Author(s) Type of Report & Period Covered:
Bruce Corben and Kathy Diamantopoulou GENERAL, 1987-1993

Sponsoring Organisation(s):
This project was funded through the Centre's baseline research program for which grants have been received from:
Ministry for Police and Emergency Services Roads Corporation (VicRoads)
Royal Automobile Club of Victoria (RACV) Ltd Transport Accident Commission

Abstract:
This study has attempted to identify and develop a wide range of potential countermeasures for targeted application to common pedestrian crash problem types.

Recognising that few proven pedestrian safety strategies and countermeasures exist, this project, while setting out to achieve specific objectives, also endeavoured to be innovative in generating possible solutions to Melbourne's long-standing pedestrian crash problems along arterial roads. In particular, because conventional approaches appear relatively ineffective, countermeasure options have intentionally not been constrained by traditional views and established practices for managing traffic, for providing public transport services and for land use development along Melbourne's arterial roads.

The project aimed to systematically investigate locations and location types with clustering of pedestrian crashes over several years, to identify crash countermeasures and to recommend which countermeasures have the potential for widespread application to other locations with like-problems.

Countermeasure options were identified and, in the case of road and traffic engineering-based measures, were evaluated in terms of their estimated economic worth. Overall, economic benefits were estimated to be well in excess of costs and readily attainable along many of Melbourne's arterial roads.

Actions recommended to improve pedestrian safety include treating the locations investigated as part of this project and developing a program for implementing generic countermeasures. Specifically, high priority should be given to developing, implementing and evaluating generic countermeasures for high pedestrian activity arterial roads. Proposed countermeasures aim to reduce vehicle speeds and road widths, provide medians, especially along Melbourne’s arterial tram routes; increase pavement skid resistance; improve pedestrian level-of-service at traffic signals; use fencing or other barrier types to guide pedestrians; change driver and pedestrian behaviour through targeted, high-profile publicity programs and/or using public transport vehicles and passenger stops; provide safer interaction between pedestrians/passengers and public transport services; target Police enforcement at risky behaviours, and develop local government pedestrian safety and land use planning strategies for high risk areas, with new and existing developments being subject to "safety impact assessments/statements".

It is concluded that, unless there is a willingness and commitment by society and responsible agencies to accepting some loss of traffic capacity and speed of vehicle movement, which may actually be marginal only and be largely confined to non-peak periods, only minor improvements to pedestrian safety can be expected.

Key Words:
(IRRD except when marked*)
Accident, Pedestrian, Speed limit, Traffic engineering, Traffic control devices, Economic analysis, countermeasures*

Reproduction of this page is authorised
Monash University Accident Research Centre,
Wellington Road, Clayton, Victoria, 3168, Australia.
Telephone: +61 3 9905 4371, Fax: +61 3 9905 4363
# Contents

ACKNOWLEDGEMENTS........................................................................................................... ix

EXECUTIVE SUMMARY ........................................................................................................ xi

1. INTRODUCTION .................................................................................................................. 1

1.1 AIMS OF THE PROJECT .................................................................................................. 1

1.2 SCOPE AND BACKGROUND OF THE PROJECT ......................................................... 1

1.3 THE PEDESTRIAN SAFETY PROBLEM IN VICTORIA ............................................. 3

1.3.1 The Magnitude of the Problem ................................................................................ 3

1.3.2 Social Costs of Pedestrian Deaths and Serious Injuries ...................................... 6

1.3.3 Contributing Factors to Pedestrian Crashes .......................................................... 6

1.4 CURRENT APPROACHES AND STRATEGIES TO PEDESTRIAN SAFETY .......... 8

1.5 CURRENT PROGRAMS AND COUNTERMEASURES .............................................. 10

1.5.1 Environmental Improvements .............................................................................. 10

1.5.2 Behavioural Change Measures ............................................................................ 11

1.6 INNOVATION .................................................................................................................... 11

2. PEDESTRIAN CRASHES AT HIGH RISK MELBOURNE LOCATIONS ............... 13

2.1 ROAD ENVIRONMENT FACTORS ............................................................................. 13

2.1.1 Road Location Type .............................................................................................. 14

2.1.2 Road Geometry ..................................................................................................... 16

2.1.3 Traffic Control ....................................................................................................... 17

2.1.4 Road Surface Condition ...................................................................................... 18

2.2 PEDESTRIAN CRASH CHARACTERISTICS ............................................................. 19

2.2.1 Crash Type (DCA) ................................................................................................. 19

2.2.2 Crash Severity ....................................................................................................... 21

2.3 SITUATIONAL FACTORS .............................................................................................. 22

2.3.1 Year of Crash ......................................................................................................... 22

2.3.2 Month of Crash ...................................................................................................... 25

2.3.3 Day of Week .......................................................................................................... 26

2.3.4 Time of Day ........................................................................................................... 27

2.3.5 Light Condition ..................................................................................................... 28

2.4 ROAD USER CHARACTERISTICS ............................................................................. 28

2.4.1 Age of Pedestrian ................................................................................................. 28

2.4.2 Age of Drivers, Motorcyclists and Bicyclists ....................................................... 31

2.4.3 Road User Gender ................................................................................................. 32

2.5 OTHER FACTORS ........................................................................................................ 33

2.5.1 Type of Vehicle ..................................................................................................... 33

2.5.2 Speed Limit ............................................................................................................ 34

2.6 SUMMARY ..................................................................................................................... 34

3. COMMON CRASH CIRCUMSTANCES ......................................................................... 37

3.1 ROAD AND TRAFFIC ENVIRONMENT ..................................................................... 37

3.2 WHEN CRASHES OCCUR ......................................................................................... 38

3.3 PEDESTRIAN CHARACTERISTICS .......................................................................... 39

3.4 PEDESTRIAN BEHAVIOUR ......................................................................................... 40
7. SUMMARY AND COUNTERMEASURE RECOMMENDATIONS ........................................ 65
    7.1 OVERVIEW OF CRASH CHARACTERISTICS ................................................. 65
    7.2 COMMON CRASH CIRCUMSTANCES AT HIGH CRASH LOCATIONS .................. 66
    7.3 GENERIC COUNTERMEASURES ...................................................................... 68
        7.3.1 Traffic Engineering/Management ...................................................... 68
        7.3.2 Road/Physical Engineering ............................................................... 69
        7.3.3 Strategic Planning Measures ............................................................ 69
        7.3.4 Publicity and Behavioural Change .................................................... 69
        7.3.5 Police Enforcement ............................................................................ 70
        7.3.6 Vehicle-Based Countermeasures ....................................................... 70
    7.4 ECONOMIC EVALUATION OF ENGINEERING-BASED COUNTERMEASURES .............................................................................................................. 70
    7.5 RECOMMENDED ACTIONS TO IMPROVE PEDESTRIAN SAFETY ................. 71
        7.5.1 Treatment of Specific Hazardous Locations ...................................... 71
        7.5.2 Development of a Program for Implementing Generic Countermeasures ... 71
    7.6 IMPLEMENTATION ....................................................................................... 72

REFERENCES: ....................................................................................................... 73

APPENDIX 1: LISTING OF MELBOURNE HIGH PEDESTRIAN CRASH FREQUENCY LOCATIONS INVESTIGATED ................................................................. 75
ACKNOWLEDGMENTS

The authors would like to acknowledge the valuable assistance and insights provided by Members of the Project Advisory Committee, which comprised:

- Anne Harris and Ian Woff - RACV
- Samantha Cockfield and Mike Hammond - TAC
- Robert Klein - VicRoads
- Greg Deimos, John Todor and Martin Phillips - Victoria Police
- Peter Cairney - ARRB
- Rob Mc Donald - Department of Justice
- Peter Vulcan - MUARC
- Max Cameron - MUARC.

Thanks are also due to John Sliogeris, Elizabeth Hovendon and Julie Maley (VicRoads), Jared Rechnitzer (MUARC) for assistance with essential historical crash data and its presentation, and to Bruce Mainka (on secondment from VicRoads) for his guidance on a number of countermeasure issues, including the provision of cost estimates for the economic evaluation.
EXECUTIVE SUMMARY

This study has identified and developed a wide range of potential countermeasures for targeted application to common pedestrian crash problem types. An important inference from this study is that few existing pedestrian safety strategies and countermeasures stand out as clearly successful. While progress in reducing serious pedestrian crashes has been very promising since 1990, observed reductions appear to have resulted from the general reduction in serious crashes (e.g. due to drink/driving and speed camera initiatives), rather than programs targeted specifically at pedestrians.

With this in mind, the project, while setting out to achieve specific objectives, sought to be innovative in generating solutions to Melbourne’s long-standing arterial road crash problems. In particular, because conventional approaches appear to have had little direct effect, countermeasure options have not been constrained by the traditional views and established practices for managing traffic, for providing public transport services or for land use development along Melbourne’s arterial roads.

This study aimed to capitalise on the successes of accident black spot programs, undertaken in Victoria, interstate and overseas, which have shown that targeting improvements to high crash frequency locations, routes and areas cost-effectively reduces casualty crashes at treated sites.

The two main aims of this project were to:

- systematically investigate locations and location types with a high concentration of pedestrian crashes over several years, and

- identify pedestrian crash countermeasures for the investigated locations and to recommend which countermeasures have the potential for widespread application to other locations with like-problems.

Countermeasure options were identified and, in the case of road and traffic engineering-based measures, were evaluated in terms of their estimated economic worth. Overall, the results indicated that virtually all proposed countermeasures would be economically worthwhile, delivering, even at modest levels of effectiveness, attractive economic benefits, well in excess of costs. If applied at other Melbourne locations with like-crash problems, the road safety benefits would build quickly across the road network.

While the emphasis of the study was on road and traffic engineering countermeasures, behavioural and, to a lesser extent, vehicle engineering measures were also considered. Recommended actions to improve pedestrian safety are:

1. **Treatment of Specific Hazardous Locations** - implement and evaluate recommended countermeasures at the hazardous routes investigated as part of this project.

2. **Development of a Program for Implementing Generic Countermeasures** - give high priority to developing, implementing and evaluating the following generic countermeasures because of their **high potential** to improve pedestrian safety in high activity arterial road environments:
• reduce vehicle speeds by developing variable speed limit signing or by modifying the design of the road and the roadside;

• reduce road widths, provide medians throughout hazardous sections of arterial roads and, in particular, develop a generic form of median, practical for use along the many Melbourne arterial roads served by trams;

• provide distinctive skid resistant pavements to improve the braking capabilities of vehicles on both wet and dry surfaces, and to beneficially influence driver behaviour;

• improve the level-of-service provided to pedestrians at traffic signals, by reducing signal cycle times, permitting late introduction (and re-introduction) of pedestrian walk phases, extending walk times and, at specific high risk intersections, installing flashing pedestrian warning displays to supplement existing displays;

• install pedestrian fencing or other barrier types on the approaches to and departures from signalised and other pedestrian facilities, to encourage pedestrians to cross at these devices, rather than in the nearby zones of high risk;

• develop high profile publicity programs to educate road users of the hazards to pedestrians crossing Melbourne’s arterial roads, particularly in strip shopping centre environments. Target programs at high risk pedestrian and driver groups;

• develop, in conjunction with the Public Transport Corporation, road safety training programs for tram drivers and safer passenger boarding and alighting arrangements. Use the interior and exterior of trams and tram shelters on hazardous routes to target messages encouraging safe behaviour by both pedestrians and drivers;

• target Police enforcement at unsafe behaviours by pedestrians and drivers, at high risk locations and at high risk times of the day and week;

• develop local government pedestrian safety and land use planning strategies for strip shopping centres, to influence longer term outcomes in high risk areas, with new and existing developments being subject to “safety impact assessments/statements”.

