycling AADT

No information regarding before counts or estimates of future volumes was available. However count data shortly after construction in August 2005 was available for analysis.

AA.9.4 Findings

Based on the automatic tube counts, the estimated 2007 cycling AADT on Atawhai Path is 74 cyclists per day.

The count data indicates that the weekend volumes are similar to weekday volumes, suggesting that this facility is well used by both commuter and recreational cyclists. This is supported by manual counts undertaken by Nelson City Council in August 2005 that showed that pedestrian numbers are also higher during the weekend.

AA.10 Harakeke Path (Porirua)

AA.10.1 Site description

The Harakeke Path is in a rural environment and runs for approximately 6 km parallel to SH 1, north of Plimmerton, linking Plimmerton with Pukerua Bay. A map of the general area is shown in Figure AA.10.1.

There are a few schools in the area, however these are not thought to contribute significantly to the volume of cyclists using the path as they would not need to use the path unless travelling from out of zone.

Tube count location
Schools (*U* = University, *H* = High School, *I* = Intermediate, *P* = Primary, *O* = Other)
Recreational Areas (*R* = Recreational Parks, *F* = Sports Fields, *G* = Golf Course)

Figure AA.10.1 Harakeke Path - map of facility and surroundings.

As shown in Figure AA.10.2, the shared walking and cycling path separates cyclists from the high speed motor vehicle environment and the use of native plants established as part of the project helps to provide an attractive route. Key facility and motor vehicle volume information is summarised in Table AA.10.1.

Table AA.10.1 Harakeke Path - summary of infrastructure and traffic data.

Cycle Path Width	Cycle Path Length	Year of Installation	Motor Vehicle AADT of Parallel Road (SH 1)	Speed Limit of Parallel Road (SH 1)
3.0 m	6 km	2004	22,000	100 km/h

Figure AA.10.2 The Harakeke Path with SH1 to the left.

AA.10.2 Tube Counter setup

The tubes were placed across the off-road path at the southern end of Taupo Swamp (approximately 150 m north of the Plimmerton Weigh Station) and operated between 20 March 2007 and 10 April 2007.

AA.10.3 Original estimate of cycling AADT

An estimate of 30 cyclists per day was used as part of the funding application. The following is from the economic analysis *"... existing volumes are first projected to increase by five commuter cyclists each weekday and 20 recreational cyclists per day on weekends following completion of a safe bridge link across the rail corridor, and are then projected to increase by 2% per annum in response to Council's forward strategies and objectives of promoting and encouraging cycling."*

This new section of off-road path connects existing paths at each end. This prediction is based on counts undertaken on off-road paths at each end of the new path.

AA.10.4 Findings

Based on the automatic tube counts, the estimated 2007 cycling AADT on Ara Harakeke Path is 43 cyclists per day. Count data indicate that the weekend volumes are 17% higher than weekday volumes, suggesting that the path is used by both recreational and commuter cyclists.

Appendix B

Guidelines for Counting Cycles with Tube Counters

Appendix B: Guidelines for Counting Cycles with Tube Counters

AB.1 Disclaimer

These guidelines are to assist in the installation of MetroCount 5600 traffic counters when counting cycles. The manufacturer's instructions should be used as the main source of advice when using any automated traffic counters. These guidelines have been prepared by MWH New Zealand Ltd and ViaStrada Ltd to complement information from MetroCount and are provided in good faith; however, no responsibility for the results achieved by following these guidelines is accepted. Those counting cycle traffic should use their best judgement and if in doubt, seek assistance from MetroCount directly.

AB.2 General

The tubes used for counting cycles are smaller and also softer, but the set up parameters are the same as used for motor vehicles. The softer tubes mean that it is preferable to minimise the amount of motor vehicle traffic across the tubes, to minimise damage by trucks in particular. Metro Count 5600 counter can easily distinguish between motor vehicles and bikes. The setup for counting cycles is similar to that for classified counts for motor vehicles (two tubes). The main differences are the tube type used and some layout considerations.

The tubes used for counting cycles are smaller and softer, but the set up parameters are the same as used for motor vehicles. The softer tubes mean that it is preferable to minimise the amount of motor vehicle traffic across the tubes, to minimise damage by trucks in particular. Metro Count 5600 counters can easily distinguish between motor vehicles and bikes, but as with most automatic counters, if there are multiple simultaneous "hits", the counter is likely to be confused. The length of tubes should be limited to 7 m.

AB.3 Guidelines for paths

The layout for off road paths is simple. The tubes should traverse the entire path with care taken not to place the tubes in the vicinity of obstacles such as overhanging trees etc that may affect the cyclists' behaviour or trajectory. A typical installation is illustrated in Figure AB.1

Figure AB.1 Typical off-road path counting installation.

AB.4 Guidelines for roads

A separate counter should be set up on each side of the road, with tubes extending into the road only as far as necessary to record cycles, based on observation of where cyclists actually ride. This minimises the recording of motor vehicles, which may reduce the accuracy of the cycle counts if traffic volumes are high.

The tubes should be installed on uniform mid-block sections of road. Try to avoid getting too close to intersections where there may be "intersection noise" such as left turn lanes.

Avoid placing the tubes near service lids such as fire hydrants, valve covers, etc as cyclists often try to avoid these and they may miss the tubes in the process.

Where possible avoid placing the tubes in areas where parking exists as a car parked on a tube will stop that tube from detecting cycles. If car parking can't be avoided then an assessment has to be made of the parking demand. For an area with high parking demand the tubes should be fenced or coned off. If the area has low parking demand then it may be preferable to not use cones, which would highlight the presence of the tubes and increase the risk of vandalism. Spray painting the road and the tubes in the parking area with a pseudo crosshatching as shown in Figure AB.2 can be beneficial.

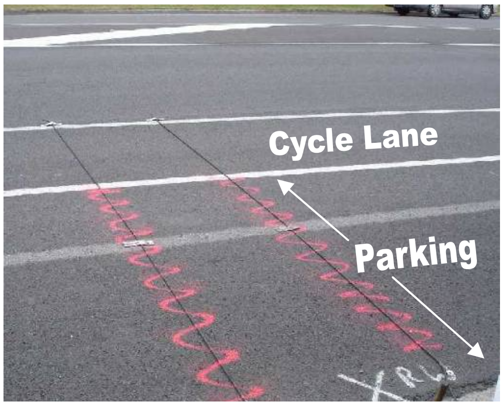


Figure AB.2 Spray painting tubes in the parking area. Used to discourage parking where parking demand is low.

If the tubes are being placed across a cycle lane, they should extend approximately 400 mm beyond the cycle lane line (measured from the centre of the line to the end of the tube) as shown in Figure AB.3. This provides space to secure the tubes with straps well clear of the cycle lane, to encourage cyclists to ride over the tubes.


Figure AB.3 Tubes extend 400 mm beyond the cycle lane or edge line.

If the tubes are being placed on a section of road with no cycle lanes, then as a general rule of thumb the tubes should extend to 40% of the traffic lane width. For example, on a traffic lane 4 m wide, the tubes should extend 1.6 m from the kerb, edge line or car parking line.

Appendix C

AADT Calculations and Process Using Automatic Tube Counters

Appendix C AADT Calculations and Process Using Automatic Tube Counters

AC.1 The process

AC.1.1 If you have a full week of data or more.

(a) A 'full week' of data is a full day's worth of data for each day of the week at least once.

(b) If any day that data was collected was a 'wet' day (dependent on the amount of rain and the time of the day) apply the relevant factors to that day's raw data.

(c) If the tubes were put in and taken out on the same day of the week and the data for that day is needed to get a full week's worth of data, combine the two records to give a day's worth of data.

(d) If the tubes were put in earlier in the day than they were taken out then average the overlapping time periods.

