Evaluation of Automatic Bicycle Counters in New Zealand

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An Important Note for the Reader

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

Transfund New Zealand is a Crown entity established under the Transit New Zealand Act 1989. Its principal objective is to allocate resources to achieve a safe and efficient roading system. Each year, Transfund New Zealand invests a portion of its funds on research that contributes to this objective.

Abbreviations and Acronyms

AADT	Annual average daily traffic volume
AUSTROADS	Association of Australian and New Zealand Road Transport and Traffic Authorities
CCC	Christchurch City Council
cm	centimetre
GR	Golden River
km/h	kilometres per hour
m	metre
MC	MetroCount
mm	millimetre
MV	motor vehicle
MWH	MWH New Zealand Ltd
PC	personal computer
Transfund	Transfund New Zealand

Contents

Executive Summary

Bicycle traffic data are generally scarce and of poor quality. Reliable estimates of cycling activity levels will allow a better understanding of bicycle travel behaviour and user preferences, which will help in the provision of appropriate infrastructure for cyclists. Better cycling use data will assist in understanding and improving cycling safety.

Research was undertaken in Christchurch, New Zealand, from October 2001 to May 2002, to select and evaluate automatic traffic counting equipment for counting bicycles. The objectives of the research were to:

1. Research the international literature on "state of the art" bicycle counting technologies;

2. Consult with selected practitioners in New Zealand road controlling authorities about the current needs and existing technologies and methodologies in use locally;

3. Communicate with suppliers (either local or overseas as necessary) for detailed specifications of potentially useful and cost-effective equipment;

4. Test one or two of the most promising technologies in a variety of settings, including off-street bicycle paths, and urban and rural on-street locations;

5. Evaluate the effectiveness and ease of use of any associated computer software for each piece of equipment;

6. Make recommendations on the preferred technology or technologies for particular circumstances; and

7. Publish the findings of the research in a user-friendly format and work with Transfund to ensure that the information is easily accessible to end users.

The research started with a literature review of six types of automatic traffic counting technologies. The researchers then consulted with staff responsible for traffic counting and cycling within road controlling authorities, and contacted suppliers of traffic counting equipment as to the capabilities of various pieces of equipment. Based on this work, two traffic counting machines were tested extensively. Both machines used pneumatic rubber tubes to detect air pulses generated by the tyres of passing vehicles.

The tests consisted of installing the counters at three locations in Christchurch. Armagh Street near Hagley Park, with relatively low traffic volumes, was tested first, to gain familiarity with the machines and to generate some data for analysis. The next location tested was Kilmarnock Street, an urban minor arterial road, and Marshland Road, a rural arterial road, was the third location tested. These sites covered a wide range of road types and vehicle speeds.

The testing considered a variety of sources of potential error in counting bicycle traffic, including rubber tube type and length, bicycle speeds, and bicycle tyre type.

A number of conclusions were drawn from the research:

1. Both counters performed satisfactorily and are recommended for use in New Zealand for counting bicycles, either off-street or on-street.

2. Bicycles can be counted accurately in mixed traffic as part of routine automatic traffic counts in both urban and rural environments.

3. Both motor vehicles and bicycles can be counted simultaneously and classified by vehicle type, using commercially available traffic counting machines.

4. On roads with modest motor vehicle traffic volumes (up to approximately 7,000 motor vehicles per day), counts of both bicycles and motor vehicles can be carried out simultaneously using one traffic counting machine.

5. Pneumatic rubber tube traffic counters appear to be the most cost-effective technology currently available for counting bicycle traffic automatically for short-term durations (typically up to one or two weeks).

6. Other rubber tube traffic counters may be able to count bicycle traffic accurately in mixed traffic. Other types of traffic counters (such as inductive loop detectors) may be more suitable for longer term bicycle counting.

7. The Golden River Marksman 410 Bicycle Classifier (GR M410) is a specialised bicycle counter which can count bicycles and different classes of motor vehicles at the same time. It can count bicycles wherever they are ridden (even at slow speeds). The counter can count bicycles and motor vehicles accurately using rubber tubes up to 15 m in length.

8. The MetroCount Vehicle Classifier 5600 Series (MC 5600) traffic counter is a general purpose vehicle counter which is able to count bicycle traffic. It can detect and count bicycles accurately if they are travelling faster than 10 km/h. The machine can count bicycles (and motor vehicles) accurately using rubber tubes up to 10 m in length.

9. Of the two machines tested, the GR M410 counts bicycles better than the MC 5600 at slow speeds (under 10 km/h), but its data analysis software is not as versatile or user-friendly as that of the MC 5600.

10. The GR M410 uses more durable rubber tubes than the MC 5600.

11. Vehicle classification systems currently in use in New Zealand need to be updated to recognise bicycles as a class of vehicle distinct from motor cycles, cars, and other motor vehicles.

12. The research shows that automatic bicycle counting is feasible and relatively easy to do as part of routine traffic counting. It is now up to road controlling authorities to apply the research and count bicycles at key locations.

Based on the research, it is recommended that:

1. When automatic bicycle traffic counts are required, they should be undertaken using special bicycle-sensitive rubber tubes as recommended by traffic counter suppliers or manufacturers.

2. When a road's annual average daily traffic volume (AADT) is less than 7,000 motor vehicles per day, one counter can be used to record both motor vehicles and bicycles.

3. When a road's AADT is greater than 7,000 but less than 14,000 motor vehicles per day, one counter should be used on each side of the road to record motor vehicles and bicycles.

4. When a road's AADT is greater than 14,000 motor vehicles per day, one counter should be used in each motor vehicle and bicycle lane (or typical bicycle trajectory).

5. When using the GR M410 for counting bicycle traffic (with or without motor vehicle traffic), the rubber tubes should not be longer than 15 m.

6. When using the MC 5600 for counting bicycle traffic, the rubber tubes should not be longer than 10 m, and the survey site should not be located on an incline.

7. When using the MC 5600 for counting both bicycle and motor vehicle traffic, composite tubes should be used. These consist of bicycle counting tubes at the edge of the road (to detect bicycles) joined to conventional traffic counting tubes in the centre (to detect motor vehicles).

8. Road controlling authorities should count bicycle traffic as part of routine automatic traffic counts.

9. Transfund should ensure that a national or Australasian standard for automatic traffic counter vehicle classifications is developed and implemented to include bicycles as a separate class of vehicle from other vehicles.

10. Transfund should commission further research to develop robust methods to estimate AADTs for bicycles based on short-term automatic bicycle counts.

11. Transfund should commission further research to establish appropriate AADT limits for simultaneous counting of bicycles and motor vehicles with one traffic counting machine.

12. Transfund should commission further research to establish recommended traffic counting technologies for long-term bicycle counting at control stations.

Abstract

This report summarises research undertaken in Christchurch, New Zealand, between October 2001 and May 2002, to evaluate automatic bicycle counting technologies. A literature review and consultation with key staff in road controlling authorities were undertaken to select the equipment to test.

Rigorous testing was performed on two counters which used pneumatic rubber tube detectors: the Golden River Marksman 410 Bicycle Classifier and the MetroCount Vehicle Classifier 5600 Series. Tests were undertaken both off-street, to simulate conditions in parks and on cycle paths, and on-street in mixed traffic, to simulate typical conditions for cyclists. Other types of equipment were not tested, although they may be satisfactory for counting bicycles.

Both counters performed satisfactorily and are recommended for use in New Zealand for counting bicycles, either off-street or on-street, and in both urban and rural situations. They are capable of counting and classifying bicycles and motor vehicles simultaneously. Recommendations are made about correct procedures for using the machines for counting bicycle traffic and for further research into bicycle counting.

The research is important as it demonstrates that automatic bicycle counting is feasible and relatively easy to do as part of routine traffic counting.

1. Introduction

Bicycle counting has usually been a difficult, expensive and labour-intensive task for road controlling authorities. The reliability of many conventional traffic counting machines for counting bicycles has not previously been assessed. In New Zealand, routine manual intersection traffic counts rarely include bicycle traffic, and for those counts where these data are captured, they may be unreliable because traffic counting staff either do not notice the relatively few bicycles on the road or are fully occupied counting motor vehicles. Consequently, few road controlling authorities in New Zealand (including local authorities and Transit New Zealand) have reliable data on how many bicycles use their roads and streets.

Yet most road controlling authorities undertake routine classified counts of traffic using traffic counting machines, where the composition of traffic is determined from the arrangement of axles of each passing vehicle. The challenge for the research reported here was to assess whether the existing technology (or something similar) commonly in use in New Zealand could reliably count and classify bicycle traffic as well.

From a policy perspective, growth in bicycle traffic (rather than motor vehicle traffic) is desirable, as the bicycle is the most efficient vehicle in terms of road space, parking space, fuel consumption and emissions. Increased bicycle use can reduce the need for expensive new road infrastructure. While cycling is supported at a policy level by local, regional and national governments, cost-effective methods of monitoring cycling activity are needed to ascertain the effectiveness of existing and future transportation, health, energy and land use policies.

Cost-benefit analyses will be necessary in many cases to justify investment in specific new transport facilities, whether these are to be used exclusively by cyclists or whether cyclists are just one of a variety of road users. Transfund allows existing and/or anticipated bicycle traffic volumes to be quantified and given economic value for their health benefits in cost-benefit analyses[1]. Reliable bicycle traffic data will improve the accuracy of these analyses, not only for bicycle facilities, but also for any project where bicycle traffic is a factor.

The main objectives of the research were to:

1. Research the international literature on "state of the art" bicycle counting technologies;
2. Consult with selected practitioners in New Zealand road controlling authorities about the current needs, and existing technologies and methodologies in use locally;
3. Communicate with suppliers (either local or overseas as necessary) for detailed specifications of potentially useful and cost-effective equipment;
4. Test one or two of the most promising technologies in a variety of settings, including off-street bicycle paths, and urban and rural on-street locations;

[1] Transfund General Circular No. 02/04, March 2002: Implementation of a value for the health benefits of cycling into the PEM (Transfund Project Evaluation Manual).

5. Evaluate the effectiveness and ease of use of any associated computer software for each piece of equipment;
6. Make recommendations on the preferred technology or technologies for particular circumstances; and
7. Publish the findings of the research in a user-friendly format and work with Transfund to ensure that the information is easily accessible to end users.

The research was carried out in Christchurch, New Zealand, between October 2001 and May 2002. The research team, peer reviewers and technical advisors are recorded in Table 1.1.

Table 1.1 Research Team, Peer Reviewers and Technical Advisors.