The potential benefits are threefold. Firstly, benefits would accrue from implementing corrective measures at the locations investigated. Secondly, and more importantly, if the proposed measures are applied to like-problems elsewhere across the road network, crash savings will be cumulative and widespread. Thirdly, planning, design and traffic operational features which are intrinsically safer will not only save crashes, but will avoid the need for costly remedial treatments for problems which were predictable.

Resolution of the conflicting objectives which characterise high pedestrian activity routes is essential to successfully treating Melbourne’s long-standing pedestrian crash problem. The central issue in actually implementing some of these generic countermeasures is their incompatibility with maximising arterial road traffic flow. Unless there is a willingness and commitment by society and responsible agencies to accept some loss of capacity or speed of movement, which may actually be marginal only and be largely confined to non-peak traffic periods, there will be few genuine opportunities to improve pedestrian safety along Melbourne’s arterial roads.
1. INTRODUCTION

1.1 AIMS OF THE PROJECT

The two main aims of this project were to:

- systematically investigate locations and location types with a high concentration of pedestrian crashes over several years, and

- identify pedestrian crash countermeasures for the investigated locations and to recommend which countermeasures have the potential for widespread application to other locations with like-problems.

The study also addressed the difficulties of treating long-standing pedestrian crash problems, where the implementation of potential solutions has been impeded by competing objectives. While the emphasis of the study was on road and traffic engineering countermeasures, behavioural and, to a lesser extent, vehicle engineering measures have also been considered.

The potential benefits from identifying and applying these countermeasures are threefold. Firstly, there are direct benefits to be gained from implementing corrective measures at the actual locations investigated. Secondly, and more importantly, if the proposed countermeasures are applied to like-problems elsewhere across the road network, the pedestrian crash savings will be cumulative and widespread. Thirdly, design and traffic operational features which prevent the creation of future problems of the same type will not only save pedestrian crashes, but will also avoid the need for costly remedial treatments for problems which were predictable at the planning and design stages. These benefits are potentially relevant not only to new land use developments but also to the redevelopment of older areas. Overall, this approach attempts to capitalise on traffic engineering safety principles which have been demonstrated to succeed in their more general application to road safety problems.

1.2 SCOPE AND BACKGROUND OF THE PROJECT

This study has attempted to identify and develop a wide range of potential countermeasures for targeted application to common pedestrian crash problem types.

Target crash types can be defined or viewed in a number of ways. Much of the information from crash data analyses and from reviews of the pedestrian safety literature highlight the associations between pedestrian crash occurrence, and environment type and/or geographic location. For example, pedestrian crashes tend to be more concentrated in urban environment types, such as along arterial roads in general, within strip shopping centres in particular, and in local streets for child pedestrian crashes. While progress in reducing the pedestrian crash problem has been very promising since 1990, it may be that the reductions observed in recent years have been the result of the general reduction in fatal and serious injury crashes throughout Victoria (e.g. due to drink/driving initiatives and the speed camera program), rather than as a result of programs targeted specifically at pedestrians.
This study aimed to take advantage of the findings of previous evaluations of accident black spot programs, undertaken in Victoria, interstate and overseas, which have shown that targeting improvements to high crash frequency locations, routes and areas cost-effectively reduces casualty crashes at treated sites.

In summary, the following two areas have been addressed in this study:

1. **Investigation of High Pedestrian Crash Frequency Environment Types**
   
   There are specific and identifiable location types at which clustering of pedestrian crashes occurs. Suburban strip shopping centres and other sections of arterial roads, intersection and mid-block locations within the central business district of Melbourne and high density inner urban/residential developments are all associated with high pedestrian casualty crash frequencies.

   By investigating a group of high crash frequency locations/routes with like-characteristics, the study has attempted to provide a more comprehensive and accurate understanding of the factors contributing to these types of problems. The crash data analyses were supplemented by observational studies of pedestrians in the identified high crash involvement situations. This has enabled generic solutions to be developed for generic problems (e.g. strip shopping centres) on a more reliable basis than when individual locations have been investigated separately. Generic solutions, however, need to allow a degree of flexibility to accommodate site specific circumstances.

   Situations where conventional pedestrian safety measures can be successfully applied have been identified and opportunities have been presented to generate new and innovative countermeasures for use in similar circumstances. These hazardous environments have been known for many years and require a more concerted approach to uncover practical, cost-effective solutions.

2. **New and Improved Solutions for High Pedestrian Crash Frequency Environment Types**

   Past efforts to reduce the number and severity of pedestrian crashes in high pedestrian crash frequency environments have often been frustrated by conflicting objectives such as commercial, other land use and/or traffic flow objectives. For example, there are many situations where lengths of pedestrian fencing in strip shopping centres would effectively direct pedestrians to safer crossing facilities, but such measures are frequently not implemented because of commercial pressures to preserve on-street car parking.

   The continual pressures to implement annual programs of engineering improvements within budget and on time sometimes make it difficult for those responsible for negotiating final design agreements, to resolve such complex, often intractable issues. As a result, less effective approaches are sometimes adopted.

   A major aim of the study was to identify and develop practical, cost-effective solutions to commonly encountered problems of this nature. A wide range of measures was considered, including initiatives aimed at behavioural change, land use and traffic planning, and road/traffic engineering improvements. If an approach which is balanced in terms of safety, commercial objectives, traffic movement objectives, etc., can be developed, there is considerable potential to treat a sizeable portion of urban pedestrian
crashes - a long standing problem, for which few practical and cost-effective solutions have been available.

The development of innovative new approaches was explored through the use of a group of experts in relevant fields. Members of the group were asked to think creatively in generating possible solutions, outside of the traditional boundaries where appropriate. The likely success of this approach is not yet known but, given the high social cost of pedestrian fatal and serious injuries in Victoria, needs only to produce one or two “good ideas” to have been worthwhile.

In addition to describing the results of the investigations outlined above, this report briefly describes the overall pedestrian safety problem in Victoria, particularly in Melbourne, quantifies recent progress in reducing serious pedestrian casualty crashes and summarises current approaches and strategies for improving pedestrian safety. An economic evaluation, incorporating Benefit to Cost Ratios and Net Present Worth values, was also undertaken to estimate the social costs and benefits of generic pedestrian treatments for the high risk Melbourne locations. The report recommends priority areas for countermeasure development, application and evaluation.

The study's recommendations for countermeasure implementation and future research effort give emphasis to the following criteria:

a) identifying ways to achieve both sizeable and cost-effective reductions in pedestrian deaths and injuries;

b) ensuring early reductions, as well as developing approaches which will sustain crash savings in the long term;

c) capitalising on measures and approaches used successfully overseas, elsewhere in Australia and/or which have already been successfully used in Victoria;

d) in parallel with c) above, developing innovative approaches to serious pedestrian safety problems for which current techniques appear inadequate;

e) developing practical approaches and programs which can be readily implemented by State and Local Government agencies.

1.3 THE PEDESTRIAN SAFETY PROBLEM IN VICTORIA

1.3.1 The Magnitude of the Problem
Analysis of data on Victorian road traffic accidents (VIC ROADS, July 1995) shows that pedestrian fatalities in Victoria averaged 144 per annum during the seven-year period between 1983 and 1989. In 1990 there was a dramatic drop to 93 fatalities per year. Fatalities have continued to decline between 1991 and 1994, contributing to a 40% reduction in pedestrian fatalities between the periods 1983-1989 and 1990-1994. Pedestrian fatalities in 1995, however, were 31% higher than in 1994 and included an increase in the number of pedestrian fatalities occurring during “high-alcohol hours”.

For crashes involving serious injuries to pedestrians, the corresponding drop in 1990 was substantial, though less dramatic at 23%. During the period from 1990-1994, serious
injuries to pedestrians fell by 26% compared with the period from 1983-1989. These data are summarised in Table 1.1 and illustrated in Figures 1.1 and 1.2, below.

<table>
<thead>
<tr>
<th>Year</th>
<th>Persons Killed</th>
<th>Persons Seriously Injured</th>
<th>Total Persons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>148</td>
<td>1024</td>
<td>1172</td>
</tr>
<tr>
<td>1984</td>
<td>139</td>
<td>1077</td>
<td>1216</td>
</tr>
<tr>
<td>1985</td>
<td>134</td>
<td>1124</td>
<td>1258</td>
</tr>
<tr>
<td>1986</td>
<td>139</td>
<td>1095</td>
<td>1234</td>
</tr>
<tr>
<td>1987</td>
<td>136</td>
<td>1113</td>
<td>1249</td>
</tr>
<tr>
<td>1988</td>
<td>154</td>
<td>1194</td>
<td>1348</td>
</tr>
<tr>
<td>1989</td>
<td>159</td>
<td>1152</td>
<td>1311</td>
</tr>
<tr>
<td>1990</td>
<td>93</td>
<td>928</td>
<td>1021</td>
</tr>
<tr>
<td>1991</td>
<td>94</td>
<td>848</td>
<td>942</td>
</tr>
<tr>
<td>1992</td>
<td>89</td>
<td>799</td>
<td>888</td>
</tr>
<tr>
<td>1993</td>
<td>73</td>
<td>774</td>
<td>847</td>
</tr>
<tr>
<td>1994</td>
<td>64</td>
<td>775</td>
<td>839</td>
</tr>
</tbody>
</table>

Figure 1.1 Pedestrian Road Fatality Statistics for Victoria, 1983-1995
At a national level (Federal Office of Road Safety, 1995) the number of pedestrian fatalities per annum showed a generally declining trend, with the most marked reductions occurring after 1989. The trend over the period 1983 to 1994 is shown in Figure 1.3, the drop from 1989 to 1994 being 31%.
1.3.2 Social Costs of Pedestrian Deaths and Serious Injuries
Using 1992 reported fatal and serious injury data and the corresponding estimated social
costs of fatalities and serious injuries, as reported by Andreassen (1992), it is estimated
that the social costs of Victorian pedestrian fatal and serious injury accidents alone exceed
$150m per annum. This estimate does not include the social costs of pedestrian crashes
less severe than to require hospital admission.

1.3.3 Contributing Factors to Pedestrian Crashes
Studies of pedestrian crash involvement in Victoria show that the main predisposing
factors in pedestrian crashes are related to alcohol, age (both young and older pedestrians)
and the road environment. Struik et al. (1988a), in a literature review of factors
contributing to pedestrian accidents, summarised the findings of numerous studies which
examined the nature and characteristics of pedestrian crashes. Some of the more relevant
findings for this present study are:

Alcohol
The principal findings of overseas and Australian research into the involvement of alcohol
in pedestrian crashes are:

- almost half of adult pedestrians killed or injured have been drinking alcohol;
- approximately one third of casualties involving pedestrians over 14 years of age
  involved BAC's of 0.10 g/100 ml or greater;
- between 15% and 30% of casualties involving pedestrians over 14 years of age
  involved BAC's of 0.15 g/100 ml or greater;
- in a study of Victorian pedestrian crash data, it was found that alcohol involved
  pedestrian crashes were characterised by:
    - being greatest among males;
    - being greatest among middle-aged pedestrians;
    - occurring mostly at night and mostly on weekends.