(e) If the tubes were put in later in the day than they were taken out then estimate the missing time periods based on data from other days using CNRPG Appendix 2 factors or factors from the ARTA Report for Auckland sites.

(f) Average the data for each day of the week - ie: if you have data for two Mondays average these two data sets to get a "virtual" Monday.

(g) You should now have a full "virtual" week's worth of data ready to be analysed.

(h) Add the data from each day to get a weekly volume of cyclists for that site.

(i) Apply the relevant weekly, factor and the factor to get from a tube count to an actual count to get an AADT for that site.

AC.1.2 If you have less than a full week of data..

(a) If any day that data was collected was a 'wet' day, apply the relevant factors to that days raw data.

(b) Apply the relevant hourly, daily and weekly factors and the factor to take it from a tube count to an actual count for each full day.

(c) This should give you an AADT based on each day's data.

(d) Average the AADT from each day to get an AADT for each site.

AC.1.3 Factors.

(a) There are two sets of factors;

(b) Cycling Network and Route Planning Guide factors - to be used for all sites except the wider Auckland region.

ARTA report - to be used for the wider Auckland region.

AC.2 Verification of the automatic tube count

Site	Location	Time start		Time end		Sensor Balance	Applicable time period (if different from installation period)				Comments	Class
							Start		End			0%
Waterview Overbridge	Auckland	2:07	6/03/2007	23:14	15/03/2007	101.87%						0.6%
George Bolt MemorialDrive - NBD	Manukau	12:53	6/03/2007	2:44	17/03/2007	**177.00%**	12:53	6/03/07	23:59	10/03/07	Tube was dislodged	6.0%
George Bolt Memorial Drive - SBD	Manukau	12:51	6/03/2007	2:37	17/03/2007	**89.79%**						14.2%
Pioneer Highway - East tube	Palmerston North	10:41	12/02/2007	12:56	19/02/2007	97.71%						5.9%
Pioneer Path – West tube	Palmerston North	10:30	12/02/2007	12:50	19/02/2007	99.92%						3.6%
Harakeke Path	Porirua	18:42	20/03/2007	17:08	10/04/2007	95.44%						6.2%
Wakefield Quay – NBD	Nelson	10:44	26/04/2007	0:32	8/05/2007	**55.85%**	10:44	26/04/07	23:59	29/04/07	Plug popped out of the end of the tube	3.9%
Wakefield Quay – SBD	Nelson	10:53	26/04/2007	0:07	8/05/2007	**110.26%**						3.9%
Atawhai Path	Nelson	12:00	26/04/2007	23:56	8/05/2007	**87.94%**	12:00	26/04/07	23:59	3/05/07	Tubes were slashed	9.6%
Travis Road Path	Christchurch	8:37	21/02/2007	12:57	2/03/2007	100.26%						3.4%
Centaurus Road – EBD	Christchurch	9:10	13/02/2007	8:08	21/02/2007	98.64%						2.8%
Centaurus Road – WBD	Christchurch	8:21	13/02/2007	8:12	21/02/2007	**140.90%**	0:00	16/02/07	8:12	21/02/07	Car parked on tube	3.8%

AC.2 Verification of the automatic tube count (continued)

Site	Location	Time start		Time end		Sensor Balance	Applicable time period (if different from installation period)				Comments	Class
							Start		End			0%
Halswell Road – NBD	Christchurch	8:22	13/02/2007	8:35	21/02/2007	95.26%						4.4%
Halswell Road – SBD	Christchurch	8:22	13/02/2007	8:28	21/02/2007	99.71%						2.1%
North Road – NBD	Dunedin	9:54	12/03/2007	9:42	20/03/2007	100.34%						6.6%
North Road – SBD	Dunedin	9:52	12/03/2007	9:44	20/03/2007	98.33%						3.6%

AC.3 Calculation of the AADT for sites with at least a full week's data

Site	Start Date	End Date	Week Period	Type	"Virtual Week" Mon	Tue	Wed	Thu	Fri	Sat	Sun	Total	Scale Factors Rain (R)	Tube (T)	Week (W)	AADT
Waterview Overbridge	6/03/07	15/03/07	term 1	School	348	277	328	289	270	217	230	**1959**	64%	97%[3]	0.9	260
George Bolt- SBD	6/03/07	17/03/07	term 1	Commuter	20	8	16	16	17	12	16	**105**	64%	100%[2]	0.9	13
Pioneer Path	12/02/07	19/02/07	term 1	School	123	128	130	142	118	61	98	**800**	64%	85%	0.78	105
Pioneer Path	12/02/07	19/02/07	term 1	School	151	169	181	191	159	76	100	**1027**	64%	85%	0.78	135
Harakeke Path	20/03/07	10/04/07	term 1	School	33	16	17	17	52	49	68	**251**	64%	85%	0.78	43
Wakefield Quay- SBD	26/04/07	8/05/07	term 2	Commuter	118	137	103	128	121	98	126	**830**	64%	62%	1.04	228
Atawhai Path	26/04/07	8/05/07	term 2	Commuter	54	79	58	56	45	30	88	**410**	64%	85%	0.98	74

[3] The specific value calculated from the comparison of automatic counts and manual counts was used instead of the default value.

AC.3 Calculation of the AADT for sites with at least a full week's data (continued)

Site	Start Date	End Date	Week Period	Type	"Virtual Week"							Total	Scale Factors			AADT
					Mon	Tue	Wed	Thu	Fri	Sat	Sun		Rain (R)	Tube (T)	Week (W)	
Travis Road Path	21/02/07	2/03/07	term 1	School	95	105	97	95	38	50	101	**580**	64%	85%	0.78	76
Centaurus Road- EBD	13/02/07	21/02/07	term 1	School	222	243	264	260	206	243	275	**1713**	64%	62%	0.78	308
Halswell Road- NBD	13/02/07	21/02/07	term 1	School	260	246	261	216	311	101	98	**1493**	64%	62%	0.78	268
Halswell Road- SBD	13/02/07	21/02/07	term 1	School	285	262	243	247	284	112	122	**1555**	64%	62%	0.78	280
HALSWELL ROAD																**548**
North Road - NBD	12/03/07	20/03/07	term 1	School	166	130	131	121	166	107	109	**930**	64%	62%	0.78	167
North Road - SBD	12/03/07	20/03/07	term 1	School	183	148	154	127	176	121	94	**1003**	64%	62%	0.78	180
NORTH ROAD																**347**

AC.4 Calculation of the AADT for sites with less than a full week's data

Site	Date	Day	Data	D	W	T	R	AADT
George Bolt Memorial Drive - NBD	6/03/2007	tue	68	14%	0.9	48%	100%	129
George Bolt Memorial Drive - NBD	7/03/2007	wed	31	14%	0.9	48%	64%	93
George Bolt Memorial Drive - NBD	8/03/2007	thu	45	14%	0.9	48%	100%	86
George Bolt Memorial Drive - NBD	9/03/2007	fri	25	14%	0.9	48%	100%	48
George Bolt Memorial Drive - NBD	10/03/2007	sat	40	14%	0.9	48%	100%	77
George Bolt Memorial Drive - NBD								**86**
Wakefield Quay - NBD	26/04/2007	thu	72	17%	1.04	62%	100%	101
Wakefield Quay - NBD	27/04/2007	fri	73	16%	1.04	62%	64%	168
Wakefield Quay - NBD	28/04/2007	sat	51	10%	1.04	62%	64%	193
Wakefield Quay - NBD	29/04/2007	sun	137	7%	1.04	62%	100%	444
Wakefield Quay - NBD								**226**
Centaurus Road - WBD	16/02/2007	fri	137	15%	0.78	62%	64%	253
Centaurus Road - WBD	17/02/2007	sat	320	9%	0.78	62%	100%	639
Centaurus Road - WBD	18/02/2007	sun	330	9%	0.78	62%	100%	659
Centaurus Road - WBD	19/02/2007	mon	215	17%	0.78	62%	100%	226
Centaurus Road - WBD	20/02/2007	tue	251	16%	0.78	62%	100%	275
Centaurus Road - WBD	21/02/2007	wed	287	17%	0.78	62%	100%	313
Centaurus Road - WBD								**394**