Andrew Macbeth	Principal Researcher	MWH New Zealand Ltd
Mark Weeds	Research Assistant	MWH New Zealand Ltd
Bruce Galloway	Research Assistant	MWH New Zealand Ltd
Norm Pilling	Traffic Counting Contractor	Pilling Performance Ltd
Roger Boulter	Peer Reviewer	Hamilton City Council
Alix Newman	Peer Reviewer	Christchurch City Council
Tony Spowart	Peer Reviewer	Transit New Zealand (Christchurch)
Chris Bennett	Technical Advisor	MWH New Zealand Ltd
Lindsay Joyce	Technical Advisor	Transit New Zealand (Christchurch)
Bruce Kelly	Technical Advisor	Christchurch City Council
Aaron Phillips	Technical Advisor	Palmerston North City Council
John Shrewsbury	Technical Advisor	MWH New Zealand Ltd
Bill Sissons	Technical Advisor	Christchurch City Council

The assistance of Mary Boyle and Peter Tutt of Harding Traffic, and Vern Bastion, Mark Eyre and Greg Juracich of MetroCount, is also acknowledged.

Figure 1.1 The research team, from left: Norm Pilling (Pilling Performance); and Mark Weeds, Andrew Macbeth and Bruce Galloway (MWH New Zealand Ltd).

2. Literature Review and Consultation

2.1 Literature Review

After an initial literature search (via the Internet) of existing automatic bicycle counting equipment and current best practices, it became apparent that automatic traffic counting equipment designed specifically to count bicycles was not common. However, from the limited information found, six technologies emerged for counting bicycles. These were:

1. Infrared or radar detectors – use emitted and reflected electromagnetic waves to detect bicycles;

2. Magnetic proximity detectors – use magnetic imaging technology to detect the presence of a vehicle. As an object (such as a vehicle) passes close to the detector, the change in the earth's magnetic field is recorded and the vehicle is registered;

3. Piezoelectric counters – use pressure exerted by a tyre on an embedded metal strip to generate an electrical signal which is recorded by a central control unit;

4. Video-image processing – takes sequences of scale images from a video camera system to monitor bicycle activity;

5. Inductive loop detectors – are buried in the pavement, and have coiled wire carrying small electrical currents, which generate local magnetic fields. When a metal object crosses the loop, the field is disturbed and this disturbance is detected as a vehicle by a control unit;

6. Pneumatic tube counters – use rubber tubes connected to a counter unit. Vehicle tyres depressing the tube cause pneumatic pulses to be sent to the counter unit.

Infrared and radar detectors and video-image processing are relatively expensive technologies and were considered impractical options for road controlling authorities. Proximity detectors do not classify vehicles and therefore will not distinguish between bicycles and motor vehicles. Piezoelectric counters appeared to be too expensive for routine use in traffic counting, and are not widely used in New Zealand for traffic counts.

Inductive loops and pneumatic rubber tube counters appeared from the literature review to be effective for counting bicycles. Consequently, the detailed literature search focused primarily on inductive loop technology and rubber tube counters. A list of Internet sites used for the research is contained in Appendix A.

2.2 Inductive Loops

Inductive loops are a viable method of counting traffic at a fixed location over a long period. They are advantageous in that they provide virtually "invisible" detection. Once installed, they are out of view from traffic and are less prone to vandalism and interference from passers-by. Additionally, loops require little maintenance once they are installed. However, the relatively small amount of metal in a bicycle means that bicycles travelling over a loop are difficult to detect accurately (although this can be mostly overcome by using specific loop configurations resulting in more sensitive detection).

Inductive loops are a proven vehicle detection technology. However, the ability of inductive loops to discriminate between bicycles and motor vehicles is unconfirmed. Inductive loops may be suitable for use where long-term counts at a single location (free of motor vehicle traffic) are required, but it was felt that most road controlling authorities are more likely to need a more portable traffic counting technology. Consequently, inductive loops were not tested as part of this research.

2.3 Pneumatic Rubber Tube Counters

Pneumatic rubber tubes are one of the most cost-effective traffic sensing methods, particularly for short-term surveys. Tubes are relatively cheap, reliable, accurate, and effective over a wide range of environmental conditions. Vehicles are detected when a wheel crosses the tube and generates an air pulse. The pulse triggers an air switch located in the counter, which in turn sends an electrical impulse to the data logger and an "axle event" is recorded.

By using two parallel tubes separated by a known distance (typically one metre), rubber tube traffic counters can measure the speed (and direction) of vehicles crossing the tubes, as well as the distance between wheels or axles. Using these principles, many road controlling authorities now undertake classified traffic counts where the composition of traffic is measured based on recognised vehicle "footprints" from axle spacings. What was unknown in the New Zealand traffic engineering community, however, was whether traffic counters were able to detect and record bicycles, which would generate relatively small, weak pulses compared to those generated by motor vehicles.

2.4 Consultation with Practitioners and Suppliers

Several practitioners in New Zealand road controlling authorities were consulted about the current needs for equipment of this type, and any experience with existing technologies and methodologies in use locally. Authorities consulted included the Christchurch City Council, Palmerston North City Council, Hamilton City Council, and Transit New Zealand in Christchurch.

Local and overseas suppliers were contacted to provide technical specifications, product brochures and advice on suitable equipment. As a result of the literature review and consultation, two promising pneumatic rubber tube traffic counters were tested:

- **Golden River Traffic Marksman 410 Bicycle Classifier**
  The Golden River Traffic Marksman 410 (GR M410) measures tyre contact width and claims to be able to distinguish between bicycles and other traffic. Its product brochure on the Internet claims: *"The Marksman 410 counter-classifier is a general purpose traffic recorder but also ideal for bicycle counts... "*.

- **MetroCount 5600 Vehicle Classifier System**
  The MetroCount 5600 (MC 5600) claims *"our adaptive auto-ranging axle sensors (or "air switches") will detect a huge variety of vehicles, from bicycles to heavy vehicles, without any user-adjustment"*.

Both counters are designed for short-term traffic surveys (up to a few weeks) and many road controlling authorities (or their contractors) already operate similar equipment as part of their routine traffic count programmes. The counters would be particularly useful if they proved successful at counting (and classifying) bicycles simultaneously with motor vehicles. Product brochures from the Internet are contained in Appendix B and the counters are illustrated in Figure 2.1 below.

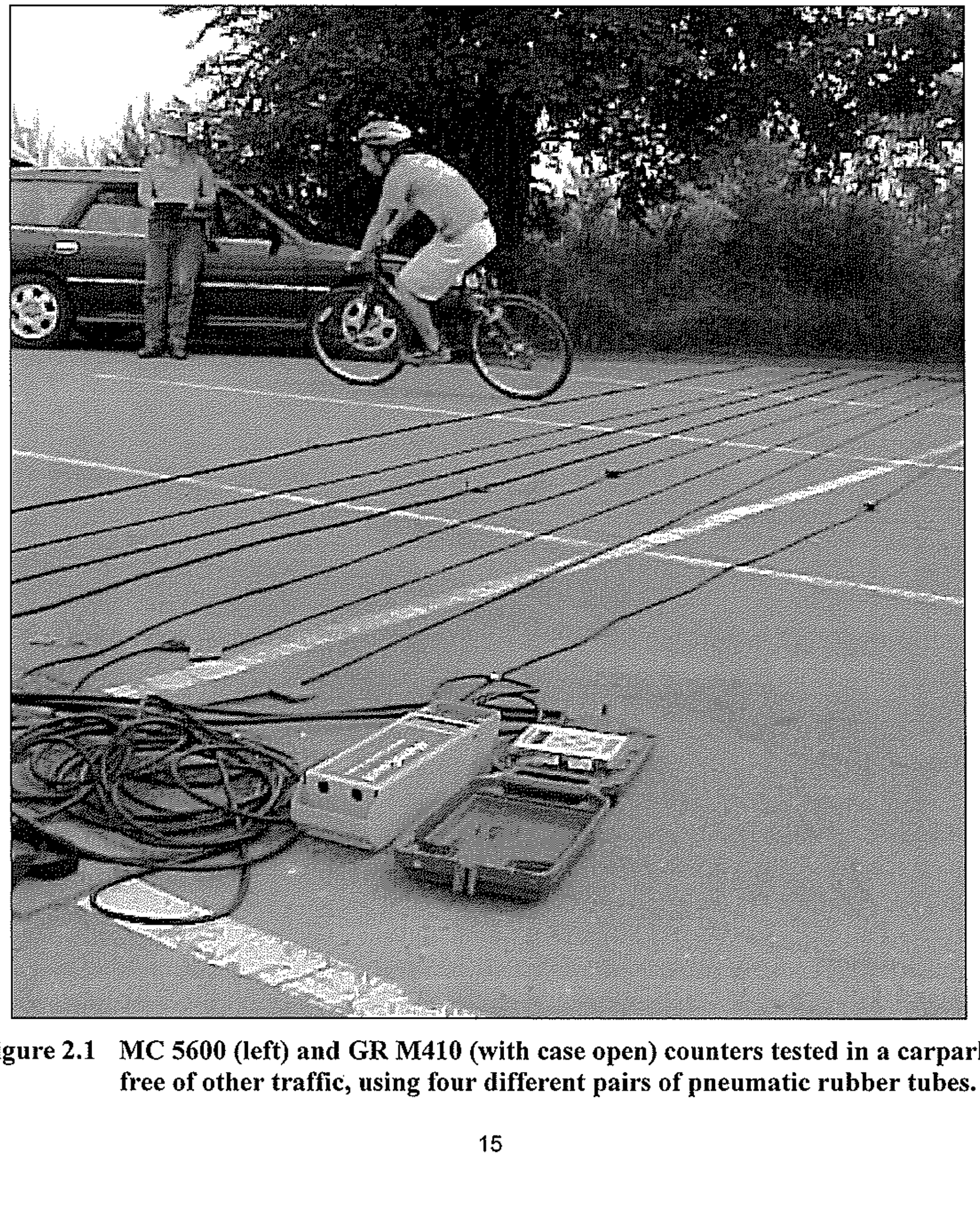


Figure 2.1 MC 5600 (left) and GR M410 (with case open) counters tested in a carpark, free of other traffic, using four different pairs of pneumatic rubber tubes.

3. Data Collection

3.1 Site Selection

Three sites were selected for testing to simulate a range of different traffic environments found on New Zealand roads. A map of the on-street testing sites is contained in Appendix C. The MWH car park was also used to test the counters with a variety of different rubber tubes in controlled conditions, without interference from motor vehicles.