Age
Children up to the age of seventeen are over-represented in pedestrian casualty crashes,
making up approximately one sixth of pedestrian fatalities and one third of severe injuries,
while children up to ten years of age are estimated to have between four and eleven times
the risk of pedestrians generally. Child pedestrian crash involvement declines with
increasing age. In Victoria, five to eleven year olds are involved in more crashes than are
older children.

Most child pedestrian crashes occur in local streets near home, and three quarters of local
street crashes involve children. Pedestrian crossing devices reduce the high risk for
children, though heightened risk is associated with crossing near but not on these devices.

6 MONASH UNIVERSITY ACCIDENT RESEARCH CENTRE
Most child pedestrian crashes occur during daylight, with morning and afternoon peaks being the periods of highest hourly crash rate. Young boys show particularly high rates during the afternoon peaks (3-5 p.m.).

Precipitating behaviours, reported in the work of Struik et al. (1988a) as being disproportionately associated with child pedestrian crashes, relate to children making unexpected or careless crossing movements, or playing in local streets near home. Other indirect predisposing factors include child stature and a range of perceptual and age-related human development limitations (e.g. perception of the direction of sound, peripheral vision, information processing and experience in traffic).

Pedestrians aged 60 years and over make up approximately 40% of pedestrian fatalities and 20% of pedestrian severe injuries. Older pedestrians involved in crashes are estimated to be five times more likely to be killed than are 17 to 25 year old pedestrians involved in crashes. European research indicates that pedestrian crashes are the main cause of death in the elderly and that the risk of being killed in a pedestrian crash increases with age, up to the age of 80.

Failing to detect the colliding vehicle before being struck, being struck during daylight on busy roads, and crossing alone and at uncontrolled locations were among the circumstances and behaviours reported as characterising older pedestrian crashes. Physical and cognitive capabilities of older pedestrians (e.g. vision and hearing, decision-making and reaction times, information processing, agility and walking speed) limit a pedestrian’s ability to evade vehicles in critical circumstances.

Evidence from various sources indicates that the role of the driver is an important contributing factor to pedestrian crashes and that drivers tend not to accommodate the pedestrians in their driving behaviour.

Environment
In their literature review of the factors contributing to pedestrian accidents, Struik et al. (1988a) reported that the aspects of the road environment identified as relevant to pedestrian casualty accidents include:

- characteristics of the road and surroundings (e.g. road hierarchy and land use type);
- road section - mid-block or intersection;
- traffic control - type and compliance;
- traffic and pedestrian volumes;
- engineering innovations which alter usual functions - one-way streets, barriers, median strips and refuges;
- visibility and conspicuity issues.

The characteristics of reported pedestrian casualty accidents reported by Struik et al. (1988a) may be summarised as follows:
• pedestrian crashes occur most frequently on undivided arterial roads, especially secondary arterials;

• approximately one-third of pedestrian casualties occur in the metropolitan area in eight central municipalities. These accidents predominantly involve pedestrians being struck on their left side on the far-side of the road (25%), near-side of the road (23%), pedestrians emerging from behind vehicles (23%) and pedestrians being struck by turning vehicles (16%);

• child pedestrian casualties tend to be evenly spread throughout the Melbourne Metropolitan area, with a predominance in several inner suburbs;

• parked vehicles and turning traffic (especially right-turners) are associated with pedestrian crashes in inner suburban areas;

• inner suburban, older style strip shopping centres on arterial roads, with nearby pedestrian generators (e.g. train stations) are predominant environments for pedestrian casualty crashes. In overseas studies, land use of the adjacent hinterland (e.g. large housing estates and factories) predominate;

• high vehicle and pedestrian volumes are associated with higher pedestrian crash involvement;

• there is a fairly even spread of pedestrian crashes between intersection and mid-block locations;

• higher severity crashes occur at unsignalised intersections;

• crash risks on pedestrian crossings are lower than crossing elsewhere. The risks of crossing near, but not on, the crossing are very high, especially for the young and the aged. The reason for pedestrians crossing near but not on signalised crossings is thought to be associated, at least in part, with the generally high delays pedestrians encounter at signalised crossings if they use the devices correctly;

• unsignalised pedestrian crossings are considerably less safe than signalised or supervised crossing facilities;

• up to 30% of pedestrian casualties involve poor conspicuity of pedestrians, with the risks of pedestrians being struck in darkness and/or in bad weather being many times higher than for daylight hours or in fine conditions.

1.4 CURRENT APPROACHES AND STRATEGIES TO PEDESTRIAN SAFETY

The National Road Safety Strategy (Federal Office of Road Safety, 1992) reflects the view that Australians expect the protection of vulnerable road users (i.e., the young, the elderly, pedestrians, cyclists and motor cyclists). The need for special attention to road users who are particularly vulnerable to road trauma is a major component of the "equity and vulnerability" principle supporting the National Strategy.
The National Strategy comprises eight strategic objectives. **Objective D - road safety as a priority in the management of transport and land use** - includes the encouragement of land use planning and development decisions that minimise the physical risk to road users, including pedestrians. The expected outcomes of this Strategy are to incorporate the potential crash costs in the ‘user pays’ principle and a reduction in the community’s total exposure to crash risk.

**Objective E - safer vehicles, safer roads and safer road users** - seeks to redress existing inequities through targeting disadvantaged and vulnerable road users. The proposed approach is to use strategies based on developing more appropriate behaviour and providing opportunities for modifying high risk behaviour. Among the expected outcomes of this objective are the elimination of road hazards, the consistent application of "best world practices" to similar circumstances, and the removal of inequities in the level of protection offered any group of road users.

The Victorian Road Safety Strategy (VIC ROADS et al., 1991) identifies a number of program directions, including safer road use, which seek, inter alia, to improve awareness of the vulnerability of motor cyclists, bicyclists and pedestrians. Pedestrians in the age groups nine to seventeen and over 71 years old are among the highest risk groups by age. The Victorian Strategy focuses on crash reduction initiatives for this and other high risk groups. Measures such as systematic improvements to the road and road environment, reductions in excessive speeding and in drink/driving, and better land use planning appear as the most likely to provide safety benefits to pedestrians.

In 1990, pedestrians comprised 28% of fatalities in the Melbourne Metropolitan area and 17% throughout Victoria. The Strategy emphasises the importance of reducing the extent and severity of injuries to pedestrians and other vulnerable road users.

Most of the road safety benefits for pedestrians potentially arise from programs not specifically targeting pedestrians but, rather, the more general category of drivers. Existing initiatives such as those targeting the high risk behaviours of drink driving and speeding of drivers may benefit pedestrians indirectly. There are few specific measures and initiatives in the Strategy for reducing the incidence and severity of pedestrian crashes, especially in one of the five key program directions of providing safer roads. This aspect of the Strategy could be strengthened.

In September 1995 the State Minister for Roads and Ports released the Victorian Government’s new road safety strategy, “Safety First”, for the period 1995 to 2000 (VIC ROADS, Transport Accident Commission and Victoria Police, (1995)). Among the primary issues and principal objectives of the strategy is the development of programs to make the roads safer for pedestrians. There are five elements to the approach, namely:

- identify high-risk locations and involve local government in the process.
- introduce design features and engineering treatments to make roads safer for pedestrians.
- develop programs for improving visibility of pedestrians.
- undertake educational programs in schools and with local government and community groups.
- help health professionals to understand the issues relevant to older pedestrians.
The Victorian Local Government Road Safety Strategy (Institute of Municipal Engineering Australia, 1992) identifies the role of Local Government as including supervising school crossings, planning for and building pedestrian facilities, and lists many factors which can influence road safety. Those relating specifically to pedestrians include young school children coping with traffic, children playing near heavy traffic and elderly pedestrians crossing busy roads. The Safer Road Use program direction of the Strategy contains explicit reference to the importance of encouraging and supporting "Safe-Routes-to-School".

The Strategy is also supported by road accident data which show that pedestrians account for 19% of Victorian fatalities and almost 30% of fatalities in urban areas. Pedestrian crashes are among the most severe at intersections and are a predominant category of crashes between intersections.

Other issues which pertain explicitly to pedestrians and for which Local Government can exert an influence include:

- **Land Use Planning** - attend to car parking layouts, access points, set backs and avoid on-street parking in traffic lanes to make individual developments safer for pedestrians and motorists;

- **Road User Behaviour** - discuss safety issues (e.g. pedestrian safety) with elderly people, possibly through Elderly Citizens Centres;

- **Alcohol and Road Users** - use pedestrian fencing to redirect alcohol-affected pedestrians away from problem locations;

- **Staff as Road Users** - encourage staff to adopt good practices as pedestrians.

### 1.5 CURRENT PROGRAMS AND COUNTERMEASURES

The main programs and countermeasures for pedestrians are primarily behavioural or environmental in nature. The major approaches used in Victoria are described below:

#### 1.5.1 Environmental Improvements

There is a range of engineering-type measures being implemented in Victoria to improve the safety of the road environment for pedestrians. A focus of Victoria's Accident Black Spot Program is the road and traffic engineering treatment of pedestrian black spots/routes. Typical treatments include providing pedestrian crossing facilities on arterial roads (i.e. pedestrian operated signals/school signals, pedestrian refuges, zebra crossings), extending pedestrian crossing times at traffic signals, more frequent introduction of pedestrian phases at traffic lights, improving conspicuity of traffic signals for drivers, and constructing medians and approach islands at intersections to enable pedestrians to stage their crossing movements.

In recent years, community-based programs have been introduced to develop "Safe-Routes-to-School" and "Walk with Care" programs in several Melbourne areas having a record of child and older pedestrian crashes, respectively. These programs typically include road/traffic engineering treatments in the package of measures implemented.
For example, municipalities such as Dandenong, Springvale, Coburg and Brunswick have each participated in the introduction of “Safe-Routes-to-School” programs in hazardous local areas and, as a result, provided a range of physical improvements to the road environment. Footpath widenings/road narrowings, pedestrian refuges, indented parking, kerbside or median fencing, pedestrian crossing facilities, etc., are typical forms of improvement used in this program. As part of the “Walk with Care” program, similar types of improvements are provided in areas or along routes with a history of crashes involving aged pedestrians.

Other pedestrian safety improvements to involve the provision of pedestrian crossing facilities at individual sites on the arterial road network. However, Liew (1987) found no significant reduction in pedestrian crash rates where pedestrian operated signals had been installed, notwithstanding a reduction in pedestrian exposure at these locations. This contrasts with a later evaluation by Tziotis (1993) who found that both new pedestrian operated signals and non-signal pedestrian treatments implemented at pedestrian midblock black spot locations reduced pedestrian casualty crashes. Reductions ranged from 50 to 69%.

1.5.2 Behavioural Change Measures

The pedestrian safety problem is also addressed in Victoria through a range of programs and measures aimed at achieving behavioural change in pedestrians and/or in other road users. Behavioural change measures typically include traffic safety education for pre-school and school children, raising the awareness of motorists to the vulnerability of pedestrians, through mass media campaigns, and targeting child and aged pedestrians, as part of behavioural change components of the “Safe-Routes-to-School” and “Walk-with-Care” programs, respectively.