Appendix D

Data Collection Recommendation

Appendix D: Data Collection Recommendation

1. A cycle facilities database be established to allow further research on more facilities. It is recommended that the database should record the following information:
   - Facility installation type and date.
   - Cycle counts prior to the installation of the cycle facility. For off-road paths, counts be undertaken on any adjacent road.
   - Method used to derive the cycling AADT estimate and annual growth rate in the funding application.
   - All assumptions, e.g. the percentage of cyclists that are expected to transfer from the adjacent road to the cycle path.
   - Key attractors and schools (including size) in the vicinity.
   - Cycle count within a month of the installation of a new facility.
   - Cycle count a year after the installation date.
   - Cycle count every two to three years following the installation of a cycle facility.
2. Tube or manual counts be undertaken as part of every application for funding through Land Transport NZ.
3. That manual validations be carried out whenever an automatic tube count is undertaken. This manual count should record the total number of cyclists, and differentiate school cyclists, and note the number of cyclists who do not hit the count tubes and record any observations such as large groups of cyclists.
4. That the manual count be undertaken in the morning and afternoon and should differentiate school cyclists.
5. For “after counts” on off-road paths, the cycle volumes on both the path and the adjacent road also be counted. Monitoring this will provide information on the proportion of cyclists that transfer from the road to the off-road path. In addition the number of pedestrians should be recorded to gauge how busy the path is the level of conflict.
6. That tube counts (with manual verification as above) be undertaken as part of every application for cycle facility funding through Land Transport NZ.
7. The tube counter set-out procedures developed (see Appendix B) be used as a guide to ensure a consistent methodology around New Zealand.

Appendix E

Methods Used to Estimate Cycling AADT from Manual Counts

AE.1 Estimating the Cycle AADT from Cycle Counts Using the CNRPG

(Reprinted from Appendix 2 of the Cycle Network and Route Planning Guide, Land Transport Safety Authority, New Zealand, 2004.)

AE.1 Development of a Cycle Traffic AADT (Auckland Region)

APPENDIX 2
SCALING CYCLE COUNTS

Introduction

The number of cyclists using a facility varies by time of day, day of the week and week of the year. Based on some Christchurch cycle counts described below, the variation over an average weekday is shown in Figure A2.1. The variation in weekly flows across one year is shown in Figure A2.2. The purpose of this appendix is to recommend a procedure for estimating the average annual daily flow of cyclists (cycling AADT) from cycle counts conducted at one time. It is not normally practical to count cyclists over a whole year. A formula for scaling up short-period cycle counts is described below.

Scaling factors

The scale factors in Tables A2.1 to A2.3 are based on year-round continuous cycle counts from 13 cycle loops around Christchurch. If an adequate set of continuous count data is available for the local area concerned it should be used instead. (A programme for collecting and updating such data for each area is recommended elsewhere in this guide.) The scale factors account for the time of day (H), day of the week (D), and week of the year (W). The week factor varies with school holidays and season. The pattern was found to vary depending on the presence of cyclists riding to and from school. The presence of school cyclists is shown by a peak after 3 pm (see Figure A2.1) that is absent from work commuting. The amount of school cycling at the site also affects the extent of the drop in cycling during school holidays. For this reason there are two sets of factors in the tables to provide for situations with and without school cycle traffic.

Figure A2.1 Weekday daily cycling count profile corresponding to H-weekday for all sites in Table A2.1.

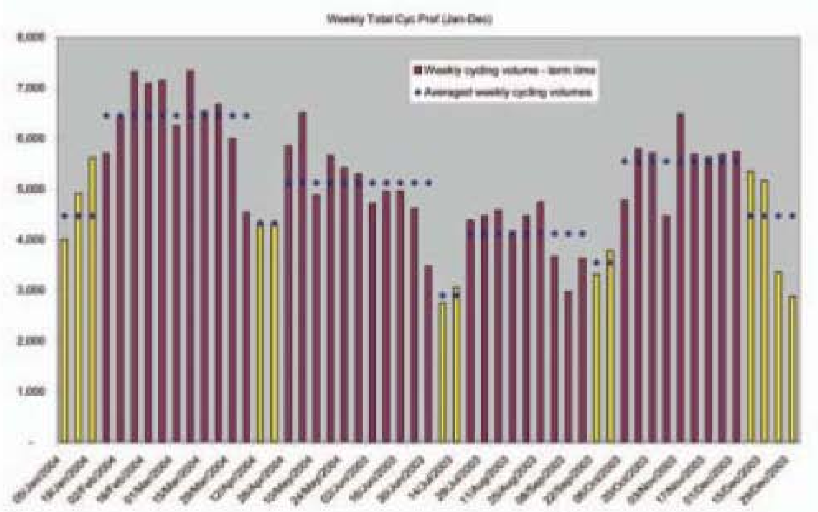


Figure A2.2 Profile of weekly cycling counts corresponding to W-all in Table A2.3.

Calculation equation

The following equation yields the best estimate of a cycling AADT:

$$AADT_{Cyc} = Count \times \frac{1}{H} \times \frac{1}{D} \times \frac{W}{7}$$

where *Count* = result of count period

H = scale factor for time of day

D = scale factor for day of week

W = scale factor for week of year

If cycle count data for more than one day is available, then the calculation should be carried out for each day, and the results averaged.

Worked example

Suppose two counts (of 90 and 165 minutes respectively) have been undertaken on weekdays in May. The site is used by both school children and commuters. The count data and the coefficients to be used are shown in the table below, as well as the AADT estimates resulting from the two counts.

	AM COUNT	PM COUNT
TIME	7.30 to 9.00	3.00 to 5.45
CYCLISTS	125	127
DATE	29-May-03	30-May-03
DAY	Thursday	Friday
H	25.5%	30.6%
D	16.8%	15.2%
W	0.98	0.98
AADT ESTIMATE	410	382

Averaging the estimates yields a cycling AADT of 396.

Recommendations

We recommend using the above equation for approximating the cycling AADT. As cycling volumes fluctuate from day to day depending on the weather, this method should be used with caution, and ideally the estimate should be achieved based on the average of the results of several counts. Individual counts should be for periods of no less than 60 minutes. Counts should be of cyclists in both directions and cover at least the morning peak period, the after school hour and the evening commuter peak. Counts during warmer months and school terms will provide the most reliable estimates. Also take note of tertiary calendars when planning counts. It is not appropriate to scale up counts from Christmas/New Year holidays.

Use the Christchurch data in the absence of better local information, but take into account any demonstrable local factors. While the data has limitations, being from a limited number of sites in Christchurch only, it is now possible for the first time to scale up cycle count data with some confidence.

Acknowledgement

The method was developed by Axel Wilke of Christchurch City Council, building on work by Aaron Roozenburg (Beca Christchurch) in preparing data and undertaking some of the analysis. A fuller description of how the method was derived is available for Axel Wilke at Christchurch City Council. As more data is collected and the figures are refined, updated tables will be published.