The Armagh Street entrance to Christchurch's Hagley Park was used initially to test the equipment. This site was chosen as it contains a relatively high volume of cyclists coupled with low motor vehicle speeds and volumes (approximately 1,500 motor vehicles per day). These conditions permitted simple equipment installation and testing, and provided preliminary data for experimenting with downloading and analysis.

Further testing at Kilmarnock Street, east of Darvel Street, aimed to check the accuracy of the counters on medium volume urban roads. Kilmarnock Street, a Christchurch City Council (CCC) street with an average annual daily traffic volume (AADT) of about 13,000 vehicles per day, has a 50 km/h speed limit.

Figure 3.1 Marshland Road test site.

Marshland Road north of McSaveneys Road was selected as a trial site because of its similarity to a rural New Zealand State Highway environment (Figure 3.1). Marshland Road, also under the jurisdiction of the CCC, has a wide carriageway with large roadside verges in a rural setting. The speed limit is 80 km/h and the road has an AADT of about 22,000 vehicles per day. This was expected to be the most challenging condition for counting bicycles. If traffic counters could count bicycles successfully here, they would be able to do so on almost any street or road in New Zealand.

3.2 Data Collection Methodology

Manual counts were undertaken simultaneously with the machine counts to evaluate the effectiveness and accuracy of each counter. A bicycle ridden by a staff member was used to ensure that an adequate sample of cycles was recorded (rather than waiting for the random arrival of members of the public travelling by bicycle). It was decided that about 50 manually counted bicycles would be an adequate minimum sample size. Typically, this required a survey period of between 15 and 30 minutes, which was also sufficient to obtain a reasonable sample of motor vehicles.

All data collection was undertaken in dry, sunny weather in normal traffic operating conditions. Most testing was performed during several mornings after the peak flow period. Initially, trials were undertaken at all three mixed traffic sites: Armagh Street, Kilmarnock Street, and Marshland Road. The aim of these trials was to develop the methodology, experiment with the installation and operation of the equipment, and gain an initial understanding of the effectiveness of the counters in mixed traffic.

While the GR M410 counted bicycle traffic well, poor results (detection of fewer than half of the bicycles at each location) by the MC 5600 suggested the need for a second phase of testing. It was surmised that the poor results from the counter were related to the type of rubber tube. The second phase consisted of a series of tests conducted in a controlled environment in the researcher's carpark. The aim was to isolate bicycles and see how effective the counters were at detecting and recording bicycles in the absence of other vehicles. Consequently, in this phase, four different types of tubes were tested on each machine with the aim of finding the best tube type for each counter.

With the GR M410 machine, Harding Traffic supplied a multi-purpose set of pneumatic rubber tubes recommended for detecting both motor vehicles and bicycles. The tubes were similar to commonly used, cylindrically shaped traffic counting tubes, and appeared to be durable. The tubes were 15 m long (although the supplier subsequently advised that the desirable tube length was between 4 m and 8 m) with a 13 mm external diameter.

Initially MetroCount supplied bicycle tubes that had a small external diameter (9 mm) with thin walls. The tubes were supplied in standard 30 m lengths, allowing two 15 m tubes to be made. They were very soft in comparison to traffic counting tubes currently used by road controlling authorities (and softer than the Golden River tubes). MetroCount later (in response to the poor preliminary results achieved with the MC 5600) supplied two further sets of tubes; a set of conventional motor vehicle tubes, and another set of bicycle tubes. The bicycle tubes were of much harder rubber than the original bicycle tubes supplied. In these tests, the GR M410 counted all bicycles with the Golden River tubes but the MC 5600 still counted unreliably, with only 42% of bicycles counted using the original (soft) MetroCount tubes. No bicycles were detected with the other three sets of tubes.

The next phase of testing was to install the equipment again in mixed traffic environments. Here it was not considered necessary to test the Armagh Street site again, but rather to test the machines at the more demanding Kilmarnock Street and Marshland Road sites. For these tests, the Golden River tubes were used with the GR M410 machine and the MetroCount soft bicycle tubes were used with the MC 5600 counter. The bicycles observed during these tests were, overwhelmingly, bicycles ridden by research staff. Care was taken to ensure that bicycles did not cross the counter tubes simultaneously with motor vehicles, as this could have resulted in erroneous vehicle classification. The MC 5600 was still not counting reliably at the conclusion of this phase, and detected only 45% of bicycles.

The thinner tyre width of racing or 10-speed bicycles might result in these cycles not being counted accurately, compared with mountain bikes which have a greater tyre width and thus generate a stronger air pulse. However, this possibility was discounted at Kilmarnock Street where both types of bicycle were detected well by the GR M410, and equally poorly by the MC 5600. This phase of the research is illustrated in Figure 3.2.

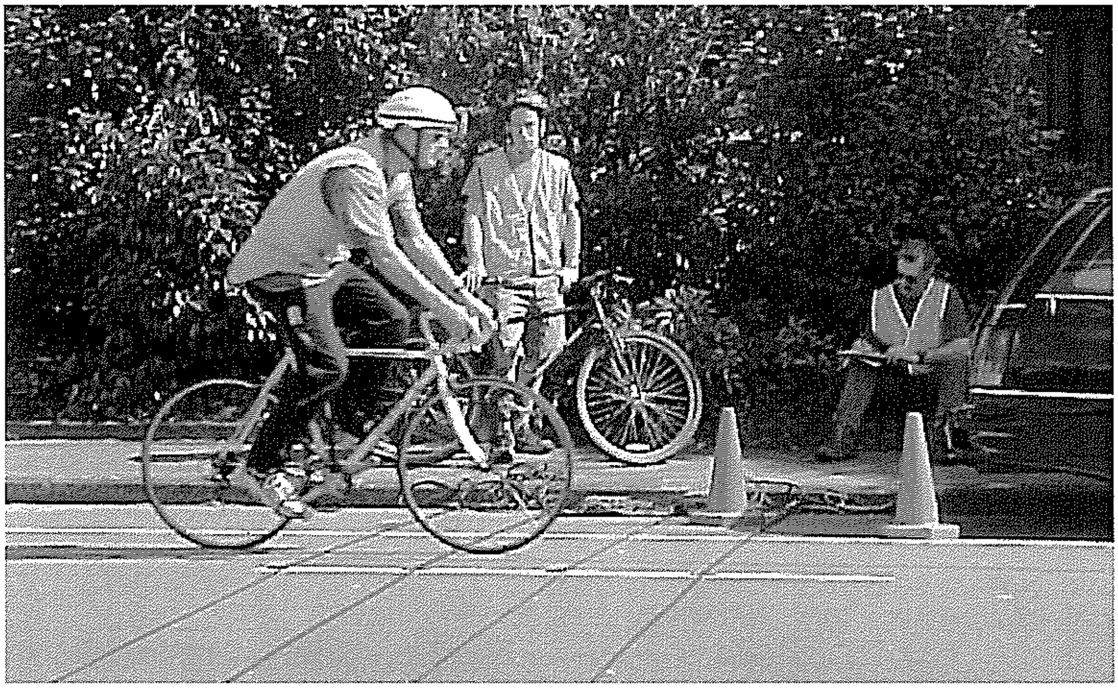


Figure 3.2 Testing different bicycle tyre types (10-speed cycle on left, mountain bike on right) at Kilmarnock Street.

It is possible that different air pressures in bicycle tyres may also have an effect on the strength of the pulse generated but this was not tested.

While this research was being conducted, Palmerston North City Council staff were also testing the MC 5600 and had succeeded in counting bicycles accurately. As Palmerston North staff had used shorter tubes (5 m or less), the research team in Christchurch decided to test different tube lengths with the MC 5600 counter.

The final set of tests was conducted at the Marshland Road site, with high motor vehicle speeds and thus relatively severe conditions for testing the equipment. The

GR M410 was not tested at this stage, as it had already demonstrated its capability well. In this phase, both 5 m and 10 m tubes were used (instead of 15 m) with the MC 5600, with the tubes extending only across the road shoulder to detect bicycles. These shorter tubes were also used in combination with motor vehicle tubes connected to the end of the bicycle tubes. The motor vehicle tubes extended over the traffic lane to test whether motor vehicles could also be detected simultaneously.

3.3 Equipment Set-up

3.3.1 Set-up Procedures

Using a personal computer (PC), the GR M410 could be programmed to start a survey immediately or to start at some pre-determined future time. Another option was to programme a survey to start at any time on site using a keypad on the counter. However, from a user perspective, the survey was easier to programme via a PC terminal.

The MC 5600 required a PC to set up surveys. As with the GR M410, surveys could be started immediately or at a specified future time. Starting the machine on site could also be done using a portable PC such as a "laptop" computer.

3.3.2 Layout in the Field

The set-out of the rubber tubes was documented in the material supplied by the manufacturers of the counters. Both systems tested required two tubes, spaced typically 100 cm apart, to be firmly fixed to the pavement. If the tubes spanned two lanes, the counter manuals recommended placing fixing straps at each edge of the carriageway, on the centreline, and in the centre of each lane. This prevents the tubes rolling as a vehicle passes over them, which can lead to incorrect measurement of wheel-bases and speeds.

Before each survey, the GR M410 counter needed to be calibrated for bicycle detection. This was done using a keypad on the counter and involved recording at least five passes of a bicycle.

3.4 Software Analysis

3.4.1 Golden River Marksman 410

Golden River's "Target Lite" Windows-based data analysis and presentation program is recommended for use with the GR M410 counter. The software can also be upgraded for more detailed analyses. Software was inadvertently not supplied with the GR M410 counter leased by the researcher, which resulted in considerable difficulty downloading and analysing data.

Without the benefit of the appropriate software, the downloading process for the GR M410 was substantially more difficult than for the MC 5600 machine. The data were first retrieved from the counter using Golden River's Windows-based "front end" software. Following this operation, data files were then converted into text files using Golden River's "GRformat", a DOS-based program. Finally, the text files were analysed in a conventional spreadsheet. Sample data printouts (in spreadsheet format) for both counters are contained in Appendix D.

With the Golden River system, once the survey type has been selected in the survey set-up process, it cannot be changed. This means that during the analysis stage it is not possible to change to a different classification scheme, or to request an individual vehicle report rather than a time interval report. In the view of the researchers, this is the major disadvantage of this system. The GR M410 does its data processing within the counter rather than recording axle events and allowing a full range of analyses to be performed subsequently using the software.

3.4.2 MetroCount 5600

The MetroCount Classifier System is a combination of both a counter and PC-based software, "Traffic Executive". The counter records and stores every detection as a time-stamped axle event. This is a major advantage as it enables the user to obtain and manipulate a variety of outputs and change classification systems at the data analysis stage.