In addition, Victoria’s random breath testing of drivers and its speed and red light camera programs of enforcement, penalties and public education through the mass media, are all likely to change road user behaviour in a way that will contribute to a reduction in the incidence and/or severity of pedestrian crashes.

1.6 INNOVATION

One of the major inferences from the overview presented above is that there is a lack of pedestrian safety strategies and countermeasures which stand out as clearly successful. In recognition of this, the Pedestrian Safety Issues for Victoria project, while setting out to achieve the specific objectives described earlier, has deliberately endeavoured to be innovative in generating possible solutions to the long-standing pedestrian crash problems along Melbourne’s arterial roads. In particular, because conventional approaches appear to have had little direct effect on pedestrian safety, it was considered highly desirable to be constrained to accepting the traditional views and established practices for managing traffic, for providing public transport services and for land use development along Melbourne’s arterial roads.
2. PEDESTRIAN CRASHES AT HIGH RISK MELBOURNE LOCATIONS

The environment types with high pedestrian crash frequencies considered for this study were Commercial (primarily inner suburban strip shopping centres), Residential (including parkland and surrounding areas), a mixture of Commercial/Residential and Bayside areas. Routes with a history of serious pedestrian crashes were identified through the preparation by VicRoads of arterial road network plots of crashes occurring between 1987 and 1993, in Melbourne and Geelong.

Fifty-eight high pedestrian crash frequency locations in Melbourne (excluding the CBD) were chosen for categorisation by environment type and for subsequent analysis. Of the 58, sixteen were combined Commercial environment types, twelve were Residential, twenty were Commercial/Residential and the remaining ten were Bayside types. The 58 locations are listed in the Appendix 1.

Having regard to the relatively smaller size of the pedestrian crash problem in the Bayside areas, it was decided to direct the limited resources available for this project to the Commercial, Residential and Commercial/Residential environment types.

The factors contributing to pedestrian crashes were initially investigated for all locations combined. The crash data were then analysed and compared for the individual environment types (excluding Bayside). Pedestrian crashes occurring at these Melbourne locations between 1 January 1987 and 31 December 1993 were considered for the study.

During 1987-1993, 1,305 pedestrian casualty crashes, involving 1,350 pedestrians, occurred at these selected high-pedestrian crash frequency locations. The Commercial, Residential and Commercial/Residential environments' share of these crashes was 28%, 21% and 42%, respectively (the remaining 9% of crashes occurred in Bayside areas).

Road environment factors, road user characteristics, situational factors, as well as crash type and crash severity level, were investigated for the pedestrian crashes at the combined Melbourne locations. Further, the crash data were analysed for the three environment types to determine which environment types differed from the overall patterns with regard to particular contributing crash factors and characteristics.

2.1 ROAD ENVIRONMENT FACTORS

Aspects of the road environment identified by Struijk et al. (1988) as relevant to pedestrian casualty crashes include:

- road section or road section type
- traffic control
- type of land use
- road hierarchy
- visibility and conspicuity issues.
For this study, however, four road environment factors were available from the mass data base of reported crashes, namely:

- Road Location Type
- Road Geometry
- Traffic Control
- Road Surface Condition.

For the above road environment factors, a summary of the proportion of pedestrian crashes that occurred at all selected Melbourne locations and at each particular environment type is given in Table 2.1.

2.1.1 Road Location Type
Each pedestrian crash was classified as occurring at either an intersection or at a mid-block location. For all selected Melbourne environments, more pedestrian crashes occurred in mid-block locations, 54%, than at intersections, 46% during 1987-1993 (Figure 2.1). As depicted by the 95% confidence limits, there was a significantly greater proportion of pedestrian crashes occurring at mid blocks than at intersections. Struik et al. (1988a), however, reported an even spread of pedestrian crashes between intersection and mid-block locations.

Commercial and Residential environments exhibited similar proportions of mid-block and intersection pedestrian crashes, as did all environments (Table 2.1). However, in Commercial/Residential environments, more pedestrian crashes occurred at intersections (52%) than mid-blocks (48%). The difference between these proportions is less marked than for other environments, and is more in accord with Struik et al.'s (1988a) even spread of crashes at the two location types. Nevertheless, no statistically significant association between road location and environment type existed.

**Figure 2.1:** Pedestrian Crashes by ROAD LOCATION TYPE in ALL High Crash Pedestrian Environments: Melbourne, 1987-1993
Table 2.1: Road Environment Factors for All Selected Melbourne Environments and for Each Environment Type 1987-1993

<table>
<thead>
<tr>
<th>ENVIRONMENT TYPE</th>
<th>ALL</th>
<th>COMMERCIAL</th>
<th>RESIDENTIAL</th>
<th>COMMERCIAL/RESIDENTIAL</th>
<th>BAYSIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUMBER OF PEDESTRIAN CRASHES</td>
<td>1305</td>
<td>359</td>
<td>280</td>
<td>554</td>
<td>112</td>
</tr>
<tr>
<td>PROPORTION OF CRASHES (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOCATION TYPE</td>
<td>Mid-block</td>
<td>54</td>
<td>55</td>
<td>57</td>
<td>48</td>
</tr>
<tr>
<td>Road</td>
<td>Intersection</td>
<td>46</td>
<td>45</td>
<td>43</td>
<td>52</td>
</tr>
<tr>
<td>GEOMETRY</td>
<td>Cross Intersection</td>
<td>18</td>
<td>18</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>T-intersection</td>
<td>27</td>
<td>25</td>
<td>22</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Not at intersection</td>
<td>52</td>
<td>52</td>
<td>55</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Other/Unknown</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>TRAFFIC CONTROL</td>
<td>No control</td>
<td>75</td>
<td>74</td>
<td>66</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>Signals</td>
<td>13</td>
<td>11</td>
<td>23</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Ped. Signals/Crossing</td>
<td>7</td>
<td>10</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Other/Unknown</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>ROAD CONDITION</td>
<td>Dry</td>
<td>85</td>
<td>85</td>
<td>88</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>Wet</td>
<td>13</td>
<td>14</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Other/Unknown</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
2.1.2 Road Geometry

The predominant road geometry types considered were:

- Cross intersection
- T-intersection
- Not at intersection
- Other (Y and multiple intersections, dead-end, road closure, private property).

Figure 2.2 gives the distribution of road geometry types as both frequencies and proportions for all selected Melbourne environments. Over 50% of the 1,305 pedestrian crashes did not occur at an intersection. The remaining crashes were predominantly divided between T-intersections (27%) and cross intersections (18%). Furthermore, the 95% confidence limits show that there were significantly more crashes occurring at mid-block locations and significantly less at cross intersections than at T-intersections during 1987-1993.

Commercial/Residential and Residential environments showed different pedestrian crash patterns with regard to location geometry than all environments (Table 2.1). A greater proportion of crashes occurred at T-intersections (31%) for Commercial/Residential environments than at all environments (27%).

Residential environments, however, had fewer pedestrian crashes (22%) occurring at T-intersections than did other environment types and also more occurring at locations where there was no intersection (55%). These road geometry differences between the various environment types, nevertheless, were not statistically significant at the 5% level.

The location geometry crash patterns for Commercial environments were similar to the corresponding ‘all environment’ crash patterns of Figure 2.2.

**Figure 2.2 Pedestrian Crashes in ALL High Crash Environments by ROAD GEOMETRY: Melbourne, 1987-1993**
2.1.3 Traffic Control

For the selected Melbourne locations, there was a significantly greater proportion of pedestrian crashes (75%) occurring in environments where there was no traffic control (Figure 2.3). Pedestrians were struck by vehicles at signalised intersections in 13% of crashes, and a further 7% were struck at pedestrian lights or pedestrian crossings.

Figure 2.3: Pedestrian Crashes by TRAFFIC CONTROL in ALL High Crash Pedestrian Environments: Melbourne, 1987-1993

Figure 2.4: Proportion of Pedestrian Crashes by TRAFFIC CONTROL and ENVIRONMENT TYPE: Melbourne, 1987-1993
Residential environments showed somewhat different traffic control crash patterns than those displayed in Figure 2.3. There was a statistically significant difference between Residential environments and all other environment types with regard to the number of crashes occurring at signalised intersections (refer Figure 2.4). In fact, the percentage of pedestrians struck at signalised intersections in Residential environments was nearly double the 'all environment' proportion (23% and 13% respectively). There were also significantly fewer pedestrian crashes in Residential road environments with no traffic control, 66%, compared to the corresponding 'all environment' proportion of 75%.

Commercial and Commercial/Residential environments displayed a similar spread of pedestrian crashes for each traffic control type as did all road environments in Melbourne, with no significant differences resulting.

2.1.4 Road Surface Condition

Figure 2.5 displays the road surface condition patterns for the 1,305 pedestrian crashes. Predominantly the crashes occurred in dry conditions, with 13% of crashes occurring on wet roads during or after rain. Low skid resistance, due in part to a wet road surface, may be a contributing factor to these crashes.

Ratios of dry to wet road pedestrian crashes for the individual environment types were similar to the overall crash patterns displayed in Figure 2.5. However, marginally fewer wet road crashes occurred in Residential environments (10%) than at other environments (Table 2.1), although this difference was not statistically significant.

Figure 2.5: Pedestrian Crashes by ROAD SURFACE CONDITION in ALL High Crash Pedestrian Environments: Melbourne, 1987-1993
2.2 PEDESTRIAN CRASH CHARACTERISTICS

The pedestrian casualty crash characteristics considered were 'Crash Type' and 'Crash Severity Level'. The percentage distribution of the pedestrian crashes for these characteristics are given in Table 2.2 for all locations and for each environment type.

2.2.1 Crash Type (DCA)

Each pedestrian crash was classified according to VicRoads' codes for classifying accidents (i.e. DCA's). The following categories were used to define each crash type:

- Near side or pedestrian hit by vehicle from the right (DCA 100)
- Pedestrian emerges from in front of parked/stationary vehicle (DCA 101)
- Far side or pedestrian hit by vehicle from the left (DCA 102)
- Pedestrian playing, lying, working or standing on carriageway (DCA 103)
- Pedestrian walking with/against traffic (DCA's 104-105)
- Vehicle strikes pedestrian on footpath, median or traffic island (DCA 106)
- Pedestrian on footpath, struck by vehicle entering/leaving driveway (DCA 107)
- Pedestrian struck walking to/from or boarding/alighting vehicle (DCA 108)
- Other pedestrian manoeuvre (DCA 109)
- Non-pedestrian (DCA's 110-198).

The distribution of pedestrian crash types is shown in Figure 2.6. The predominant crash types for all selected environments were pedestrians struck from the right or near-side (DCA 100), 40%; pedestrians emerging from in front of parked or stationary vehicles (DCA 101), 17%; and pedestrians struck from the left or far-side (DCA 102), 27%. Combining DCA's 100 and 101 showed that 57% of pedestrians were struck as they negotiated vehicles travelling in the direction first encountered. A smaller proportion, 27%, were struck by a vehicle from the left or far-side. Four percent of pedestrians were struck while standing on the carriageway (DCA 103), and a further 4% were struck while boarding or alighting from a vehicle (DCA 108).