PERIOD STARTING	PERIOD ENDING	ALL SITES		COMMUTER SITES	
		H WEEKDAY MON TO FRI	H WEEKEND SAT & SUN	H WEEKDAY MON TO FRI	H WEEKEND SAT & SUN
0:00	7:30	4.8%	5.3%	7.8%	12.7%
7:30	7:45	2.0%	0.5%	1.9%	0.5%
7:45	8:00	3.1%	0.6%	2.5%	0.5%
8:00	8:15	3.0%	0.5%	2.5%	0.5%
8:15	8:30	4.9%	0.7%	2.6%	0.5%
8:30	8:45	7.8%	1.1%	3.1%	1.0%
8:45	9:00	4.7%	1.2%	2.0%	1.0%
9:00	10:00	5.1%	5.2%	4.9%	4.2%
10:00	11:00	3.1%	7.5%	3.4%	6.0%
11:00	12:00	3.1%	8.3%	3.8%	6.8%
12:00	13:00	3.5%	8.5%	4.6%	8.2%
13:00	14:00	3.5%	8.5%	4.5%	8.0%
14:00	14:15	0.9%	2.7%	1.1%	1.6%
14:15	14:30	1.0%	2.2%	1.2%	1.7%
14:30	14:45	1.6%	2.4%	1.4%	1.8%
14:45	15:00	1.5%	2.4%	1.4%	1.7%
15:00	15:15	1.5%	2.8%	2.0%	1.7%
15:15	15:30	1.9%	2.7%	1.8%	2.0%
15:30	15:45	4.7%	2.8%	1.9%	2.0%
15:45	16:00	3.3%	2.9%	1.9%	2.3%
16:00	16:15	2.2%	2.5%	2.2%	2.2%
16:15	16:30	2.2%	2.7%	2.2%	2.1%
16:30	16:45	2.2%	2.8%	2.5%	2.0%
16:45	17:00	2.3%	2.7%	2.9%	2.0%
17:00	17:15	3.1%	2.2%	3.8%	1.9%
17:15	17:30	3.5%	1.8%	4.3%	1.6%
17:30	17:45	3.7%	1.8%	4.6%	1.7%
17:45	18:00	2.8%	1.4%	4.0%	1.4%
18:00	19:00	5.7%	4.5%	7.4%	5.9%
19:00	20:00	2.7%	2.8%	3.2%	3.9%
20:00	0:00	4.6%	6.0%	6.4%	10.4%

Table A2.1 Typical daily cycling profile.

DAY	D ALL %	D COMMUTE %
MONDAY	17.1%	16.1%
TUESDAY	16.4%	16.6%
WEDNESDAY	16.5%	16.7%
THURSDAY	16.8%	17.0%
FRIDAY	15.2%	16.3%
SATURDAY	9.0%	9.9%
SUNDAY	9.0%	7.4%

Table A2.2 Weekday usage percentages.

SECONDARY SCHOOL PERIOD	W ALL (FACTOR)	W COMMUTE (FACTOR)
SUMMER HOLIDAYS	1.13	1.02
TERM 1	0.78	0.84
APRIL HOLIDAYS	1.17	0.97
TERM 2	0.98	1.04
JULY HOLIDAYS	1.74	1.40
TERM 3	1.22	1.19
SEPT/OCT HOLIDAYS	1.42	1.24
TERM 4	0.91	0.93

Table A2.3 Period adjustment factors.

AE.2 Development of a Cycle Traffic AADT (Auckland Region)

(Reprinted from ViaStrada report prepared for Auckland Regional Transport Authority, 2007.)

Auckland Regional Transport Authority

TRAFFIC ENGINEERING AND PLANNING

ARTA

Development of a Cycle Traffic AADT Tool

May 2007

Contact Details, Quality Statement and Revision History

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Contents

1. Introduction

ViaStrada (formerly Traffix) was engaged by ARTA to develop a tool to convert short-term manual cycle counts to “annual average daily traffic” (AADT) estimates of cycle traffic. Funding support for the project was provided by Land Transport New Zealand. The methodology used standard pneumatic traffic counters with softer than normal rubber road tubes for detecting cycles. Cycle traffic was counted at five sites around Auckland, with counts undertaken continuously for up to two weeks. In addition, manual counts were commissioned by ARTA and undertaken by Gravitas during March 2007, while the automatic counters were in place. The manual counts were used to verify the reliability of the automatic counts and to help develop the AADT estimation tool. MWH New Zealand Ltd (Christchurch) assisted with automatic counter data collection and data analysis of both the manual and automatic counts.

This report documents the recommended procedure for establishing cycling AADTs from manual counts undertaken in the Auckland region. The methodology for developing factors for AADT estimation from short term manual counts is based on that published in Appendix 2 of the Cycle Network and Route Planning Guide (CNRPG)[1], adjusted for Auckland conditions and data. The aim was to use the published methodology as much as possible, with any necessary departure from it documented. A worked example of the resulting estimation tool is provided in Section 4.

Manual counts are able to distinguish types of cyclists (for example adults or school students), but are susceptible to human error that can arise from fatigue, distraction or high levels of cyclist activity. The main drawbacks of manual counts are that they are necessarily limited to a few hours at a time unless multiple staff are involved, they can be expensive and their reliability depends on the skill and diligence of the staff involved. In addition, manual counts are not readily compared with motor vehicle and public transport flows, which are usually reported as daily traffic flows. This project allows short-term manual counts to be converted to estimates

Automatic counts from pneumatic rubber tubes can provide cost-effective data for days or weeks at a time, although they are also subject to error. Care must be taken in placing the counter tubes to record as many cyclists as possible on the relevant paths and roads, but even so, some cyclists may choose to avoid the tubes by riding around the end of them. Bunches of cyclists may cross the tubes simultaneously which is also likely to result in counter error (i.e. under-counting). When counters are located on roads, they are able to distinguish between cycles and motor vehicles based on wheel base, but they can be confused when the tubes are hit simultaneously (or nearly so) by motor vehicle and cycle tyres.

Five count stations were used, as follows:

- Tamaki Drive east of The Strand (Auckland City Council);
- Waterview interchange – Great North Road pedestrian and cycle overbridge (north-west end; Auckland City Council);
- George Bolt Memorial Drive north of Montgomerie Road (Manukau City Council);
- Lake Road outside Takapuna Grammar (North Shore City Council); and
- Te Atatu off-ramp path (Waitakere City Council).

These locations were also counted manually by Gravitas staff. Typically staff would count cycles at all legs of an intersection, whereas the automatic counts were done on just one leg of an intersection, or a path.

[1] LTSA, 2004

George Bolt Memorial Drive and Lake Road were on-road sites where cycle traffic was counted by separate machine counters on each side of the road, while the Waterview overbridge and Te Atatu sites were off-road and were counted with single traffic counters. At Tamaki Drive, cyclists could ride on either an off-road path or on the road itself, and counter tubes were positioned to extend across both the path and the kerb lane to count cyclists in either position. The counter set-up at Tamaki Drive (North Side) is shown in Figure 1. The two rubber tubes can be seen extending over the footpath and across the kerb lane of the road, 1.0 m apart.

Figure 1: Tamaki Drive (north side) site for automatic counting

MetroCount 5600 traffic counters were used with special cycle counting tubes supplied by the manufacturer. MetroCount proprietary software was used to analyse the counts, with the ARX classification system used to identify cycle traffic

2. Results and Analysis

Automatic traffic counts varied by day for each site. The second week was mostly wet, and the counts are correspondingly lower. Some sites exhibited higher counts at weekends; others did not. One counter was used on each side of the roads that were counted (the paths were counted with a single counter); accordingly there are eight counts for the five sites. These daily variations are shown in Figure 2, with a single colour representing each site; a dashed or dotted line indicates a separate count on each side of the road, while a solid line indicates a path count.