MetroCount's Windows-based software "MCSurvey" was used to download the data from the counter onto a PC for analysis. The software has the ability to retrieve data either after the survey is finished or while the counter is still logging.

4. Results

4.1 Golden River Marksman 410

The GR M410 performed well from the outset. It counted all bicycles in the controlled environment of the researcher's carpark. In the on-street, mixed traffic environments of Armagh Street, Kilmarnock Street and Marshland Road, the results of counting are recorded in Table 4.1.

Table 4.1 Testing the GR M410.

Site	Environment	No. of Lanes	Manual Count	Machine Count	Accuracy %
Armagh St	Urban	2	122	117	96
Kilmarnock St	Urban	1	155	142	92
Marshland Rd	Semi-Rural	1	150	150	100
Total			**427**	**409**	**96**

The GR M410 counted bicycles at acceptable levels of accuracy within the scope of the study. Although the recorded average of three tests (as shown above) was 96%, it is possible that the counter was 100% accurate, because the team member counting bicycles was also counting and classifying motor vehicles, and in these circumstances it would be easy to under-count or over-count a few bicycles. In the car park testing, the GR M410 appeared to over-count bicycles by 4% (104 recorded by machine and 100 manually), which was probably a result of manual under-counting. As with much research, the methodology was refined as the research continued. By the time final tests were performed on the MC 5600, two or three staff were counting bicycles to ensure a reliable count, and motor vehicles were merely counted (not classified). The conclusion from the GR M410 tests was that the counter was accurate at counting bicycles.

4.2 MetroCount 5600

After much preliminary (and somewhat unsuccessful) testing of the MC 5600 at all three sites and in the consultant's carpark, a final series of tests was undertaken at the Marshland Road site. Many potential sources of error had been eliminated in the earlier testing, and the remaining variable appeared to be tube length. The results of testing the tube length are shown in Table 4.2.

Table 4.2 Testing the MC 5600.

Test Description	Bicycle Tube Length (m)	MV Tube Length (m)	Combined Tube Length (m)	Manual Count	Machine Count	Accuracy %
Bicycles only	5	0	5	50	50	100
Bicycles + MVs	5	3.5	8.5	47	47	100
Bicycles only	10	0	10	45	45	100
Bicycles + MVs	10	3.5	13.5	49	42	86

MV – motor vehicle

The research demonstrated that, with tubes not longer than 10 m, the counter performed accurately, but that accuracy declined as the tube length increased. At 13.5 m length (10 m of bicycle tube with an additional 3.5 m of conventional traffic counting tube to span the general traffic lane), the accuracy dropped to 86%. The earlier work had shown that with 15 m tubes the accuracy of the machine at counting bicycles was around 42% to 45%, although motor vehicles, which generate a stronger air pulse, were still counted satisfactorily. This suggests that with 10 m tubes the counter is reliable for counting bicycles, but accuracy declines with tubes longer than that.

Bicycle speeds were tested as part of this phase of the research. When bicycle speeds fell below 10 km/h, the MC 5600 would not detect bicycles. In practice, this would not be an issue on flat ground or a downhill grade, but uphill grades should be avoided as bicycle counting locations where possible. The reliability of the GR M410 was not specifically tested in relation to bicycle speed, but a number of bicycles were recorded travelling between 5 km/h and 10 km/h.

4.3 Further Discussion

4.3.1 AADT Limits for Simultaneous Counts of Bicycles and Motor Vehicles

At modest motor vehicle traffic volumes, the likelihood of bicycles and motor vehicles being on or close to the counter tubes simultaneously (and thus resulting in false bicycle or motor vehicle detection) is relatively small. This research did not quantify this aspect of potential error.

CCC staff responsible for traffic counting use one counter with tubes spanning both sides of a road when the AADT is less than about 8,000 motor vehicles per day. In the absence of further research or evidence, extending this rule of thumb using similar logic would seem prudent, with the following suggested guidelines (Table 4.3).

Table 4.3 Suggested arrangements to count bicycles and motor vehicles (MV) simultaneously.

AADT* (MV per day)	Pneumatic Rubber Tube Arrangement	Number of Counters
< 7,000	One pair of tubes spanning road	1
> 7,000 but < 14,000	One pair of tubes spanning each side of road	2
> 14,000	One pair of tubes for each shoulder or bicycle lane; One pair of tubes for each general traffic lane	4 or more

* Assumes that bicycle traffic flows will typically be less than 1,000 vehicles per day.

Further research is recommended to review these limits and modify them as necessary.

4.3.2 Counting Cyclists on Footpaths

In some locations, conventional automatic traffic counts will miss important bicycle flows where cycling on footpaths is common. This can be quantified by undertaking separate automatic counts on the footpaths in question. The machines are able to distinguish bicycles from skateboards and scooters, which have shorter wheel-bases. Where cyclists on footpaths are travelling at very low speeds (for example where very young children are present), the GR M410 would be superior to the MC 5600.

4.3.3 Vehicle Classification Systems

Currently no standard New Zealand or Australasian vehicle classification scheme is available that classifies bicycles separately from other vehicles. AUSTROADS[2] in 1994 developed a vehicle classification system (AUSTROADS94) with 13 classes, with one class including cars, utility vehicles, four-wheel drives, motorcycles and bicycles. The AUSTROADS ARX scheme is a later version which separates bicycles and motorcycles from other small vehicles (such as cars), and also accomplishes this within 13 classes by amalgamating double and triple road trains as the largest vehicle class. But bicycles are still not distinguished from motorcycles. The AUSTROADS ARX scheme is generally not used in New Zealand. Transit New Zealand's current 14-class system (TNZ 1999), like AUSTROADS94, groups bicycles, motorcycles and cars in the same class. These classification systems are documented in Appendix E.

Of the vehicle classification systems used in New Zealand, AUSTROADS94 is the only one offered by Golden River. The use of a spreadsheet is necessary to separate bicycles from cars (and motorcycles) on the basis of wheel-base. Golden River is understood to be currently working on adding the TNZ 1999 classification system to its traffic counting machines.

The MC 5600 machine can provide traffic counts based on the AUSTROADS94, AUSTROADS ARX and TNZ 1999 systems. The MetroCount Traffic Executive software is also able to group vehicles into six standard vehicle classifications (car, light commercial vehicle, medium commercial vehicle, two classes of heavy commercial vehicles, and buses) to comply with Transfund's Project Evaluation Manual. Bicycles, however, are currently not recognised in Transfund's six-class system. MetroCount's latest software version allows users to define their own vehicle classes but developing a standard New Zealand or Australasian classification system would be preferable.

This research shows that bicycles and motor vehicles can be distinguished using commercially available traffic counting equipment. Furthermore, bicycles can be separated from motorcycles, as bicycles typically have wheel-bases of 120 cm or less (most are around 100 cm to 110 cm), while motorcycles are typically 140 cm or more.

Transfund has recently modified its procedure for economic project evaluation to recognise the health benefits which accrue to society when people cycle[3].

---

[2] Association of Australian and New Zealand Road Transport and Traffic Authorities.

[3] See footnote on p.11.

Quantification of the economic benefits of cycling depends on estimates of actual or anticipated numbers of cyclists. While both traffic counters tested are capable of distinguishing and recording bicycles, the existence of a standard vehicle classification system would assist practitioners in analysing, storing and reporting traffic counts, including bicycle traffic. Liaising with traffic counter manufacturers would also be prudent, to ensure that any new classification systems can be supported by commercially available hardware and associated software.

Given the increasing importance of cycling from a policy perspective, the time seems right to recognise bicycles as a separate vehicle class in routine traffic counting and the underlying vehicle classification systems.

4.3.4 Determination of AADTs for Bicycle Traffic

Bicycle traffic can be extremely variable from day to day, and from season to season, on any given road. Consequently, estimates of AADT for bicycles based on manual counts of a few hours may grossly under-report or over-report reality. This research has demonstrated that manual bicycle counts of a few hours can be replaced with automatic counts of a few days (or weeks, if necessary), greatly improving the potential for reliable bicycle traffic surveys. A seasonal factoring system developed from a series of bicycle counts conducted throughout a year on a range of roads would allow reliable AADTs for bicycles to be determined. Further research is recommended in this area.

4.3.5 Long-term Counting of Bicycle Traffic

Tube counters are not ideal for long-term counting of traffic. They may be subject to vandalism or theft and require on-going maintenance to ensure that the hardware (especially the tubes) is still properly installed. A number of alternatives to pneumatic rubber tubes exist in the traffic sensor market, and they may have the potential to accurately count bicycles and provide useful data, particularly for long-term counts at fixed locations. Further research is recommended in this area.

5. Conclusions

A number of conclusions were drawn from the research:

1. Both counters performed satisfactorily and are recommended for use in New Zealand for counting bicycles, either off-street or on-street.

2. Bicycles can be counted accurately in mixed traffic as part of routine automatic traffic counts in both urban and rural environments.

3. Both motor vehicles and bicycles can be counted simultaneously and classified by vehicle type, using commercially available traffic counting machines.

4. On roads with modest motor vehicle traffic volumes (up to approximately 7,000 motor vehicles per day), counts of both bicycles and motor vehicles can be carried out simultaneously using one traffic counting machine.

5. Pneumatic rubber tube traffic counters appear to be the most cost-effective technology currently available for counting bicycle traffic automatically for short-term durations (typically up to one or two weeks).

6. Other rubber tube traffic counters may be able to count bicycle traffic accurately in mixed traffic. Other types of traffic counters (such as inductive loop detectors) may be more suitable for longer term bicycle counting.

7. The GR M410 is a specialised bicycle counter which can count bicycles and different classes of motor vehicles at the same time. It can count bicycles wherever they are ridden (even at slow speeds). The counter can count bicycles and motor vehicles accurately using rubber tubes up to 15 m in length.

8. The MC 5600 traffic counter is a general purpose vehicle counter which is able to count bicycle traffic. It can detect and count bicycles accurately if they are travelling faster than 10 km/h. The machine can count bicycles (and motor vehicles) accurately using rubber tubes up to 10 m in length.

9. Of the two machines tested, the GR M410 counts bicycles better than the MC 5600 at slow speeds (under 10 km/h), but its data analysis software is not as versatile or user-friendly as that of the MC 5600.

10. The GR M410 uses more durable rubber tubes than the MC 5600.

11. Vehicle classification systems currently in use in New Zealand need to be updated to recognise bicycles as a class of vehicle distinct from motorcycles, cars, and other motor vehicles.

12. The research shows that automatic bicycle counting is feasible and relatively easy to do as part of routine traffic counting. It is now up to road controlling authorities to apply the research and count bicycles at key locations.