In comparison, Struik et al. (1988a) reported a relatively even spread of crashes occurring between the three predominant pedestrian crash types in inner and near-inner Melbourne suburbs - namely pedestrians struck on near-side (DCA 100), 23%; pedestrians emerging from in front of parked or stationary vehicles (DCA 101), 23%; and pedestrians struck from the left or far-side (DCA 102), 23%. Combining DCA's 100 and 101 showed that 46% of pedestrians were struck as they negotiated vehicles in the direction first encountered. However, the Melbourne high crash locations experienced a significantly greater proportion of crashes in which the pedestrian was struck from the right (57% - refer Figure 2.6), although this sample covered a greater area of Melbourne than only the inner suburbs.

In a later study, Struik et al. (1988b) found that in a survey of hospitalised and casualty pedestrian patients in the Melbourne Statistical Division, 43% of pedestrians were struck on their left side in 25% of crashes and pedestrians emerging from behind vehicles in 23% of crashes (that is 46% of pedestrians were struck as they negotiated vehicles in the direction first encountered). However, the Melbourne high crash locations experienced a significantly greater proportion of crashes in which the pedestrian was struck from the right (57% - refer Figure 2.6), although this sample covered a greater area of Melbourne than only the inner suburbs.

In a later study, Struik et al. (1988b) found that in a survey of hospitalised and casualty pedestrian patients in the Melbourne Statistical Division, 43% of pedestrians were struck on the near-side, 13% on the near-side emerging from behind vehicles and 28% on the far-side. Thus 56% were struck as they negotiated vehicles in the direction first encountered (a similar proportion to that found for the Melbourne high crash locations).

Figure 2.6 shows similar crash type patterns for the 'all environment' distribution as for Commercial and Commercial/Residential environments. Residential environments, however, differed somewhat from the overall crash type patterns. A greater proportion of
Table 2.2: Crash Type (DCA) and Crash Severity Level for All, Commercial, Residential, Commercial/Residential and Bayside Melbourne Environments, 1987-1993

<table>
<thead>
<tr>
<th>Environment Type</th>
<th>All</th>
<th>Commercial</th>
<th>Residential</th>
<th>Commercial/Residential</th>
<th>Bayside</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Pedestrian Crashes</td>
<td>1305</td>
<td>359</td>
<td>280</td>
<td>554</td>
<td>112</td>
</tr>
<tr>
<td>Proportion of Crashes (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Crash Type (DCA)

<table>
<thead>
<tr>
<th>Crash Type</th>
<th>All</th>
<th>Commercial</th>
<th>Residential</th>
<th>Commercial/Residential</th>
<th>Bayside</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ped. hit from right (100)</td>
<td>40</td>
<td>42</td>
<td>37</td>
<td>40</td>
<td>45</td>
</tr>
<tr>
<td>Ped. emerging (101)</td>
<td>17</td>
<td>19</td>
<td>15</td>
<td>18</td>
<td>10</td>
</tr>
<tr>
<td>Ped. hit from left (102)</td>
<td>27</td>
<td>25</td>
<td>31</td>
<td>27</td>
<td>23</td>
</tr>
<tr>
<td>Ped. on carriageway (103)</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Ped. walking/facing traffic (104-105)</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Ped. on footpath/path (106-107)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Ped. hit boarding/alighting (108)</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Other pedestrian (109)</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Non-pedestrian/unknown (110-199)</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

### Crash Severity

<table>
<thead>
<tr>
<th>Crash Severity</th>
<th>All</th>
<th>Commercial</th>
<th>Residential</th>
<th>Commercial/Residential</th>
<th>Bayside</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Serious Injury</td>
<td>46</td>
<td>44</td>
<td>55</td>
<td>44</td>
<td>39</td>
</tr>
<tr>
<td>Other Injury</td>
<td>50</td>
<td>54</td>
<td>40</td>
<td>52</td>
<td>49</td>
</tr>
</tbody>
</table>
pedestrians were struck from the left, 31%, in Residential environments than in other environment types. Furthermore, twice as many pedestrians were hit while boarding or alighting from a vehicle in Residential environments than in all locations combined. The differences between the Residential and 'all environment' crash patterns, however, may have been due to chance, as no statistically significant differences were found.

Figure 2.6: Pedestrian Crashes by CRASH TYPE (DCA) in ALL High Crash Pedestrian Environments: Melbourne, 1987-1993

2.2.2 Crash Severity
Amongst the 1,305 pedestrian crashes, serious injury and other injury crashes occurred in similar proportions, 46% and 50%, respectively (Figure 2.7). During the seven-year period 1987-1993, 58 (or 4%) fatal crashes occurred at these selected environment types.

Figure 2.7: Pedestrian Crashes by SEVERITY LEVEL in ALL High Crash Pedestrian Environments: Melbourne, 1987-1993
Figure 2.8 shows the severity level of the pedestrian crashes for all locations and for each environment type. As depicted by the 95% confidence limits, significant differences existed in crash severity level between the environment types. Commercial environments had significantly fewer fatal pedestrian crashes than did the combined sample of crashes, whereas other environment types showed no differences. Fifty-five percent of the residential environment crashes resulted in serious injuries compared with the overall proportion of 46%. Conversely, Residential environments had significantly fewer 'other injury' crashes than did other environment types. Thus the severity of the pedestrian crashes was significantly greater in Residential environments than in other environments.

Figure 2.8: Proportion of Pedestrian Crashes by SEVERITY LEVEL and ENVIRONMENT TYPE: Melbourne, 1987-1993

2.3 SITUATIONAL FACTORS

Situational factors relevant to the occurrence of pedestrian crashes and considered in this study were:
- Year of Crash
- Month of Crash
- Day of Week of Crash
- Time of Crash
- Light Condition.

For the combined environments and for each environment type, the proportion of crashes for each of the above situational factors are given in Table 2.3.

2.3.1 Year of Crash

The number of pedestrian crashes occurring during 1987-1993 for all selected Melbourne locations is presented in Figure 2.9. After a peak of 233 crashes in 1988 a decline in pedestrian crash frequency occurred. Crash frequency was lowest in 1991 at 156 crashes.

As depicted by the 95% error bars in Figure 2.9, pedestrian crashes significantly reduced by one third from 18% in 1988 to approximately 12% during 1991-1993.
Table 2.3: Situational Factors for All, Commercial, Residential, Commercial/Residential and Bayside Melbourne Environments, 1987-1993

<table>
<thead>
<tr>
<th>ENVIRONMENT TYPE</th>
<th>ALL</th>
<th>COMMERCIAL</th>
<th>RESIDENTIAL</th>
<th>COMMERCIAL/RESIDENTIAL</th>
<th>BAYSIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUMBER OF PEDESTRIAN CRASHES</td>
<td>1305</td>
<td>359</td>
<td>280</td>
<td>554</td>
<td>112</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Situational Factor</th>
<th>PROPORTION OF CRASHES (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>YEAR OF CRASH</td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td>17</td>
</tr>
<tr>
<td>1988</td>
<td>18</td>
</tr>
<tr>
<td>1989</td>
<td>14</td>
</tr>
<tr>
<td>1990</td>
<td>14</td>
</tr>
<tr>
<td>1991</td>
<td>12</td>
</tr>
<tr>
<td>1992</td>
<td>12</td>
</tr>
<tr>
<td>1993</td>
<td>13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MONTH OF CRASH</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>7</td>
</tr>
<tr>
<td>February</td>
<td>9</td>
</tr>
<tr>
<td>March</td>
<td>10</td>
</tr>
<tr>
<td>April</td>
<td>8</td>
</tr>
<tr>
<td>May</td>
<td>9</td>
</tr>
<tr>
<td>June</td>
<td>9</td>
</tr>
<tr>
<td>July</td>
<td>7</td>
</tr>
<tr>
<td>August</td>
<td>8</td>
</tr>
<tr>
<td>September</td>
<td>9</td>
</tr>
<tr>
<td>October</td>
<td>7</td>
</tr>
<tr>
<td>November</td>
<td>8</td>
</tr>
<tr>
<td>December</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LIGHT CONDITION</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td>69</td>
</tr>
<tr>
<td>Dark</td>
<td>26</td>
</tr>
<tr>
<td>Dusk/Dawn</td>
<td>4</td>
</tr>
<tr>
<td>Unknown</td>
<td>1</td>
</tr>
</tbody>
</table>

|                  |                           |
|                  |                           |
|                  |                           |
|                  |                           |
Table 2.3 (continued): Situational Factors for All, Commercial, Residential, Commercial/Residential and Bayside Melbourne Environments, 1987-1993

<table>
<thead>
<tr>
<th>ENVIRONMENT TYPE</th>
<th>ALL</th>
<th>COMMERCIAL</th>
<th>RESIDENTIAL</th>
<th>COMMERCIAL/RESIDENTIAL</th>
<th>BAYSIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUMBER OF PEDESTRIAN CRASHES</td>
<td>1305</td>
<td>359</td>
<td>280</td>
<td>554</td>
<td>112</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Situational Factor</th>
<th>PROPORTION OF CRASHES (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>14</td>
</tr>
<tr>
<td>Tuesday</td>
<td>13</td>
</tr>
<tr>
<td>Wednesday</td>
<td>15</td>
</tr>
<tr>
<td>Thursday</td>
<td>16</td>
</tr>
<tr>
<td>Friday</td>
<td>21</td>
</tr>
<tr>
<td>Saturday</td>
<td>13</td>
</tr>
<tr>
<td>Sunday</td>
<td>8</td>
</tr>
<tr>
<td>6:00am-7:59am</td>
<td>4</td>
</tr>
<tr>
<td>8:00am-9:59am</td>
<td>9</td>
</tr>
<tr>
<td>10:00am-11:59am</td>
<td>11</td>
</tr>
<tr>
<td>midday-1:59pm</td>
<td>13</td>
</tr>
<tr>
<td>2:00pm-3:59pm</td>
<td>14</td>
</tr>
<tr>
<td>4:00pm-5:59pm</td>
<td>14</td>
</tr>
<tr>
<td>6:00pm-7:59pm</td>
<td>11</td>
</tr>
<tr>
<td>8:00pm-9:59pm</td>
<td>7</td>
</tr>
<tr>
<td>10:00pm-11:59pm</td>
<td>6</td>
</tr>
<tr>
<td>midnight-1:59am</td>
<td>3</td>
</tr>
<tr>
<td>2:00am-3:59am</td>
<td>2</td>
</tr>
<tr>
<td>4:00am-5:59am</td>
<td>1</td>
</tr>
</tbody>
</table>
The proportion of pedestrian crashes occurring in each year of the study period for each environment type are given in Table 2.3. In 1987 a greater percentage of crashes existed in Residential environments (20%) relative to the overall proportion of 17%. By 1993 the Residential environment proportion had declined by a quarter to 15% compared to the ‘all environments’ proportion of 13%. Conversely, Commercial environments which started with a smaller proportion of crashes (15%) than the overall figure in 1987, had increased to 17% by 1993. Commercial/Residential environments displayed the lowest proportion in 1993, 11%. Nevertheless, the differences found between the various environment types and the year of the crash were not statistically significant.

Figure 2.9: YEARLY Pedestrian Crashes in ALL High Crash Pedestrian Environments: Melbourne, 1987-1993

2.3.2 Month of Crash
Figure 2.10 depicts the monthly distribution of crashes for the period 1987-1993 for all environments. The greatest percentage of crashes occurred in March and the least in January. However, the monthly proportions did not vary greatly, ranging from 7% to 10%. Moreover, the 95% error bars show there was no statistically significant difference between the proportion of crashes occurring in each month.