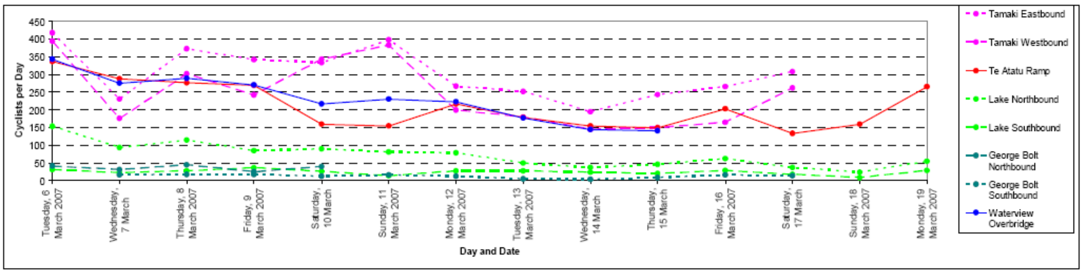

Figure 2: Daily traffic variations by site

Counts for all weekdays have been aggregated for each site and are shown in Figure 3. The chart shows the percentage of daily cyclists in each 15 minute period. The George Bolt count had very low volumes (under 50 cyclists per day), and the counter on one side of the road only worked for four days, so not too much importance should be placed on data from this site, which is quite erratic in the chart. An earlier afternoon peak is evident at the Lake Road site (outside Takapuna Grammar), reflecting the presence of school cyclists, but otherwise all sites exhibit similar morning and afternoon peaks.

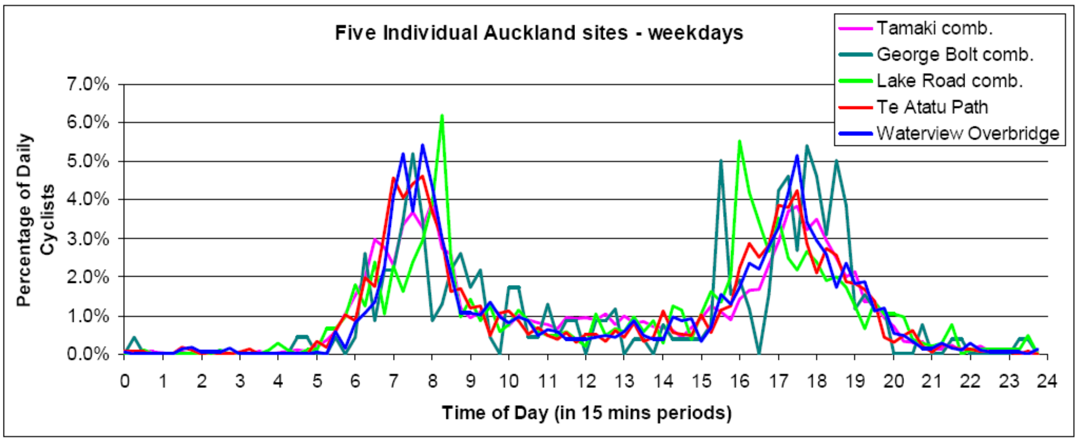

Figure 3: Hourly traffic variations by site

Data from the five Auckland locations have been amalgamated in Figure 4. The chart shows that Auckland weekday cycling patterns are similar to the CNRPG data (from Christchurch and Palmerston North) for "commuter" sites. When compared with "all" sites (which are influenced by those which have significant school cycle traffic), it can be deduced that there is not much school cycling in Auckland compared with Christchurch and Palmerston North. In particular, the two afternoon peaks of the CNRPG "all" data (blue) clearly show the influence of school traffic.

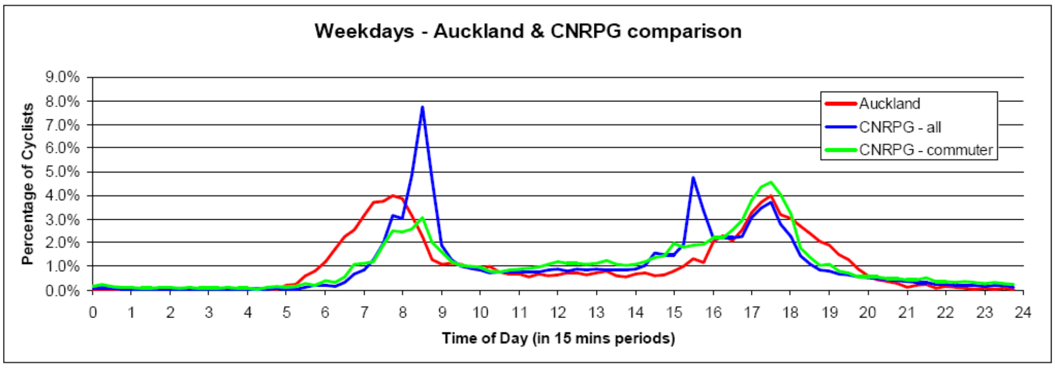

Figure 4: Hourly traffic variations – Auckland versus CNRPG

Counts on wet weekdays were 64% of the equivalent dry weekday figure. However, the hourly distribution for wet and dry days is almost identical, as shown in Figure 5.

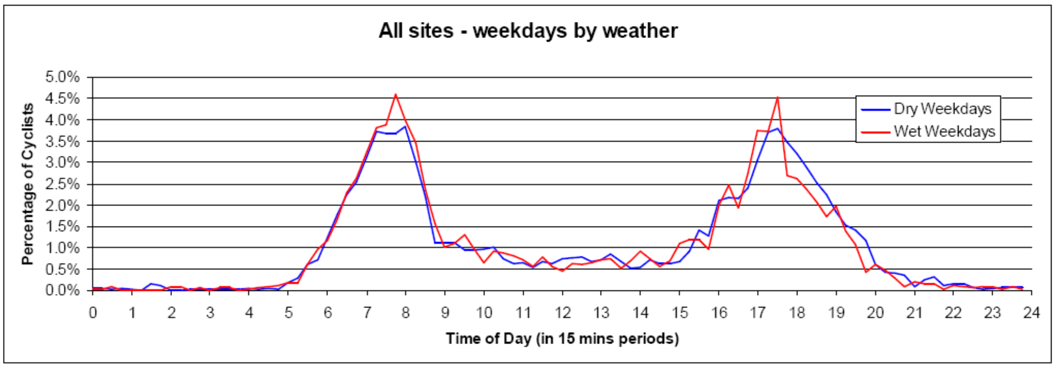

Figure 5: Effect of weather on hourly patterns

The Gravitas counts showed different levels of school activity, as shown in Table 1.

Table 1: Cyclists in manual Gravitas counts

	6:30 – 9:00		16:00 – 19:00	
Site	**Number**	**% School**	**Number**	**% School**
Tamaki Drive	480	0%	420	0%
Waterview Overbridge	98	9%	134	7%
George Bolt Memorial Drive	12	0%	66	0%
Lake Road (Takapuna Grammar)	127	36%	65	3%
Te Atatu path	102	5%	130	8%

Note: These numbers do not necessarily correspond with the automatic count at the same locations as the manual counts include all cyclists at an intersection, while the automatic counts record traffic at just one leg of an intersection.

The Lake Road (Takapuna Grammar) site manual count in the afternoon is likely to have missed significant numbers of school cyclists, as schools are dismissed well before 4:00 pm when the survey began. This explains the difference between the 36% school student figure for the morning survey and the 3% school student figure for the afternoon survey.

3. Reconciliation of Automatic and Manual Counts

Comparisons of the counts for each direction and for each time period (morning and afternoon) have been made, with off-road and on-road sites being separated. Off-road sites (where motor vehicles are not present to confuse the automatic counters) were more accurate.

For on-road sites, the automatic counters undercounted cyclists, recording only 62% of the cyclists recorded in the manual counts. These results are shown in Figure 6. A significant proportion of this error is probably explained by the dominant Tamaki Drive site, where the count tubes extended well into the roadway yet may still have missed numbers of cyclists.