6. Recommendations

It is recommended that:

1. When automatic bicycle traffic counts are required, they should be undertaken using special bicycle-sensitive rubber tubes as recommended by traffic counter suppliers or manufacturers.

2. When a road's AADT is less than 7,000 motor vehicles per day, one counter can be used to record both motor vehicles and bicycles.

3. When a road's AADT is greater than 7,000 but less than 14,000 motor vehicles per day, one counter should be used on each side of the road to record motor vehicles and bicycles.

4. When a road's AADT is greater than 14,000 motor vehicles per day, one counter should be used in each motor vehicle and bicycle lane (or typical bicycle trajectory).

5. When using the GR M410 for counting bicycle traffic (with or without motor vehicle traffic), the rubber tubes should not be longer than 15 m.

6. When using the MC 5600 for counting bicycle traffic, the rubber tubes should not be longer than 10 m, and the survey site should not be located on an incline.

7. When using the MC 5600 for counting both bicycle and motor vehicle traffic, composite tubes should be used. These consist of bicycle counting tubes at the edge of the road (to detect bicycles) joined to conventional traffic counting tubes in the centre (to detect motor vehicles).

8. Road controlling authorities should count bicycle traffic as part of routine automatic traffic counts.

9. Transfund should ensure that a national or Australasian standard for automatic traffic counter vehicle classifications is developed and implemented to include bicycles as a separate class of vehicle from other vehicles.

10. Transfund should commission further research to develop robust methods to estimate AADTs for bicycles based on short-term automatic bicycle counts.

11. Transfund should commission further research to establish appropriate AADT limits for simultaneous counting of bicycles and motor vehicles with one traffic counting machine.

12. Transfund should commission further research to establish recommended traffic counting technologies for long-term bicycle counting at control stations.

Appendix A – Relevant Internet Sites

Relevant Internet Sites

http://www.transtat.dtlr.gov.uk/ltplans/trnsprt2.pdf

http://www.metrocount.com/products/

http://www.goldenriver.com/countclass/classifiers.html

http://www.bcn.es/velo-city97/velocite.htm

http://www.city.vancouver.bc.ca/engsvcs/transport/cycling/pdf/12aReview.pdf

http://www.macog.com/macoghom/mstraf.htm

http://www.dot.state.mn.us/research/bienrpt/sec8.pdf

http://www.bikeplan.com/4esteps.htm

http://www.dor.state.ne.us/transplan/docs/TMS-Demo/ppframe.htm

http://www.roads.dtlr.gov.uk/roadnetwork/research/compend/2001/03.htm#117

http://www.basicon.com/dai/products/xcounter.html

http://www.wsdot.wa.gov/ppsc/research/onepages/WA-RD3701.HTM

http://www.tlcnetwork.org/_Email/00000107.htm

http://www.peektrafficinc.com/

http://www.barkertechnics.com.au/

http://www.utmc.dtlr.gov.uk/utmc26/pdf/d2v9d.pdf

http://www.odot.state.or.us/region1/f_news/news0325.htm

http://achd.ada.id.us/images/pdfs/news919.pdf

http://www.orincon.com/itms/reno.htm

http://www.dot.state.wi.us/dtd/hdist2/monitor/detectors.htm

http://tucson.sie.arizona.edu/ATLAS/meidareport5.htm

http://www.bikeplan.com/signal.html

http://www.ci.berkeley.ca.us/planning/advance/bikeresources.htm

http://www.octa.net/streets/bikes/chapter6.pdf

http://www.bikefed.org/PDF/chapt9.pdf

http://www.sofrel.com/GB/Remote/Route/frProd.asp

http://www.irdinc.com/english/html/prod/tcc.htm

http://www.ornl.gov/dp121/piezo.htm

http://www.msiusa.com/piezo/traffic_sensors.htm

http://www.dot.state.mn.us/metro/warrant/edu/

http://home.vicnet.net.au/~arrb/pubs/245.htm

http://www.traficon.be/

http://www.siemenstraffic.com/

http://sunshinetraffic.com/

http://www.jamartech.com/prod04.htm

http://imagesensing.com/Products.html

http://www.neverfail.com/NewFiles/Products.html

http://www.editraffic.com/products/detectors/index.htm

http://www.econolite.com/company/overview/overview.htm

http://www.renoae.com/prod01.html

http://www.exceltech.com.au/

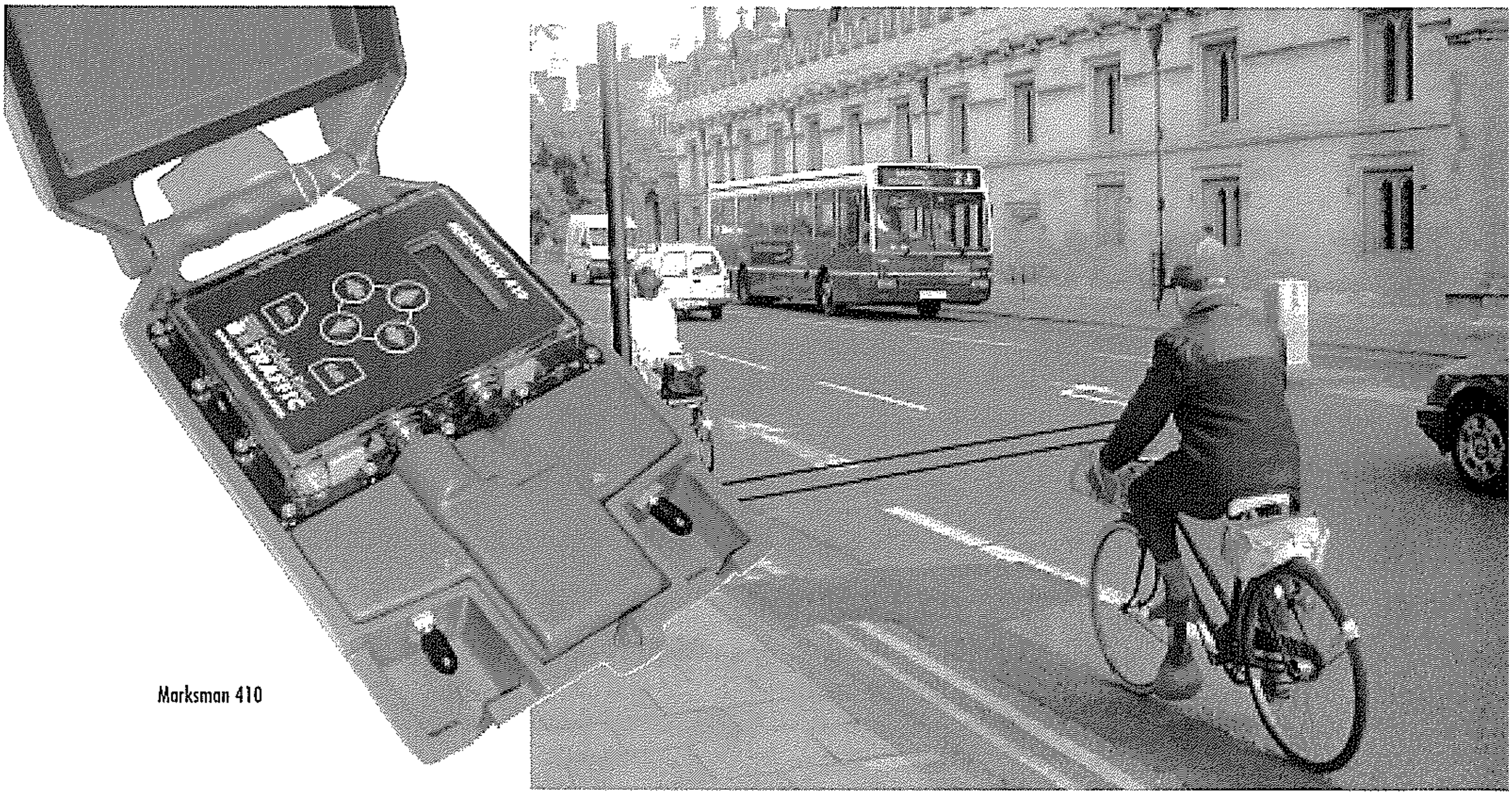
http://www.transfo.com/detect.htm

Appendix B – Product Information

- GR M410
- MC 5600

Golden River **TRAFFIC**

M410 Bicycle Counter
Mixed Traffic Counting



Marksman 410

ACCURATE BICYCLE COUNTING IN MIXED TRAFFIC

- ***Class, speed, headway and more***
- ***Automatic bicycle calibration facility***
- ***Ideal for park & ride studies***
- ***One month plus from two D-size alkaline cells***
- ***No new training for existing MK660 users***
- ***Low purchase and operational costs***

The Marksman 410 counter-classifier is a general purpose traffic recorder but also ideal for bicycle counts. Whilst offering highly sophisticated data collection, it is a flexible and easy-to-use system. When normal counting is required, it is still the most accurate unit on the UK market. With the included powerful analysis software, the Marksman 410 is the easily the best choice.

IN-DEPTH DATA COLLECTION

The 410 offers vehicle-type, speed, wheelbase, and axle-count classification. Data can be collected simultaneously for up to 3 different classifications, (e.g. speed, gap and class) with each classification analysed individually or as a two dimensional data array.

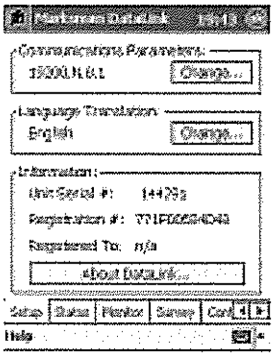
For instance, you may need to look at numbers of vehicles in each speed band, or you may require a more detailed breakdown such as vehicle types within particular speed bands at busy times of the day. The Marksman 410 provide a clear and detailed picture of, for example, bicycles versus other vehicles, but all recorded in the one machine.

Golden River **TRAFFIC**

M410 Bicycle Counter

BICYCLES IN MIXED TRAFFIC

Counting and classifying bicycles in a mixed traffic stream is the ultimate goal of any bicycle monitoring system. The Marksman 410 achieves this through a semi automatic calibration scheme that delivers accurate data for nearly all sites. Uniquely it measures the actual tyre contact width and can thus can easily distinguish between bicycles and other traffic. Even light motorbikes can be included in this classification approach if required.



PC AND LAPTOP SETUP

The new versions of our PC and Lap-top Front-End software makes even complex surveys both quick and easy. Configuration details can be defined and pre-loaded before departure for site using the menus provided. In addition, you can use the Marksman Datalink to setup and monitor the unit.