Little significant variation existed between environment types with regard to the monthly proportion of crashes (Table 2.3). Noticeable differences occurred in December, where residential environments displayed a greater proportion of crashes (12%) than did all environments (9%) and in July when commercial environments had the greatest percentage of pedestrian crashes (10%).
2.3.3 Day of Week

Figure 2.11 shows crash frequencies by day of week for all Melbourne environments. Frequencies generally increased from Monday to Friday, with Friday having the greatest proportion (21%) and Sunday the lowest (8%). Friday's proportion was significantly larger than those for other days. Statistically reliable differences also existed between the Sunday proportion and those of Monday to Saturday. However, there was no reliable difference between pedestrian crash proportions occurring during Monday to Thursday.

Figure 2.11: Pedestrian Crashes by DAY OF WEEK in ALL High Crash Pedestrian Environments: Melbourne, 1987-1993
The weekly distribution of pedestrian crashes did not differ significantly between each environment type and the overall proportions (Table 2.3). In particular, there were little differences in Wednesday to Sunday proportions between each environment type. However, there were fewer Monday crashes (10%) in Residential environments than in 'all environments' (14%). This pattern was reversed on Tuesday. The Tuesday-share of crashes in Residential environments was 17% compared with 13% overall.

2.3.4 Time of Day

The distribution of the time of each of the 1,305 pedestrian crashes is given in Figure 2.12 in hourly time intervals. The frequency of pedestrian crashes steadily increased from 6:00 a.m. to 4:59 p.m., peaking between 4:00 p.m. and 4:59 p.m. Almost 11% of the pedestrian crashes occurred during the afternoon peak-period of 4:00 p.m. to 4:59 p.m. This was significantly higher than the proportions occurring at other times of the day, except for the proportions during 3:00 p.m. to 3:59 p.m. (8%) and during 5:00 p.m. to 5:59 p.m. (9%).

Fewer crashes occurred during the morning peak-periods of 7:00 a.m. to 8:59 a.m. (8%). After 5:00 p.m. pedestrian crash frequency decreased with time, however, almost 10% of crashes occurred late at night between 10:00 p.m. and 1:59 a.m.

There was no statistically significant association between the environment type and the time of the pedestrian crash (Table 2.3). Nevertheless, it is worth noting that there were fewer crashes (7%) in commercial environments between 6:00 p.m. and 7:59 p.m. than in 'all environments' (11%).

Figure 2.12: Pedestrian Crashes by TIME OF DAY in ALL High Crash Pedestrian Environments: Melbourne, 1987-1993
2.3.5 Light Condition
Almost 70% of the selected Melbourne pedestrian crashes occurred in daylight (Figure 2.13). The remaining crashes happened in dark or near dark conditions. The individual pedestrian environments had similar light condition distributions as Figure 2.13, except Commercial environments which had fewer pedestrian crashes occurring in dark conditions (23%) than other environments, 26% (Table 2.3).

Figure 2.13: Pedestrian Crashes by LIGHT CONDITION in ALL High Crash Pedestrian Environments: Melbourne, 1987-1993

![Figure 2.13: Pedestrian Crashes by LIGHT CONDITION in ALL High Crash Pedestrian Environments: Melbourne, 1987-1993](image)

2.4 ROAD USER CHARACTERISTICS
For all Melbourne locations the following road users were involved in pedestrian crashes:
- 1,350 pedestrians
- 1,240 drivers
- 37 motorcyclists
- 19 bicyclists.

Road user age and gender distributions are given in Table 2.4. While gender is given for drivers only, age is for combined drivers, motorcyclists and bicyclists.

2.4.1 Age of Pedestrian
During 1987-1993, 1,350 pedestrians were involved in casualty crashes at the 58 high crash environments. Pedestrian ages were grouped into the following eight categories:
- 16 years and under
- 17 years to 24 years
- 25 years to 34 years
- 35 years to 44 years
- 45 years to 54 years
- 55 years to 64 years
- 65 years to 74 years
- 75 years and above.

28 MONASH UNIVERSITY ACCIDENT RESEARCH CENTRE
Table 2.4: Road User Characteristics for All Selected Melbourne Environments and for Each Environment Type: 1987-1993

<table>
<thead>
<tr>
<th>NUMBER OF PEDESTRIANS</th>
<th>ENVIRONMENT TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ALL</td>
</tr>
<tr>
<td>1350</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Road User Characteristic</th>
<th>SEX OF PEDESTRIAN</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>56</td>
<td>54</td>
<td>56</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>44</td>
<td>46</td>
<td>44</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>[0-16]</td>
<td>14</td>
<td>12</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>[17-24]</td>
<td>18</td>
<td>17</td>
<td>23</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>[25-34]</td>
<td>16</td>
<td>15</td>
<td>18</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>[35-44]</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>[45-54]</td>
<td>10</td>
<td>11</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>[55-64]</td>
<td>9</td>
<td>10</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>[65-74]</td>
<td>7</td>
<td>8</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>75+</td>
<td>7</td>
<td>8</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>unknown</td>
<td>9</td>
<td>9</td>
<td>10</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>SEX OF DRIVER</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>64</td>
<td>66</td>
<td>67</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>27</td>
<td>25</td>
<td>24</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Unknown</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>[25-34]</td>
<td>24</td>
<td>27</td>
<td>26</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>[35-44]</td>
<td>17</td>
<td>17</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>[45-54]</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>55+</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>unknown</td>
<td>15</td>
<td>15</td>
<td>18</td>
<td>14</td>
</tr>
</tbody>
</table>
Figure 2.14 shows pedestrian age distribution. Pedestrians aged 17-24 years comprised the largest proportion (18%) with "younger" age groups, 25-34 and 0-16 contributing 16% and 14%, respectively. Crash frequencies for pedestrians aged 35 years and over decreased with increasing age. Of these 118 pedestrians (or 9%) were of unknown age.

The 95% error bars in Figure 2.14 show that there was a significantly greater proportion of younger pedestrians aged 17-34 years in crashes than those aged 35 years and above. Further, there were significantly fewer children and teenagers aged under 16 years than young adults in the age range of 17-24 years amongst all Melbourne pedestrian crashes.

**Figure 2.14: Number and Proportion of Pedestrians in ALL High Crash Environments by AGE: Melbourne, 1987-1993**

**Figure 2.15: Age Distribution of Pedestrians by ENVIRONMENT TYPE: Melbourne, 1987-1993**
Figure 2.15 gives the age distribution of the pedestrians for each environment type. Commercial and Commercial/Residential environments displayed similar patterns to Figure 2.14 with regard to the pedestrian's age, whereas the age distribution for Residential environments differed somewhat from the overall picture. In particular, there were significantly fewer pedestrians aged 65-74 years (2%) involved in crashes in Residential environments than at other environment types (approximately 8% on average). Further, Residential environments had more pedestrians aged 17-24 years (23%) involved in crashes than occurred amongst all pedestrian crashes (18%), although this difference was not statistically significant.

2.4.2 Age of Drivers, Motorcyclists and Bicyclists

Figure 2.16 shows the age distribution of the drivers (including motorcyclists and bicyclists) involved in the 1,305 pedestrian crashes. Of the 1,296 drivers striking the pedestrians in all environments, 198 or 15% had unknown or unrecorded age. This large unknown proportion is partly due to drivers who leave the scene of the accident.

For persons of legal driving age, the number of drivers striking pedestrians decreased with increasing driver age. Approximately 27% of drivers involved in these crashes were young and inexperienced, aged between 17 and 24 years. Furthermore, the number of drivers striking pedestrians decreased with increasing driver age. There were significantly fewer drivers aged 35 years and above striking pedestrians than those aged 17-34 years. It should be noted, however, Figure 2.16 does not take into account the age distribution of the number of licensed drivers in Victoria nor the kilometres travelled by each driver of a particular age.
Table 2.4 shows the age distribution of drivers involved in pedestrian crashes at high risk locations, by environment type. Commercial environments had marginally more 25-34 year-old drivers striking pedestrians (27%) than did all environments (24%). However, no significant association existed between environment type and driver age.

2.4.3 Road User Gender

Figure 2.17 depicts the gender distribution of each road user type for the 1,305 pedestrian crashes. There were significantly more male than female pedestrians struck by vehicles at all selected Melbourne environments - 56% male and 44% female (p<0.0001). The individual environments displayed similar male to female ratios as Figure 2.17 (Table 2.4), with Commercial environments having marginally more female pedestrians in crashes (46%) than other environment types.

The male to female driver ratio for all environments was almost 5:2. Sixty-four percent of drivers striking pedestrians were male compared with 27% female. However, there was no significant difference between environment types with regard to driver gender (Table 2.4). It should be noted that the gender of 9% of drivers was not recorded, possibly due to drivers who did not stop after striking a pedestrian.

Thirty-seven motorcyclists were involved in pedestrian crashes, with 84% being male. Eight percent of motorcyclists were female, and a further eight percent did not have their gender recorded. All nineteen bicyclists striking pedestrians were male.

Figure 2.17: ROAD USER Patterns by GENDER for ALL High Crash Pedestrian Environments: Melbourne, 1987-1993
2.5 OTHER FACTORS

2.5.1 Type of Vehicle
The types of vehicles involved in the pedestrian crashes for all selected Melbourne environments are exhibited in Figure 2.18. Of the 1,387 vehicles involved, almost 80% were car or car derivatives. Other vehicle types were represented in low proportions, all under 5%. Of these, trams were the most frequently occurring at 4%. Five percent of vehicles were of unknown type, possibly due to drivers leaving the scene of the crash before Police or witnesses arrive.

Individual environment types displayed similar patterns to Figure 2.18 with regard to vehicle type. The one exception was for tram distributions. There was a significant difference between environment type and tram crash involvement. Figure 2.19 gives the proportion of trams in pedestrian crashes for each environment type.

There were significantly more trams involved in pedestrian crashes in Residential environments (12%) than at all combined Melbourne locations (4%). Conversely there were significantly fewer trams at Commercial environments (1%). Again this difference may partially be due to the exposure of trams in each environment type.

Figure 2.18: Distribution of VEHICLE TYPES in ALL High Crash Pedestrian Environments: Melbourne, 1987-1993
2.5.2 Speed Limit
Almost all (98%) of the 1,305 pedestrian crashes occurred in locations where the speed limit was 60 km/h. Twenty-one or 1.6% of the crashes occurred in speed zones of 75+ km/h. Similarly, Commercial, Residential and Commercial/Residential environments had at least 98% of pedestrian crashes occurring in speed zones of 60 km/h.

2.6 SUMMARY
For the selected high pedestrian risk locations in Melbourne a significantly greater proportion of crashes occurred at mid-block locations (53%) than intersections (46%) during 1987-1993. Similarly, with regard to road geometry and traffic control the majority of pedestrian crashes were most likely to occur where there was no control or no intersection. Only a small proportion (7%) of pedestrians were struck where a pedestrian traffic control was present. Commercial and Commercial/Residential environments showed similar road environment distributions to the combined Melbourne sample. However, Residential environments had a significantly greater proportion of pedestrian crashes occurring at signalised intersections (23%) than the overall proportion of 13%.