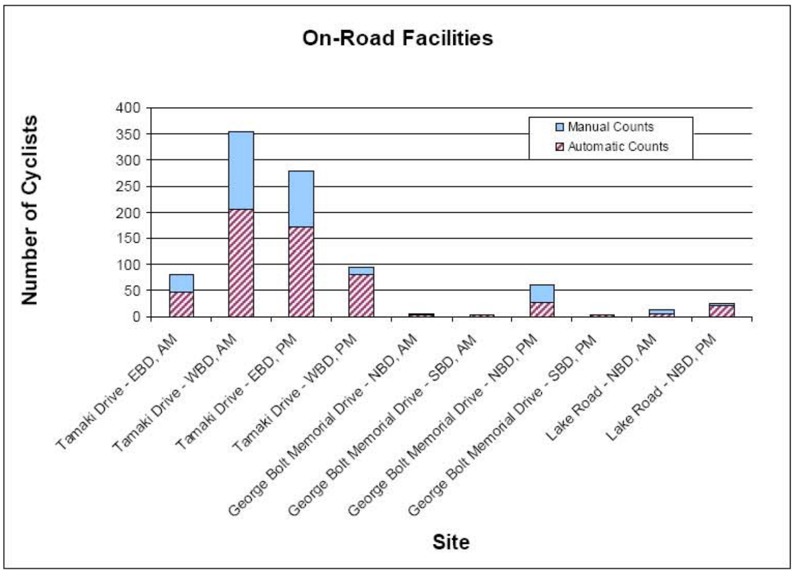

Figure 6: Comparison between manual and automatic counts – on-road

For off-road counts, the automatic counters counted 85% of the cyclists recorded by the manual counts. These results are shown in Figure 7. The Waterview Overbridge site count was quite accurate, perhaps reflecting the limited alternatives for cyclists to avoid the counters at this particular location. Counts in Christchurch have also verified that the MetroCount counters can count every cyclist. This demonstrates the importance of site selection and the placement of counter tubes (how far out into the roadway the tubes extend, for example). The sites selected for this project were dependent on the options available from the Gravitas sites. If the exercise were to monitor cycle traffic in Auckland, other sites would probably have been selected that were easier to count with the technology available, yet still represented significant cycle traffic locations.

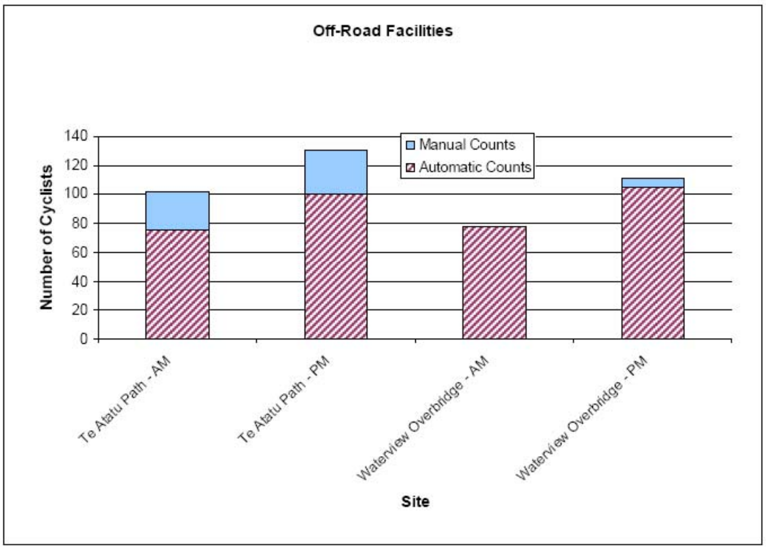

Figure 7: Comparison between manual and automatic counts – off-road

4. Amended Estimation Tool for the Auckland Region

4.1. Background

The following equation, adapted from the CNRPG, provides a recommended estimate of cycling AADT from a particular short-term count:

$$AADT_{Cyc} = Count \times \frac{1}{\sum H} \times \frac{1}{D} \times \frac{W}{7} \times \frac{1}{R}$$

Where: Count = result of count period
H = scale factor for time of day
D = scale factor for day of week
W = scale factor for week of year
R = scale factor for weather conditions on the count day

H represents a single 15 minute period, but in practice, a count should be done for at least an hour and preferably several hours in the morning and afternoon peaks. ∑H is the sum of these H factors for all the time periods being considered.

The CNRPG equation has been amended by the introduction of a scale factor *R* for weather influence, which accounts for the difference in cycle traffic between wet and dry days. The rest of the equation is identical. The scale factors are sometimes the same as in the CNRPG, and sometimes they are unique to the Auckland region.

If more than one set of count data is available (e.g. morning and afternoon counts, or counts in different months), then the AADT calculation should be carried out for each set of data to develop an AADT for those data, and the AADT estimate for each survey averaged.

4.2. Scale factor for time of day (H)

The CNRPG has one general H factor for sites where a mix of school and commuter cyclists are present and another for "commuter" sites, where numbers of school cyclists are insignificant. (There is also an H factor for weekend cycle traffic.) The Lake Road site had 36% school students in the morning survey (identified by the Gravitas survey). According to Gravitas[2], Takapuna Grammar has one of the highest cycling mode shares of Auckland schools, although it is known that many students who cycle to the school use other streets, so hence would not have been recorded in either the Gravitas or automatic surveys on Lake Road. It is thus not directly comparable with the CNRPG "all" locations. Nevertheless, the difference in the amount of traffic occurring in the morning peak between this site and the other ("commuter") sites is quite small. As there is relatively little data from which to distinguish between general sites (containing school traffic) and "commuter" sites, it has been determined that only one series of H factors should be developed for weekdays, in addition to the weekend H factor.

Auckland region weekend data have been found to be very different to the CNRPG data, as shown in Figure 8. In the Auckland region, a strong morning peak is evident for both Saturday and Sunday, whereas the CNRPG weekend data show an afternoon peak.

[2] *Manual Cycle Monitoring in the Auckland Region – Summary report*; for ARTA by Gravitas, May 2007

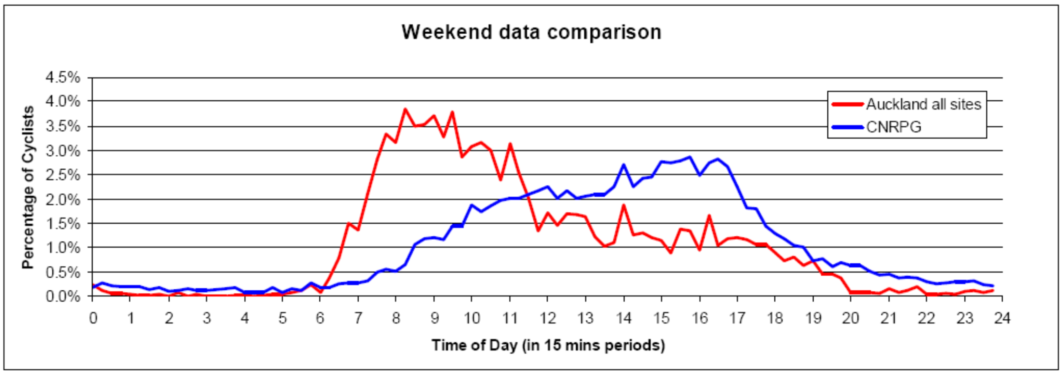

Figure 8: Auckland region weekend profile comparison to CNRPG profiles

4.3. Scale factor for day of week (D)

There is not enough data to differentiate between weekdays. Even in the CNRPG, these factors are quite similar. For the Auckland region data, the weekend day analysis is based on only one or two Saturdays and Sundays per site, respectively. It is evident from these data, though, that Auckland has proportionally more weekend cycle traffic than what is reported in the CNRPG. Based on these limited data, Table 2 shows the best estimate for the Auckland region:

Table 2: Scale factor D for Auckland region

Day	D
Weekday	14%
Saturday	14%
Sunday	16%

Due to the fact that the underlying data cover a one- or two-week period at five sites only, no differentiation between "commuter" or "non-school" and "school" sites is possible. Analysing the weekend data, it is evident that:

- Saturday and Sunday data have a very similar daily distribution (although Sundays have more cycle traffic than Saturdays);
- There is no need to differentiate between "school" and "non-school" sites for weekends; and
- The weekend daily distribution in the Auckland region is significantly different to that published in the CNRPG.