AUTO CALIBRATION

Once on-site, you only need click "start survey" using the Laptop or Psion software. In addition, you can use all both software setup programs to calibrate the bicycle sensitivity onsite. The Laptop software and DataLink does this semi automatically.

INTERNATIONAL OPTIONS

Most Western languages are supported and you can pick English or Metric units. And you are spoilt for choice on classification schemes: we offer all the popular world schemes.

RUGGED AND RELIABLE

With over 25 years' experience of traffic monitoring around the world, Golden River knows how to deliver products that stand up to the harsh realities of roadside use. The Marksman 410 has a lightweight aluminium case which is easy to carry but can withstand massive abuse and vandalism. The electronics are completely sealed in a clear plastic enclosure, eliminating moisture problems found in competitive brands.

TARGET LITE ANALYSIS

Target Lite is the Windows-based data analysis and presentation program supplied with the 410. With 5 table and 4 graphing options, Target Lite is ideal for reviewing survey results. If you require more detailed analysis or need to group surveys for periodic comparison, you can upgrade to the industry leader Target Standard or Target Professional.

SPECIFICATION

GR 4421 Marksman 410 Vehicle Classifier:
188k memory with padlock and two batteries and with bicycle discrimination class schemes

INPUTS: *2 Tube Sensors*

SERIAL INTERFACE: *300-115,200 baud; odd, even or no parity, 7 or 8 bits; CTS & RTS hardware signal lines*

POWER SUPPLY: *2 alkaline "D" cells.*

BATTERY LIFE: *Typically 5 weeks*

TRAFFIC DATA: *Count, Direction, Speed, Wheelbase, Headway, Gap, Class, Axle Count*

CLASSIFICATION SCHEMES: *Many standard classification schemes including: EUR13 European Standard, CAL15 Californian, FHWA13 US Federal Highway Admin, AUST13 AUSTROADS Scheme, TNZ13 Transit New Zealand, & SWED13 Swedish Administration.*

SOFTWARE FEATURES: *Start and stop times, stop-when-full or rolling barrel memory, battery voltage on-line & in file, ASCII data formats.*

TEMPERATURE: *-5°C to +60°C*

SOFTWARE: *Included: PC & Laptop Front End Package, Target 'Lite' for Windows, GRFORMAT Binary to ASCII PC software for DOS & Windows.*

OPTIONAL ITEM: *6 position keypad & 2X16-character alphanumeric reflective display.*

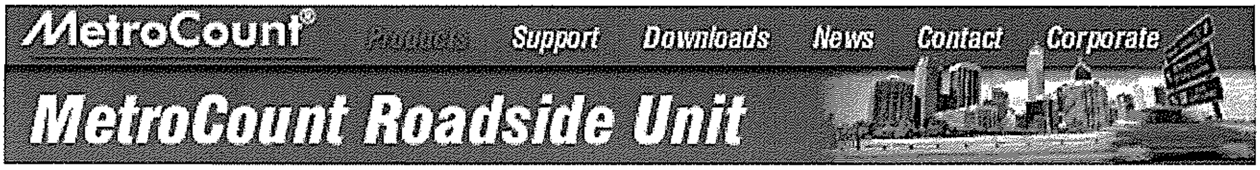
SIZE & WEIGHT: *370 x 220 x 75mm. 4kg (9lbs)*

NEXT STEPS: *Please telephone us on 01869 362800 to discuss your application and get an immediate cost and delivery quote.*

Golden River **TRAFFIC**

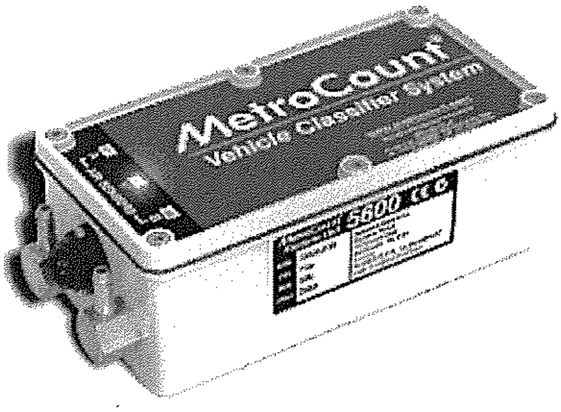
Golden River Traffic Ltd
Churchill Road, Bicester, Oxfordshire, OX26 4XT, United Kingdom
Telephone: **+44 (0)1869 362800** *Fax:* **+44 (0)1869 246858**
email: **info@goldenriver.com** *web:* **www.goldenriver.com**

NQA ISO9001 Registered Company UKAS 015 Certificate No. 11336



MetroCount 5600 Series Roadside Unit

To further improve the user-friendly features of the **MetroCount Vehicle Classifier System**, we have developed the all-new, easy-to-use MetroCount 5600 Series Roadside Unit.



New design for high reliability

The MetroCount 5600's all-new, sophisticated, modular design, with advanced firmware provides extremely high reliability, serviceability and **ultra-long battery life**. Now with a user-replaceable alkaline battery pack and advanced power-saving features, you can survey continuously for 290 days without replacing the batteries (even longer for less frequent use). The Roadside Unit's firmware is designed to prevent premature flat batteries: it automatically powers down when the survey is finished, if the memory is full or if no data is logged for more than a week.

Data collection

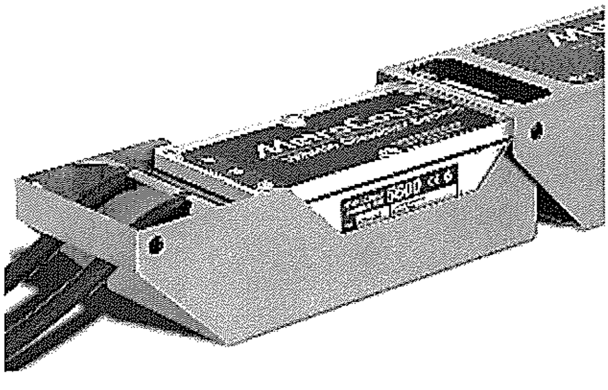
To collect traffic information, the MetroCount 5600 Series Roadside Unit uses two rubber pneumatic tube axle sensors. Unlike most other traffic survey systems, it operates in only one mode: storing every axle - you simply set the logger running. So, you don't need to worry about the traffic information you need before the survey - ALL data is available for subsequent analysis, anytime in the future.

User feedback features

With MetroCount, you have complete control over your survey activities. During site inspections, the Roadside Unit will give you critical feedback, via the software, about memory usage, battery condition or tube problems. Even if you don't have a notebook computer, the MetroCount 5600 Series Roadside Unit's LED indicators will assist you with operating and diagnostic functions.

Adaptive auto-ranging axle sensors

Our adaptive auto-ranging axle sensors (or "air switches") will detect a huge variety of vehicles, from bicycles to heavy vehicles, without any user-adjustment. Say goodbye to end valves, routine calibrations, and other sensitivity adjustments forever.



Protection from the elements

Vital components have "Dual Level" protection: the outer stainless steel road case provides robust mechanical protection, while the electronics and axle sensors are sealed, totally weatherproof, in the Main System Unit's PVC enclosure.
To frustrate vandals, the unique "Drawer" arrangement secures the road tubes without additional fasteners. Virtually any padlock can be used to lock the Roadside Unit while still allowing data access without unlocking. Ergonomic design allows up to four units to be carried easily.

Why use pneumatic tubes?

Detecting axles with rubber pneumatic tube is easily the most cost-effective traffic sensing method, especially for short-term surveys. Pneumatic tubes are cheap, accurate and reliable, and operate effectively over a huge range of environmental conditions.
Throughout the world, all detailed vehicle class schemes are based on axles. Many systems have tried inductive, optical or magnetic methods. Only axle detectors, however, give precise speeds and wheel positions over the entire vehicle spectrum, from motorcycles through to heavy vehicles.
Surveys with traditional tube-based systems may be frequently plagued by tube bounce, vehicle speed and trajectory problems. The MetroCount Vehicle Classifier System, however, has revolutionised the tried-and-tested use of pneumatic tubes. With all axles retained, MetroCount deals with these factors very effectively.

Visit the **Downloads**
section for the latest in:
- Product brochures
- Software demos
- Technical Documentation

MetroCount 5600 Series Features

- All-new, totally weatherproof, modular design for ultra-high reliability.
- Massive memory: 512kB to 2MB. Stores up to 1,000,000 individual axles.
- No classes, speed bins, or time steps required. With all axles retained, you decide later which classes, speeds, etc to report.
- User-replaceable alkaline battery pack, with advanced power saving features for long battery life – survey continuously for 290 days without replacing batteries.
- Automatic shut-down when memory is full, the battery runs low, when not in use, or if no data logged for more than a week.
- Adaptive auto-ranging axle sensors detect bicycles through to heavy vehicles, eliminating sensitivity adjustments, end valves, bleed holes and any other periodic user calibration.
- Adjustable software debounce to eliminate bad tube data.
- Unit issues warnings via the software during site visits, advising of tube or battery problems.
- High intensity LED status indicators to check operation without a computer.
- Robust comms connector with screw-on dust-proof cap.
- Easy-to-carry, stainless steel road case with integral tube clamping to deter vandalism.