Predominantly more of Melbourne crashes involved pedestrians being struck from the right, 57% (DCA's 100 and 101), than from the left (DCA 102), 27%. This contrasts with Struik's (1998a) even spread of pedestrian crashes between these crash groupings.

Residential environments had significantly more severe pedestrian crashes than did other environments, with 60% of crashes resulting in fatal or serious injury - the corresponding proportion for all environments was 50%. Furthermore, Commercial environments had significantly fewer fatal crashes (2%) than did other environment types.

A statistically significant 33% reduction occurred in the proportion of pedestrian crashes at all Melbourne locations between 1988 (18%) and 1991-1993 (12%), however there was no significant monthly variation. Conversely, there were differences in the weekly and
daily pedestrian crash patterns. A significantly greater proportion of crashes occurred on Fridays than on other days of the week, with only marginal differences between the Monday to Thursday proportions. The largest proportion of pedestrian crashes occurred during the afternoon peak-period of 4:00 p.m. to 6:00 p.m. for the combined Melbourne sample and for each environment type.

Significant differences in the age and gender of the pedestrians involved in the crashes were found. Young adults (aged 17-34 years) were the predominant age group at all locations and at each environment type. Residential environments displayed significantly fewer older pedestrians (aged 65-74 years) than all other environments. A significantly greater proportion of male pedestrians were involved in the Melbourne crashes than females (56% and 44% respectively). This male to female ratio was similar for each individual environment type.

The proportion of trams striking or obstructing pedestrians differed significantly between environments. Pedestrians in Residential environments were more likely to be struck by trams (12%) than those in Commercial environments (1%). However the number of trams (i.e. level of exposure) present in each environment should be considered for any valid conclusions to be made concerning risk.
3. COMMON CRASH CIRCUMSTANCES

To gain a more comprehensive and accurate understanding of the factors contributing to pedestrian crashes at location types at which clustering of crashes occurs (e.g. suburban strip shopping centres and/or residential land use along arterial roads), six high pedestrian casualty crash frequency locations/routes were investigated. The crash data analyses for these six arterial route sections in Melbourne were supplemented by observation of pedestrian behaviour and traffic operational characteristics in the identified high crash involvement situations. The six routes investigated were:

- Toorak Road between Chapel Street and Punt Road, South Yarra;
- Racecourse Road between Stubbs Street and Smithfield Road, Flemington;
- Brunswick Street between Victoria Parade and Johnston Street, Fitzroy;
- Flemington Road between Elliott Avenue and Gatehouse Street, North Melbourne;
- St. Kilda Road between Kings Way and Commercial Road, South Yarra.
- Johnston Street between Wellington Street and Hoddle Street, Collingwood;

The approach adopted in this phase of the study aimed to develop generic solutions to generic problem types (e.g. common problems in strip shopping centres would be addressed by a generic treatment type, where appropriate). In recognition of the potential for countermeasures aimed at behavioural or vehicle design modification to contribute towards reductions in serious crashes, generic solutions were not restricted to physical road improvements alone. While emphasising the benefits of generic type countermeasures, solutions were developed to also allow a degree of flexibility to accommodate site-specific circumstances.

By studying the problem in this way, situations where conventional pedestrian safety measures can be successfully applied would be identified, as would opportunities to creatively identify or generate new measures/initiatives for use in like-circumstances. Hazardous environments, such as those investigated here, have been known for many years and require a more concerted and innovative approach to improve on current solutions. The road safety benefits from successfully investigating these environments types would potentially commence early and accrue over the long-term future.

In summary, this section describes the major findings from analysing reported pedestrian casualty crash histories and concurrently investigating site and traffic operational characteristics to help identify common crash circumstances and, therefore, possible contributing factors. A sound knowledge of contributing factors assists with effective targeting of countermeasures.

3.1 ROAD AND TRAFFIC ENVIRONMENT

The high pedestrian crash frequency arterial roads identified in this study were typically undivided, wide and/or multi-lane routes characterised by complex traffic conditions, situated in areas of high pedestrian activity. Predictably, pedestrian activity tended to vary
according to the presence of public transport services and the type of land use, namely, strip shopping environments, other commercial/business activities and residential land use.

Of special interest are the unique road cross sections along Melbourne’s three major arterial boulevards. Flemington Road, St Kilda Road and Royal Parade comprise a centre carriageway separated from two outer carriageways by plantations. Tram tracks act as a median effectively forming two centre carriageways. Notwithstanding the presence of plantations and the tram tracks where pedestrians can stage their crossing movements, these routes have a poor record of pedestrian crashes.

While wider roads seem to present greater risk to pedestrians, many of the hazardous arterial roads have only two traffic lanes in each direction. Pedestrians typically cross the road from one kerb to the other by dodging between lanes of stationary or slow-moving vehicles, since breaks in traffic are often scarce. In numerous cases, pedestrians appear to have been struck, as they emerged from between queued or slow moving vehicles, by higher speed vehicles encountered in the adjacent lane. Alternatively, pedestrians may be struck by vehicles whose drivers have become impatient and traversed the centre line in order to overtake slow/stationary vehicles.

Predominantly, struck pedestrians appear to have walked out from between stationary or parked vehicles to cross, usually without the assistance of a median or safety refuge to stage their crossing movement. Pedestrians thus have to judge and select safe gaps in the traffic flow in both directions before and/or during their crossing movement. Given high traffic volumes and busy road environments, this is a complex and demanding task, especially for the known high risk pedestrian groups, namely young, older and alcohol-affected pedestrians.

Vehicles waiting for signal changes at nearby intersection or pedestrian operated signals frequently create congested traffic conditions. At some locations, this congestion does not ease at night and may even escalate on Thursday, Friday and Saturday nights, because of increasing night-time activity in some suburban areas.

Trams add to the congestion when traffic banks up at traffic lights. The driver’s view of pedestrians is also restricted by the presence of trams and other heavy vehicles.

In many locations around Melbourne, there are two traffic lanes in each direction. The presence of parked cars along one of these lanes restricts a driver’s view of pedestrians emerging from between parked cars onto an area of the road still used (straddled) by some motorists as a traffic lane. The shared use of this kerbside lane by parked vehicles, pedestrians stepping out to cross and motorists straddling both lanes, appeared to contribute to “near-side” (DCA 100) and “emerging” (DCA 101) type pedestrian crashes.

3.2 WHEN CRASHES OCCUR

Pedestrian crashes tended to happen more often during weekdays than at weekends and, while they occurred throughout the day and night, the period between 4 p.m. and 6 p.m. appeared to be the most prevalent for pedestrian crashes. The higher incidence during this period, while likely to be explained at least in part by exposure, may also be indicative of the contribution of traffic congestion to crash occurrence.
About one-third of pedestrian crashes occurred during dark or near-dark conditions. ‘Insufficient lighting’ and ‘dark intersection’ was mentioned in Police reports, reinforcing the possibility that inadequate street-lighting may be a problem in the vicinity of some locations. This may be so, even where street lighting meets normal standards.

3.3 PEDESTRIAN CHARACTERISTICS

Pedestrian age and the involvement of alcohol in crashes tend to vary according to surrounding land use and/or public transport services.

The type of land use activity strongly influences pedestrian crash risk. For example, land use activities occurring in strip shopping centres, office-based business environments and in residential areas clearly affect the level and nature of pedestrian interaction with traffic on Melbourne’s arterial roads. However, some special forms of land use seem to generate specific risks to pedestrians. In four of the six hazardous routes investigated Housing Commission Flats were situated nearby. This form of residential development has been found in past studies to be associated with high numbers of pedestrian crashes. The reason for this may extend beyond the generation of high pedestrian activity levels, and relate to residents’ socio-economic and/or ethnic characteristics. Such areas exhibit a substantial involvement of pedestrians of ethnic backgrounds.

The presence of a hotels, night clubs and restaurants also appears to be an important factor in a substantial number of pedestrian crashes. Crashes potentially related to alcohol commonly occurred in the vicinity of licensed premises.

Investigations along Flemington Road and Brunswick Street also identified a possible association between pedestrian crashes and centres providing welfare support/accommodation for vagrants or homeless people. These centres include St. Vincent de Paul’s ‘Bailly House’, ‘Ozanam House’, the De Paul House for Alcoholics, the Brotherhood of St Lawrence and Catholic Church Missions. In some cases, Police reports of pedestrian crashes indicated that the residential addresses of pedestrians matched those of the centres (or that pedestrians may have been attending these centres). The presence of other land use types in proximity to these centres (e.g. Royal Park on the opposite side of Flemington Road) further heightens pedestrian crash risks.

Public transport services also appeared to play an important part in many pedestrian crashes. In particular, tram involvement was high amongst crashes at some locations, with up to 30% of pedestrians struck by trams either while on pedestrian crossings or immediately after alighting from trams. In other cases, trams were indirectly involved in that other vehicle types struck pedestrians running to catch a tram. Being able to provide pedestrians/public transport passengers with safe access to and from trams is a high priority issue, in need of a generic solution for Melbourne’s arterial road tram routes.

In some areas, where nightclubs, hotels and restaurants attract young adults (i.e. aged 17 to 34 years), there was clustering of night-time crashes involving pedestrians of this age.

In other locations or at other times of the day, common crash circumstances involved older people, aged 55 years and over. These crashes tended to occur in daylight near land uses which tend to attract older pedestrians. It should be noted that the decline in the
ability of older pedestrians to judge traffic situations, together with their reduced agility and greater frailty, make them vulnerable to speeding or impatient drivers.

3.4 PEDESTRIAN BEHAVIOUR

A common observation along the routes investigated was that pedestrians use the shortest and/or quickest route to cross, and show a definite reluctance to walk substantial distances to use pedestrian signals or other facilities provided. This form of behaviour is familiar in locations such as strip shopping centres where the origins and destinations of pedestrian movements are linearly distributed along a route (i.e. having no strong focus or concentration). This minimal focus of pedestrian crossing demand results in crashes also being linearly distributed along a route, making the provision of engineering treatments at single locations of potentially limited effect. It is important that countermeasures address the spatial distribution of pedestrian crossing movements.

Along a number of routes investigated pedestrians had police-reported surnames from Asian or Southern European backgrounds. Of these, 26% were Asian. In some instances, the presence of Asian specialty food shops appears to attract persons of these ethnic backgrounds. Some of these pedestrians may not have grown up in a highly motorised environment and may have an incomplete understanding of appropriate pedestrian and actual driver behaviour in such circumstances of traffic conflict. Not being familiar with the English language, some of these pedestrians may experience difficulties in comprehending traffic signs, such as pedestrian lantern operations. It should be noted, however, that a pedestrian’s English-speaking ability cannot be assumed from their surname alone - they may not necessarily be first-generation Australians.

3.5 PEDESTRIAN MOVEMENTS

The pedestrian crash data show that about 57% of pedestrian crashes involved pedestrians struck from the right or near-side, either directly or while emerging from in front of parked/stationary vehicles. This indicates that pedestrians are being struck within the first half of their crossing movements. Pedestrians may be shifting their attention from the vehicles approaching on the near-side to search for a gap in the far-side, before attending adequately to completing the first half of their crossing task. Approximately twenty-seven percent were struck by a vehicle from the left or far-side, indicating that this smaller category reached at least half way before being struck.

Many of the crashes of this type occurred on the approaches to traffic signals, while pedestrians were crossing between queuing vehicles. Police reports indicated that fault in such accidents often lay with the pedestrian.