Scale factors for individual 15 minute periods are appended to this report (Appendix 1).

4.4. Scale factor for week of year (W)

It is not possible to give a week of year factor specific for the Auckland region, as long-term (i.e. all year round) counts have not yet been carried out. It is possible, though, to draw some conclusions from the CNRPG data.

For term 1 (i.e. the period during which the Auckland data were collected), the CNRPG suggests scale factors of 0.78 and 0.84 for “all sites” and “commuter sites”, respectively. This suggests that:

- During term 1, counts are higher than the annual average (this is presumably a function of the season), and
- “Commuter sites” are closer to the annual average than “school sites” (this is presumably because commuters are less dependant on school terms in their cycling habits than pupils).

If it is assumed that the seasonal variation is less in Auckland compared to Christchurch (where the annual data for the CNRPG values were collected), and that sites are mainly influenced by commuter traffic, a value of W = 0.90 for term 1 is recommended for Auckland.

It is recommended that year-round counts be done to confirm this assumption, and to obtain values for other periods. Until such data are available, it would be reasonable to assume that because the climate is milder in Auckland than Christchurch (the source of CNRPG data), the effects of winter will not be so pronounced. Similarly, because there is much less school cycling in Auckland than Christchurch, the effects of school holidays will be less pronounced. Thus the factors used in the CNRPG could be adjusted towards 1.0, reflecting a less pronounced effect, as illustrated in Table 3.

Table 3: Scale factor W for Auckland region

Secondary School Period	CNRPG W Factor (Commute)	Recommended Interim W Factor for Auckland
Summer holidays	1.02	1.0
Term 1	0.84	0.9
April holidays	0.97	1.0
Term 2	1.04	1.0
July holidays	1.40	1.2
Term 3	1.19	1.1
Sept/Oct holidays	1.24	1.2
Term 4	0.93	1.0

4.5. Scale factor for weather (R)

During the two-week count period, some days experienced inclement weather. As weather data are available, it is possible to obtain an estimate for the drop in cycle traffic caused by rain. This is the weather scale factor R. On average, wet days had 64% of the cycle traffic of fine days, as shown in Table 4.

Table 4: Scale factor R for Auckland region

Weather	R
Fine	100%
Wet	64%

As noted previously (Figure 5 and associated text), the hourly distribution of wet days is quite similar to fine days (even though the total numbers of cyclists are significantly lower). It is thus not necessary to have a separate set of scale factors for time of day for wet days. It is necessary, though, to apply judgement as to whether the "Weather" scale factor R should be applied or not.

4.6. Worked Example

If morning and afternoon manual traffic counts had been undertaken at a site, the AADT could be calculated using the count summaries for each period. For example, a morning survey of 102 and an afternoon survey of 130 are suggested. For the morning survey period, using the formula from Section 4.1 and the factors in Appendix 1, the calculation is as follows:

$$AADT_{Cyc} = 102 \times \frac{1}{30\%} \times \frac{1}{14\%} \times \frac{0.9}{7} \times \frac{1}{100\%} = 312$$

The values for both morning and afternoon period are illustrated in Table 5.

Table 5: Worked Example

Count Period	6.30 to 9.00	16.00 to 19.00	Average
Count (No. of Cyclists Counted)	102	130	
ΣH (hour factor; sum of all time periods)	30.0%	33.3%	
D (day of week factor; weekday)	14%	14%	
W (week of year factor; term 1)	0.9	0.9	
R (weather factor; fine)	100%	100%	
AADT Estimate (using formula)	**312**	**359**	**335**

So the AADT estimate (based on both survey periods) for this facility is 335 cyclists per day.

5. Further Research

1. More school sites should be counted (both manually and automatically) to allow the development of improved time of day factors (H) for general sites and commuter sites.
2. Continuous counts (perhaps using induction loops) should be undertaken to improve the reliability of factors for different day factors (D) and week factors (W).
3. Any further automatic or continuous counts done to improve the reliability of the AADT estimation tool should be supplemented by simultaneous manual counts during busy periods to help with calibration and to improve the wet weather estimation factor (R).

Appendix 1: Scale Factors for Auckland Region

(Use the formula in Section 4.1 to apply these factors.)

Period Starting	Period Ending	Interval (hours)	$H_{Weekday}$ Mon to Fri	$H_{Weekend}$ Sat & Sun
0:00	6:30	6.50	5.5%	1.8%
6:30	6:45	0.25	2.3%	0.8%
6:45	7:00	0.25	2.6%	1.5%
7:00	7:15	0.25	3.2%	1.4%
7:15	7:30	0.25	3.7%	2.1%
7:30	7:45	0.25	3.8%	2.8%
7:45	8:00	0.25	4.0%	3.3%
8:00	8:15	0.25	3.9%	3.2%
8:15	8:30	0.25	3.1%	3.8%
8:30	8:45	0.25	2.3%	3.5%
8:45	9:00	0.25	1.3%	3.5%
9:00	10:00	1.00	4.2%	13.6%
10:00	11:00	1.00	3.4%	11.6%
11:00	12:00	1.00	2.6%	9.1%
12:00	13:00	1.00	2.7%	6.6%
13:00	14:00	1.00	2.7%	5.0%
14:00	14:15	0.25	0.7%	1.9%
14:15	14:30	0.25	0.7%	1.3%
14:30	14:45	0.25	0.6%	1.3%
14:45	15:00	0.25	0.6%	1.2%
15:00	15:15	0.25	0.8%	1.1%
15:15	15:30	0.25	1.0%	0.9%
15:30	15:45	0.25	1.3%	1.4%
15:45	16:00	0.25	1.2%	1.3%
16:00	16:15	0.25	2.1%	1.0%
16:15	16:30	0.25	2.3%	1.7%
16:30	16:45	0.25	2.1%	1.0%
16:45	17:00	0.25	2.5%	1.2%
17:00	17:15	0.25	3.3%	1.2%
17:15	17:30	0.25	3.7%	1.2%
17:30	17:45	0.25	4.0%	1.1%
17:45	18:00	0.25	3.2%	1.1%
18:00	18:15	0.25	3.0%	0.9%
18:15	18:30	0.25	2.7%	0.7%
18:30	18:45	0.25	2.4%	0.8%
18:45	19:00	0.25	2.1%	0.6%
19:00	20:00	1.00	5.6%	2.0%
20:00	0:00	4.00	3.0%	1.5%
		24.00	100.0%	100.0%

Day	D
Monday	14%
Tuesday	14%
Wednesday	14%
Thursday	14%
Friday	14%
Saturday	14%
Sunday	16%

Period	W
Summer holidays	1.0
Term 1	0.9
April holidays	1.0
Term 2	1.0
July holidays	1.2
Term 3	1.1
Sep/Oct holidays	1.2
Term 4	1.0

Weather	R
Fine	100%
Rain	64%

Appendix F

Worked Example of AADT Estimate Using Automatic Tube Counters

Appendix F: Worked Example of AADT Estimate Using Automatic Tube Counters

Assume tube counts have been undertaken on an on-road facility in Rotorua and only six full days of counts have been collected. The combined counts from the counters on both sides of the road is as follows.