MetroCount 5600 Series Hardware Specifications

Internal battery	User replaceable battery pack 6V 18Ah, 4 D alkaline cells
Battery life	290 days at 25°C in continuous Run mode
Current drain	Run – less than 1.8mA. Stop – less than 100µA. Comms – less than 8mA
Memory	512kB, 1MB and 2MB CMOS RAM
RAM backup	3.6V Nickel Cadmium
Baud rate	9,600 or 38,000bps, using Block method with Acknowledge
Sensor type	Pneumatic tube
Time resolution	Better than 1ms
Sensor spacing	800mm to 1200mm
Enclosure	Dual system with outer stainless steel road case and internal PVC Main System Unit
Dimensions	Stainless steel road case – 350mm x 124mm x 95mm. PVC Main System Unit – 243mm x 107mm x 82mm
Weight	Stainless steel road case – 2.5kg Main System Unit without battery pack – 1.06kg Battery pack – 570g
Storage temp	-20°C to 70°C
Operating temp	-10°C to 60°C with reduced battery life at temperature extremes
Operating humidity	0 to 95%, non condensing
Altitude	0 to 3000 metres
Accessories	Traffic Executive™ software Operating and reference manual Data communications cable
Optional accessories	Traffic survey field kit Notebook computer Printer

Estimated Battery Performance*

Duty Cycle	Example of Usage	Battery Life (approx)
100%	Continuous surveys	290 days / 0.8 yr
50%	1 week survey / 1 week off	540 days / 1.5 yrs
25%	1 week survey every 4 weeks	1080 days / 3.0 yrs

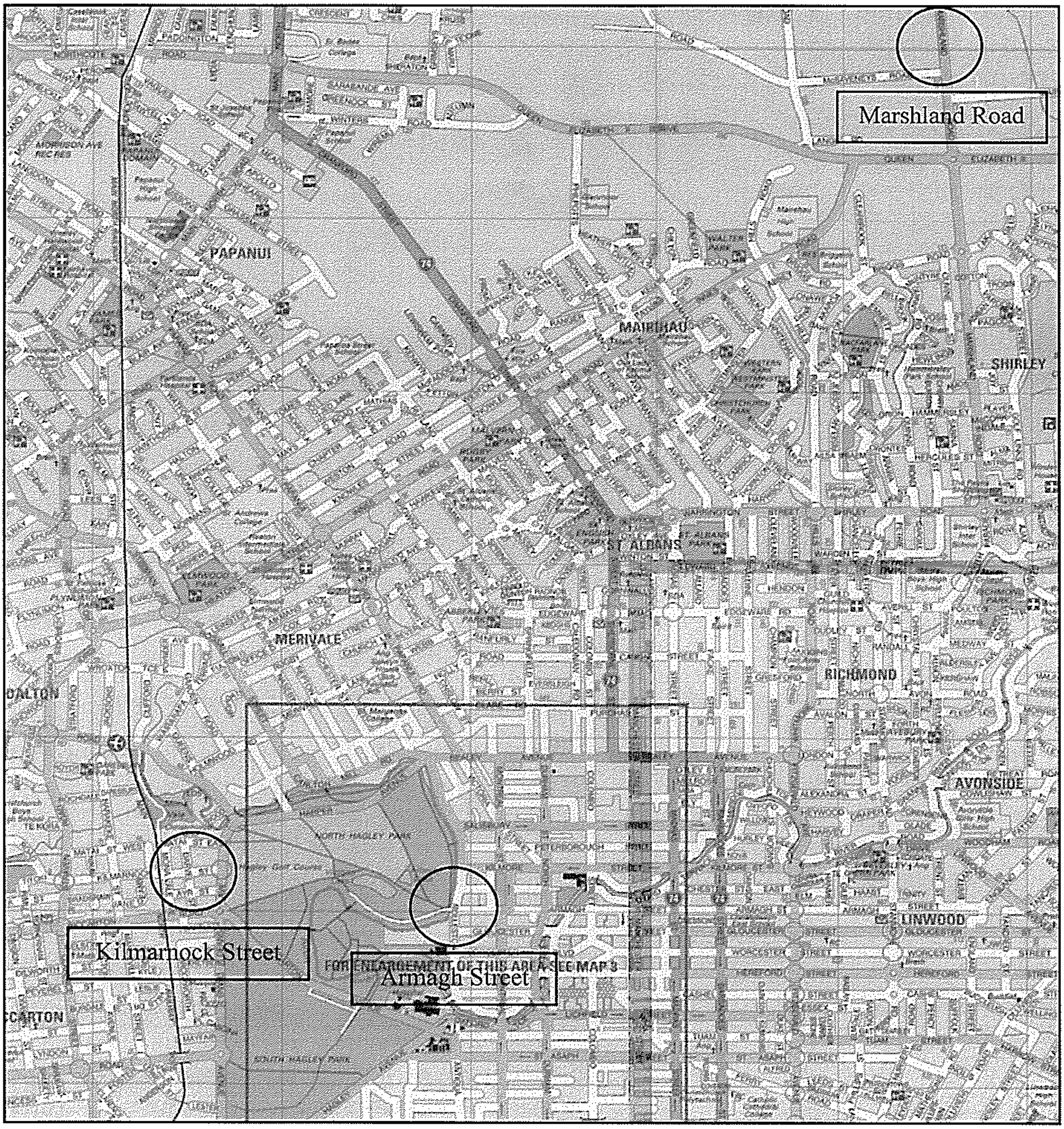
*Based on 4xD alkaline battery pack supplied by MetroCount

Individual Axle Capacity

Memory	Total Axle Events Logged (approx)
512kB	250,000
1MB	500,000
2MB	1,000,000

Appendix C – Trial Site Location Plan

CHRISTCHURCH
TRIAL LOCATION PLAN



Appendix D – Sample Data Printouts

- GR M410
- MC 5600

GR M410 Sample Data Printout

BEGIN	
FORMAT	VBV-2
FORMATTER	GRFORMAT Release 2.2
INSTRUMENT	M400 Serial 87780 Release 1.99
FILENAME	KILMAR2
SITE	KILMARNOCK2
LOCATION	Railway Crossing
GRIDREF	
HEADINGS	
STARTREC	10 11 23 1 2
STOPREC	11 6 23 1 2
BATTERY	2.6 2.6
SENSORS	TT TT
DATEFORM	DD/MM/YY
UNITS	Metric
PRUNITS	KPH-CM-10KG
CLASS	AUST13

HEAD	DDMMYY	HHMM	SS	HH	D	HEAD	GAP	SPD	AX	CS	WB TOT	W 1-2	W 2-3	W 3-4
2488	230102	1011	11	40	1	16.3	16.2	18	2	1	101	101		
2489	230102	1011	27	0	1	15.5	15.3	51	2	1	253	253		
2490	230102	1011	30	10	1	3.1	2.9	50	2	1	254	254		
2491	230102	1012	27	70	1	57.6	57.4	51	2	1	238	238		
2492	230102	1012	34	90	1	7.1	7	48	2	1	250	250		
2493	230102	1013	4	80	1	29.8	29.7	49	2	1	260	260		
2494	230102	1013	6	40	1	1.6	1.4	50	2	1	247	247		
2495	230102	1013	16	50	1	10.1	9.9	53	2	1	233	233		
2496	230102	1013	23	0	1	6.5	6.3	48	2	1	233	233		
2497	230102	1013	40	20	1	17.1	17	51	2	1	240	240		
2498	230102	1013	42	50	1	2.2	2.1	50	2	1	231	231		
2499	230102	1013	51	40	1	8.8	8.7	18	2	1	94	94		

Note:

DDMMYY	Date/Month/Year	SPD	Speed (km/h)
HHMM	Hours/Minutes	AX	Number of axles
SS	Seconds	CS	Vehicle Class
HH	Hundredths of seconds	WBTOT	Wheelbase (centimetres)
D	Direction of vehicle	W1-2	Distance between first and second axle (cm)
HEAD	Headway (seconds)	W2-3	Distance between second and third axle
GAP	Time between vehicles (seconds)	W3-4	Distance between third and fourth axle

The first and last vehicles on this printout were bicycles (with wheelbases 101 cm and 94 cm).

MC 5600 Sample Data Printout

MetroCount Traffic Executive - Individual Vehicles

Individual-4

DATASETS:

Site: **[1234] Test cycle count**
Direction: 8 - East bound A>B, West bound B>A., **Lane:** 0
Survey Duration: 07:00 Fri 14 Dec 2001 to 11:19 Mon 17 Dec 2001
File: P:\2900\801 002985\Data Collection\Trials\Raw .eco .v00 files\Armagh, Kilmarnock.ec0 (Plus)
Identifier: A367HX9J MC56-1 [MC55] (c)Microcom 07/06/99
Algorithm: Advanced

PROFILE:

Filter time: **09:00 Mon 17 Dec 2001 to 11:19 Mon 17 Dec 2001**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 0 - 160 km/hr.
Direction: North, East, South, West (bound)
Headway: All
Scheme: ARX
Name: Factory default profile
Method: Vehicle classification
Units: Metric (m, km, m/s, km/hr, kg, tonne)

Axle Num	Ht	Date	Time	Dr	Speed	Wb	Hdwy	Ax	Gp	Rho	Cl	Nm	Vehicle
00000f46	04	2001Dec17	09:30:20	AB	19.9	1.1	44.3	2	1	1.00	1	00000010	MC oo
00000f4a	04	2001Dec17	09:30:26	BA	47.0	2.8	67.3	2	2	1.00	2	00000010	SV o o
00000f4e	04	2001Dec17	09:30:42	BA	47.5	2.4	15.6	2	2	1.00	2	00000142	SV o o
00000f52	04	2001Dec17	09:30:43	BA	45.9	2.3	1.1	2	2	1.00	2	00000020	SV o o
00000f56	04	2001Dec17	09:30:45	BA	44.9	2.3	1.9	2	2	1.00	2	00000020	SV o o
00000f5a	04	2001Dec17	09:30:47	BA	36.2	2.3	1.9	2	2	1.00	2	00000020	SV o o
00000f5e	04	2001Dec17	09:30:49	BA	40.1	2.6	2.2	2	2	1.00	2	00000020	SV o o
00000f62	04	2001Dec17	09:30:53	BA	40.1	2.8	3.5	2	2	1.00	2	00000010	SV o o
00000f66	04	2001Dec17	09:31:03	BA	77.0	2.6	10.6	2	2	1.00	2	00000020	SV o o
00000f6a	04	2001Dec17	09:31:04	BA	54.3	2.4	1.1	2	2	1.00	2	00000020	SV o o
00000f6e	04	2001Dec17	09:31:06	AB	47.1	2.6	46.7	2	2	1.00	2	00000010	SV o o
00000f72	04	2001Dec17	09:31:24	AB	52.6	2.3	17.4	2	2	1.00	2	00000010	SV o o
00000f76	04	2001Dec17	09:31:40	AB	50.8	2.5	16.6	2	2	1.00	2	00000020	SV o o
00000f7a	04	2001Dec17	09:31:43	BA	48.9	2.4	38.6	2	2	1.00	2	00000010	SV o o
00000f7e	04	2001Dec17	09:31:56	AB	56.4	2.7	15.5	2	2	1.00	2	00000010	SV o o
00000f82	04	2001Dec17	09:32:03	BA	43.6	2.1	20.2	2	2	1.00	2	00000020	SV o o
00000f86	04	2001Dec17	09:32:06	AB	24.9	1.1	9.6	2	1	1.00	1	00000010	MC oo

Note

Ht	Number of axle hits
Dr	Direction of travel of the vehicle (A to B or B to A)
Wb	Wheelbase (m)
Hdwy	Headway between vehicles (seconds)
Ax	Number of axles
Gp	Number of axle groups
Rho	Sensor correlation factor
Cl	Class of the vehicle
Nm	Not defined (technical purposes only)
Vehicle	Class name and scaled wheel picture of the vehicle

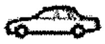
The first and last vehicles on this printout were bicycles (with wheelbases 1.1 m).

Appendix E – Vehicle Classification Systems

- AUSTROADS94
- AUSTROADS ARX
- TNZ 1999

Austroads94

Austroads94 replaced NAASRA in Australia in 1994. It is an improved system using information from the spacings of the first three axles, the total number of axles and the number of axle groups. There are 13 classes.

Level 1	Level 2		Level 3	Austroads Classification			
Length	Axles and Groups		Vehicle Type				
Type	Axles	Groups	Description	Class		Parameters	Dominant Vehicle
Short up to 5.5m	Light Vehicles						
	2	1 or 2	Short Sedan, Wagon, 4WD, Utility, Light Van, Bicycle, Motorcycle, etc.	SV	1	d(1) <= 3.2m and axles = 2	 t
Medium 5.5m to 14.5m	3, 4 or 5	3	Short - Towing Trailer, Caravan, Boat, etc.	SVT	2	groups = 3, d(1) >= 2.1m, d(1) <= 3.2m, d(2) >= 2.1m and axles = 3,4,5	 t
	Heavy Vehicles						
	2	2	Two Axle Truck or Bus	TB2	3	d(1) > 3.2m and axles = 2	 t
	3	2	Three Axle Truck or Bus	TB3	4	axles = 3 and groups = 2	 t
	> 3	2	Four Axle Truck	T4	5	axles > 3 and groups = 2	 t
Long 11.5m to 19.0m	3	3	Three Axle Articulated Three axle articulated vehicle or Rigid vehicle and trailer	ART3	6	d(1) > 3.2m, axles = 3 and groups = 3	 t
	4	> 2	Four Axle Articulated Four axle articulated vehicle or Rigid vehicle and trailer	ART4	7	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 4 and groups > 2	 t
	5	> 2	Five Axle Articulated Five axle articulated vehicle or Rigid vehicle and trailer	ART5	8	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 5 and groups > 2	 t
	>= 6	> 2	Six Axle Articulated Six (or more) axle articulated vehicle or Rigid vehicle and trailer	ART6	9	axles = 6 and groups > 2 or axles > 6 and groups = 3	 t
Medium Combination 17.5m to 36.5m	> 6	4	B Double B Double or Heavy truck and trailer	BD	10	groups = 4 and axles > 6	 t
	> 6	5 or 6	Double Road Train Double road train or Heavy truck and two trailers	DRT	11	groups = 5 or 6 and axles > 6	 t
Long Combination Over 33.0m	> 6	> 6	Triple Road Train Triple road train or Heavy truck with three trailers	TRT	12	groups > 6 and axles > 6	 t
t	Ungrouped Classes						
	t	t	Unclassifiable Vehicle	t	13	t	t
	t	t	Unclassifiable Axle Event	t	0	t	t

Group:	Axle group, where adjacent axles are less than 2.1m apart
Groups:	Number of axle groups
Axles:	Number of axles (maximum axle spacing of 10.0m)
d(1):	Distance between first and second axle
d(2):	Distance between second and third axle

ARX Classification Scheme

ARX is a modification of AustRoads94. It removes class 12, moves all other classes up by one, and inserts a cycle class as class 1.

Level 1	Level 2		Level 3	ARX Classification			
Length	Axles and Groups		Vehicle Type				
Type	Axles	Groups	Description	Class		Parameters	Dominant Vehicle
	Light Vehicles						
Short up to 5.5m	2	1 or 2	Very Short Bicycle or Motorcycle	MC	1	d(1) < 1.7m and axles = 2	 t
	2	1 or 2	Short Sedan, Wagon, 4WD, Utility, Light Van, Bicycle, Motorcycle, etc.	SV	2	d(1) >= 1.7m, d(1) <= 3.2m and axles = 2	 t
Medium 5.5m to 14.5m	3, 4 or 5	3	Short - Towing Trailer, Caravan, Boat, etc.	SVT	3	groups = 3, d(1) >= 2.1m, d(1) <= 3.2m, d(2) >= 2.1m and axles = 3,4,5	 t
	Heavy Vehicles						
	2	2	Two Axle Truck or Bus	TB2	4	d(1) > 3.2m and axles = 2	 t
	3	2	Three Axle Truck or Bus	TB3	5	axles = 3 and groups = 2	 t
	>3	2	Four Axle Truck	T4	6	axles > 3 and groups = 2	 t
Long 11.5m to 19.0m	3	3	Three Axle Articulated Three axle articulated vehicle or Rigid vehicle and trailer	ART3	7	d(1) > 3.2m, axles = 3 and groups = 3	 t
	4	>2	Four Axle Articulated Four axle articulated vehicle or Rigid vehicle and trailer	ART4	8	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 4 and groups > 2	 t
	5	>2	Five Axle Articulated Five axle articulated vehicle or Rigid vehicle and trailer	ART5	9	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 5 and groups > 2	 t
	>=6	>2	Six Axle Articulated Six (or more) axle articulated vehicle or Rigid vehicle and trailer	ART6	10	axles = 6 and groups > 2 or axles > 6 and groups = 3	 t
Medium and Long Combination Over 17.5m	>6	4	B Double B Double or Heavy truck and trailer	BD	11	groups = 4 and axles > 6	 t
	>6	5 or 6	Double or Triple Road Train Double road train or Heavy truck and two trailers	DRT	12	groups = 5 or 6 and axles > 6	 t
t	Ungrouped Classes						
	t	t	Unclassifiable Vehicle	t	13	t	t
	t	t	Unclassifiable Axle Event	t	0	t	t

Group:	Axle group, where adjacent axles are less than 2.1m apart
Groups	Number of axle groups
Axles:	Number of axles (maximum axle spacing of 10.0m)
d(1):	Distance between first and second axle
d(2):	Distance between second and third axle

TRANSIT NEW ZEALAND – VEHICLE CLASSIFICATION SCHEME (TNZ 1999)

Class	Axles	Distinguishing Features or identification algorithm	Vehicle types in class	% of total HMV	Length Range (WiM data)	RUC Class	TNZ Length Class	DKW Class	Austroads Class	Light or Heavy	Axle Groups (Pave. Des.*)	PEM Class
1	2	No. of axles & wb < 3.2m	o-o (short vehicle)				S		1	Light		Car & LCV
2	3	3 axles & sp ax1-ax2 <3.2m or 4axles & (sp ax1-ax2 < 3.2 & > 2.2) & sp ax3-ax4 <=1.0m	o-o-o (short veh towing) o-o-oo (short veh towing)				S/M S/M		2 2	Light		Car & LCV
3	2	No. of axles & wb >=3.2m	o--o (long vehicle)	28	4m-11m	2	M	3,4	3	Heavy	1s,1d	MCV
4	3	No. of axles & sp ax1-ax2 >=3.2m & sp ax2-ax3 <= 2.2m	o--oo	11	7m-12m	6	M/L	5	4	Heavy	1s,2	HCV I
5	3	No. of axles & sp ax1-ax2 >=3.2m & sp ax2-ax3 >2.2m	o-o--o	3	6m-15m	2,24	M/L	7	6	Heavy	1s,1d,1d	HCV I
6	4	No. of axles & sp ax1-ax2 <= 2.2m	oo--oo	4	8m-11m	14	M	6	5	Heavy	1s,1d,1d,1d	HCV I
7	4	No. of axles & sp ax1-ax2 > 2.2m & sp ax3-ax4 > 1.0m	o--o-o--o o-o--oo	2 2	8m-19m 10m-17m	2,30 2,29	M/L M/L	8 8	7 7	Heavy	1s,1d,1d,1d 1s,1d,2	HCV I
8	5	No. of axles	o--oo-o--o o-oo—oo	1 3	16m-19m 11m-17m	6,30 6,29	L/VL L	9 9	8 8	Heavy	1s,2,1d,1d 1s,2,2	HCV II
9	6	No. of axles & sp ax1 - ax2 > 2.2m & sp ax4 - ax5 <= 1.4m	o-oo--ooo	14	15m-18m	6,33	L/VL	10	9	Heavy	1s,2,3	HCV II

Class	Axles	Distinguishing Features or identification algorithm	Vehicle types in class	% of total HMV	Length Range (WiM data)	RUC Class	TNZ Length Class	DKW Class	Austroads Class	Light or Heavy	Axle Groups (Pave. Des.*)	PEM Class
10	6	No. of axles & sp ax1 - ax2 >2.2m & sp ax4 - ax5 > 1.4m	o-oo-o--oo	2	16m-20m	6,37	L/VL	11	9	Heavy	1s,2,1d,2	HCV II
11	7	No. of axles & sp ax1 - ax2 > 2.2m	o-oo--oo--oo (B-train) o--oo-oo--oo (T & T) o-oo--oo-o--o (A-train)	4 4	18m-21m 18m-21m 18m-21m	6,29,29 6,43 6,29,30	VL VL VL	12 13 14	10 10 10	Heavy	1s,2,2,2 1s,2,2,2 1s,2,2,1d,1d	HCV II
12	6,7,8	No. of axles, (6,7 or 8) & sp ax1 –ax2 <= 2.2m	oo--oo-o--o oo--oo-o--oo oo--oo-oo--oo	 9	15m-20m 17m-21m 18m-21m	14,30 14,37 14,43	L/VL VL VL	13 13 13	9 10 10	Heavy	1s,1s,2,1d,1d 1s,1s,2,1d,2 1s,1s,2,2,2	HCV II
13	8,9	No. of axles & sp ax1 - ax2 > 2.2m	o-oo--ooo-oo (B-train) o-oo-ooo-o--o (A-train) o-oo-oo-o--oo (A-train) o-oo--ooo--ooo (B-train)	8	19m-21m 19m-21m 19m-21m 19m-21m	6,33,29 6,33,30 6,29,37 6,33,33	VL VL VL VL	15 15 15	10 10 10 10	Heavy	1s,2,3,2 1s,2,3,1d,1d 1s,2,2,1d,2 1s,2,3,3	HCV II
14			Everything else									
Notes:		wb – wheelbase ax – axle(s) sp – spacing	T&T – truck & trailer	HMV – Heavy Motor Vehicle	WiM – Weigh-in-motion	RUC – road user charges	**S** 0-5.5m **M** 5.5-11m **L** 11-17m **VL** >17m	DKW – Classification in *Traffic Monitoring on SH (2002)*	Classes 11 & 12 not relevant in NZ		Pave.Des. – Pavement Desgn Guide s single tyre d dual tyre	LCV, MCV, HCV – light, medium, heavy commercial vehicles