Count Date	Day of the Week	Tube Count	Weather Conditions
15 March	Tuesday	120	Fine
16 March	Wednesday	97	Fine
17 March	Thursday	102	Fine
18 March	Friday	65	Rain
19 March	Saturday	52	Fine
20 March	Sunday	36	Fine
21 March	Monday	No count data available	Fine

To convert the tube counts to a cycling AADT estimate the calculation is as follows:

$$AADT = Count \times \frac{1}{\sum H} \times \frac{1}{D} \times \frac{W}{7} \times \frac{1}{R} \times \frac{1}{T}$$, where

H = Scale factor for the time of day. For whole days *H* = 1.

D = Scale factor for day of the week.

W = Scale factor for week of the year.

R = Scale factor for rain affected days. R = 64% for rain affected days (see Appendix D.2).

T = Scale factor for undercounting of tube counter. For on-road counts *T* = 62%, for off-road counts *T* = 85%. Refer to Section 3 of the report attached in Appendix D.2.

As the site is outside of the Auckland region, use the CNRPG tool for factors *H*, *D* and *W* (see Appendix D.1). For manual counts a fine day can be selected to undertake the count and the CNRPG method will suffice. However for automatic tube counts it is likely that at least one day will be rain affected. Therefore the addition of the rain day factor is recommended. The calculation is as follows:

	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Count	120	97	102	65	52	36
$\sum H$ (time period)	1	1	1	1	1	1
D (day of the week)	16.4%	16.5%	16.8%	15.2%	9.0%	9.0%
W (week of year; term 1)	0.78	0.78	0.78	0.78	0.78	0.78
R (rain factor)	100%	100%	100%	64%	100%	100%
T (tube counter factor)	62%	62%	62%	62%	62%	62%
AADT Estimate	132	106	109	120	104	72

The week day average = 117 and the weekend average = 88. Allowing for five week days and two weekend days the seven day AADT can be estimated as follows:

$$AADT = \frac{(5 \times 117) + (2 \times 88)}{7} = 109$$

Appendix G

Census Data by Council Area (Cycle Mode Share and Growth Rate)

Appendix G: Census Data by Council Area (Cycle Mode Share and Growth Rate)

Territorial Authorities	2001 # Biked (CB)	2006 # Biked (CB)	2006 Total Travel to Work	2006 Mode Share (MS)	Bike Growth (BG) (2001 to 2006)
Far North District	168	114	14841	0.8%	-7.5%
Whangarei Distri	354	366	24708	1.5%	0.7%
Kaipara District	75	57	5172	1.1%	-5.3%
Rodney District	162	162	32007	0.5%	0.0%
North Shore City	729	756	86277	0.9%	0.7%
Waitakere City	717	672	70410	1.0%	-1.3%
Auckland City	2,208	2,487	160626	1.5%	2.4%
Manukau City	807	699	113355	0.6%	-2.8%
Papakura District	168	135	16320	0.8%	-4.3%
Franklin District	159	126	21702	0.6%	-4.5%
Thames-	243	267	8232	3.2%	1.9%
Hauraki District	126	81	5034	1.6%	-8.5%
Waikato District	195	171	14430	1.2%	-2.6%
Matamata-Piako	243	198	10002	2.0%	-4.0%
Hamilton City	2,106	1,716	50640	3.4%	-4.0%
Waipa District	279	216	15846	1.4%	-5.0%
Otorohanga Distr	42	27	2658	1.0%	-8.5%
South Waika	294	180	6840	2.6%	-9.3%
Waitomo District	48	27	2988	0.9%	-10.9%
Taupo District	261	222	11886	1.9%	-3.2%
Western Bay	144	135	13299	1.0%	-1.3%
Tauranga City	1,032	999	37761	2.6%	-0.6%
Rotorua District	687	549	23520	2.3%	-4.4%
Whakatane Distr	414	324	10275	3.2%	-4.8%
Kawerau District	108	72	1905	3.8%	-7.8%
Opotiki District	45	42	2214	1.9%	-1.4%
Gisborne District	588	537	14313	3.8%	-1.8%
Wairoa District	69	69	2619	2.6%	0.0%
Hastings District	1,041	924	25527	3.6%	-2.4%
Napier City	822	855	21402	4.0%	0.8%
Central Hawk	60	48	4722	1.0%	-4.4%

Territorial Authorities	2001 # Biked (CB)	2006 # Biked (CB)	2006 Total Travel to Work	2006 Mode Share (MS)	Bike Growth (BG) (2001 to 2006)
Manawatu District	282	243	10,686	2.3%	-2.9%
Palmerston North City	2,013	1,818	30,711	5.9%	-2.0%
Tararua District	141	96	5,826	1.6%	-7.4%
Horowhenua District	369	273	9,321	2.9%	-5.8%
Kapiti Coast District	297	273	15,195	1.8%	-1.7%
Porirua City	120	114	17,610	0.6%	-1.0%
Upper Hutt City	354	282	15,612	1.8%	-4.4%
Lower Hutt City	789	627	39,702	1.6%	-4.5%
Wellington City	1,926	2,160	83,643	2.6%	2.3%
Masterton District	402	303	8,205	3.7%	-5.5%
Carterton District	66	48	2,547	1.9%	-6.2%
South Wairarapa District	81	54	3,057	1.8%	-7.8%
Tasman District	792	903	16,446	5.5%	2.7%
Nelson City	1,140	1,215	16,980	7.2%	1.3%
Marlborough District	885	831	16,668	5.0%	-1.3%
Kaikoura District	36	63	1,329	4.7%	11.8%
Buller District	222	138	3,138	4.4%	-9.1%
Grey District	159	114	5,115	2.2%	-6.4%
Westland District	159	135	3,105	4.3%	-3.2%
Hurunui District	54	69	3,276	2.1%	5.0%
Waimakariri District	330	327	16,242	2.0%	-0.2%
Christchurch City	8,667	9,093	140,562	6.5%	1.0%
Banks Peninsula District	42	*(now part of Chch CC)*			
Selwyn District	366	384	13,539	2.8%	1.0%
Ashburton District	465	438	10,515	4.2%	-1.2%
Timaru District	711	555	15,951	3.5%	-4.8%
Mackenzie District	69	54	1,317	4.1%	-4.8%
Waimate District	69	51	2,115	2.4%	-5.9%
Chatham Islands District	0	3	222	1.4%	
Waitaki District	198	183	6,924	2.6%	-1.6%
Central Otago District	240	237	6,507	3.6%	-0.3%

Appendix G: Census Data by Council Area (Cycle Mode Share and Growth Rate) (continued)

Territorial Authorities	2001 # Biked (CB)	2006 # Biked (CB)	2006 Total Travel to Work	2006 Mode Share (MS)	Bike Growth (BG) (2001 to 2006)
New Plymou	672	681	25392	2.7%	0.3%
Stratford District	45	36	2859	1.3%	-4.4%
South Taran	357	282	8334	3.4%	-4.6%
Ruapehu District	204	120	4521	2.7%	-10.1%
Wanganui District	843	627	14490	4.3%	-5.7%
Rangitikei District	150	105	5058	2.1%	-6.9%

Territorial Authorities	2001 # Biked (CB)	2006 # Biked (CB)	2006 Total Travel to Work	2006 Mode Share (MS)	Bike Growth (BG) (2001 to 2006)
Queenstown-Lakes District	225	267	10,737	2.5%	3.5%
Dunedin City	1,173	855	45,765	1.9%	-6.1%
Clutha District	114	75	6,066	1.2%	-8.0%
Southland District	195	162	9,750	1.7%	-3.6%
Gore District	132	93	4,659	2.0%	-6.8%
Invercargill City	705	471	20,370	2.3%	-7.8%
Total, New Zealand	40,653	38,091	1,511,598		