As mentioned in Section 2.2.1, it is significant that this predominance of near-side crashes contrasts with the more general finding of Struik et al. (1988a) who found a relatively even spread of crashes occurring between the three predominant pedestrian crash types - namely pedestrians struck on near-side in 23% of crashes; pedestrians struck on their left side in 25% of crashes and pedestrians emerging from behind vehicles in 23% of crashes. It is hypothesised that in the busier, more complex traffic environments under investigation here, pedestrians crossing without the assistance of a median have particular difficulty as they shift their attention from the near-side traffic to the far-side traffic, before they have safely negotiated the first direction of vehicles.
This view is consistent with the work of Oxley et al. (1995), who found indications that the presence of a median considerably simplifies the task for older pedestrians of crossing the near-side lanes in strip shopping centres, as well as providing a refuge which, furthermore, simplifies the crossing of the far-side lanes. This suggests that older pedestrians benefit more from the provision of a median, whereas young pedestrians (typically of smaller stature) may derive greater safety benefits from the provision of kerb extensions because of more favourable sight distances between driver and pedestrian and reduced exposure time of pedestrians to traffic. Clearly, providing both a median and kerb extensions is the preferred arrangement, where practicable. Ideally, these countermeasure options should undergo trial and evaluation of the effects on pedestrian behaviour and crash occurrence.

3.6 TRAFFIC SIGNALS

Another characteristic crash type occurred on signalised pedestrian cross-walks, with pedestrians failing to comply with signals applicable to them. The lengthy delays commonly encountered by pedestrians waiting to cross at signals may lead to poor compliance and an associated tendency to cross away from signalised crossing. These crashes tended to involve pedestrians in vulnerable age-groups (i.e. under 15 years, and 55 years and above). Pedestrian walk times are often inadequate for older pedestrians to cross the full width of the road during one phase, hence pedestrians may get impatient and cross against the pedestrian signal or away from them. This view is supported by Struik et al. (1988a) who reported that the reason for pedestrians crossing near but not on signalised crossings is thought to be associated, at least in part, with the generally high delays pedestrians encounter at signalised crossings if they use the devices correctly.

It is noteworthy that pedestrians were commonly struck in road sections where vehicle queuing occurred on the approaches to traffic signals. Arterial road traffic volumes create congestion and exacerbate this high risk condition.

Observations of pedestrian behaviour at particular signalised intersections suggest that, under some signal phasing arrangements, pedestrians incorrectly infer that it is “safe” to cross, even though the signals applicable to them are red. This typically occurs when stationary vehicles in a right-turning lane (such as exists at signalised intersections along both Flemington and St Kilda Roads) face a red right-turn arrow and through vehicles on the same approach face a green signal. Believing that it is safe to cross in front of the stationary right-turners, despite the red pedestrian signal, pedestrians may be struck by a vehicle in the adjacent through lane which actually has a green light. This situation is exacerbated by the stationary right-turners obscuring the view between pedestrians and the drivers of the striking vehicles. Thus pedestrian negligence, in combination with a lack of awareness of actual traffic movements, may have contributed to these crashes.

3.7 VEHICLE SPEEDS

While there is limited firm evidence in police reports on the involvement of excessive vehicle speeds in pedestrian crash occurrence at the locations investigated, the basic laws of physics show clearly that higher vehicle speeds reduce the time available to drivers to avoid conflict with pedestrians and that, if a pedestrian is struck, the higher energy transfer will result in more severe injuries.
The question also arises as to the appropriateness of the normal urban speed limit of 60 km/h for arterial road traffic passing through high pedestrian activity areas. While a limit of 60 km/h may be generally safe for traffic on urban arterial roads, its appropriateness along road sections characterised by high levels of pedestrian activity is subject to increasing public debate.

Cunningham and Muthusamy (1994) reported the results of a study of vehicle speeds along a six metropolitan major arterial roads, zoned at 60 km/h, within busy, suburban, strip shopping centres in Melbourne. In general, the shopping centres had a history of serious pedestrian crashes over many years. The authors found that "a significant percentage of traffic already travels at or below 40 km/h during shopping hours" and it was concluded that a lower speed limit in such an environment was not necessary.

Though most drivers were found to be travelling at reasonable speeds for the conditions (which are hazardous to pedestrians), a substantial proportion exceeded these speeds. An 85th percentile speed of 40 km/h indicates, by definition, that some 15% of drivers travel at speeds exceeding 40 km/h. That is, in such circumstances, one or two drivers out of every ten may be travelling within the legal limit but at speeds directly hazardous to pedestrians, especially the high risk young and older pedestrian categories. Furthermore, a few percent of vehicles may well have been travelling above the speed limit and these represent the greatest potential danger to pedestrians. Also, vehicle speeds were found to be substantially higher outside of shopping hours, at times found in at least half of the locations investigated in the present study, to be particularly hazardous to pedestrians.

The critical role of vehicle speeds in pedestrian crash outcomes is further illustrated in the study by Mclean et al. (1994) who found that for a modest reduction in travel speed from 60 to 55 km/h, there will be a reduction in the incidence of pedestrian fatalities of around 30%. This strongly suggests that an innovative approach is needed to reducing vehicle speeds to uniformly lower levels in pedestrian environments. Numerous other studies of pedestrian safety confirm that, in the absence of high vehicle speeds, pedestrian crash and injury risk are considerably reduced.

### 3.8 ROAD SURFACE AND MARKINGS

Well-worn road surfaces, common along the high pedestrian crash frequency routes, are likely to exhibit poor skid resistance for vehicles braking to avoid conflict with pedestrians - many of Melbourne's arterial routes carry high volumes of heavy vehicles which, in turn, contribute markedly to the worn condition of the pavement and pavement markings. Having regard to the findings of 3.7 above, low skid resistance of worn road surfaces means vehicle speeds will be higher when drivers are braking to avoid a collision and, therefore, the risk of severe pedestrian crashes will be higher.

Lane-markings were typically faded along some routes, leading to reduced lane discipline by drivers, greater uncertainty for pedestrians about likely vehicle paths and, ultimately, a heightened risk of conflict between pedestrian and driver.
4. COUNTERMEASURE OPTIONS

In accordance with the project aim of developing generic solutions to generic problems, this Section proposes countermeasures for the common crash circumstances described above. In most cases mechanisms by which the crash reduction effects can be achieved are clear. Where this is not necessarily the case, a more complete description, covering secondary influences where relevant, is provided. Some countermeasures, because of their nature, can be expected to address more than one common crash circumstance.

4.1 TRAFFIC ENGINEERING/MANAGEMENT

These countermeasures generally involve traffic engineering and/or traffic management type approaches, applied to routes with high pedestrian crash potential.

4.1.1 Review and Redefine Road Function

Clearly, the presence of public transport services and certain types of land use generate high levels of pedestrian activity. Where such conditions prevail along roads performing an important traffic carrying function (as is the case, by definition, with Melbourne’s arterial routes), resolution of the resultant conflict between road traffic and land use objectives is critical for pedestrian safety.

The hazardous pedestrian routes investigated in this study lie on arterial roads, usually characterised by tram services and high levels of pedestrian activity associated with strip shopping and high density residential developments.

While resolving the conflict between these quite fundamental and legitimate community objectives is usually difficult and sometimes impractical to achieve, it is important to critically review whether the road in question is an essential element of the arterial network. The traffic carrying function of a road, which at some point in history was regarded as warranting arterial status, may be changing as a result of variations in land use, major additions to the metropolitan road network and, perhaps, significant changes in public transport provision. Changing circumstances of these types may well offer a rare opportunity to redefine the traffic function of a road, thus presenting a variety of enhancement possibilities for the surrounding land use.

By way of example, the Victorian Government’s recent decision to build the Southern Bypass illustrates the opportunities available for redefinition of road function. In particular, Toorak Road through the South Yarra Shopping Centre may not be required to perform a long term primary arterial road function in Melbourne’s metropolitan system, once this major, parallel addition to the network is operational. Redefining the function of roads, such as in this section of Toorak Road, enables reductions in traffic volumes and consequent reductions in exposure to risk for pedestrians. Traffic congestion may also be reduced, thereby cutting occasions when pedestrians are required to cross between queuing vehicles - a common pedestrian crash circumstance (refer section 3.5).

As is discussed later in this section, opportunities to reduce road widths to be crossed by pedestrians, widen footpaths, improve shopping centre “streetscapes” and generally provide a better level-of-service for pedestrians at traffic signals, are all facilitated under this scenario. The character of Melbourne’s strip shopping centres can be greatly enhanced where redefinition of road function is appropriate.
In special cases, creating a pedestrian mall may be both practical and economically favourable. The development of alternative (bypass) routes may enable this to occur.

### 4.1.2 Reduce Traffic Volumes by Encouraging Alternative Routes

As described in section 4.1.1 above, pedestrian safety can be enhanced by redefining the traffic function of a road, if this results in reductions in traffic volumes and hence exposure to risk for pedestrians. Realistically, it is impractical to substantially downgrade the status of many of Melbourne's arterial roads. However, reductions in vehicle volumes may still be achievable, provided suitable alternative routes exist.

Improving traffic access to, and travel along, alternative arterial routes should attract traffic from routes known to be hazardous to pedestrians, while at the same time minimising traffic volumes through areas of high pedestrian activity, or land use types which are incompatible with arterial road traffic. Transferring traffic to *inherently safer* routes can be achieved or promoted using a range of conventional road engineering and traffic management techniques. Such techniques might include measures to ensure favourable travel times compared to the route experiencing pedestrian crashes.

### 4.1.3 Reduce Vehicle Speeds

Notwithstanding the on-going debate about the appropriateness of lower urban speed limits, there is compelling evidence that lower speeds on urban arterials will dramatically reduce the number and severity of pedestrian crashes (refer Section 3.7).

Two main options for achieving reductions in vehicle speeds in areas which present a high risk to pedestrians are proposed:

- **develop variable speed limit signing to apply over the length of arterial road potentially hazardous to pedestrians.** Recent research carried out by Mclean et al. (1994) indicates that pedestrian fatalities would be reduced by thirty-two percent if vehicle speeds could be reduced by 5 km/h from 60 km/h. The reduced speed limit would operate during high risk periods, with an expected minimal overall effect on traffic delays. Such a measure would be entirely consistent with the distinctly different traffic function of roads passing through high density commercial developments, with their associated pedestrian activity.

Revisions may be necessary to Victoria's Speed Zoning Guidelines to ensure appropriate sensitivity to road and traffic environments clearly associated with high pedestrian crash risk. Such environments have been known and reliably defined in previous pedestrian safety work. A substantial change in conventional thinking will be required if these long-standing problems are to be successfully addressed.

This form of speed zoning delivers a very important message to drivers about the crash risks within pedestrian environments. It clearly affirms to drivers that the usual 60 km/h limit generally applying is not a recommended speed, but rather, an upper limit if the conditions are safe. It also signifies that crash risks are genuinely greater within specially zoned sections of road and that travelling at the normal speed limit of 60 km/h is excessive to avoid serious conflict with pedestrians. Because most vehicles travel at lower speeds than the legal limit during these high risk periods, there would be little adverse effect on vehicle travel times overall. The major safety benefits would
result from reducing the speeds of the estimated 15% of drivers who travel above 40 km/h, especially the few percent of drivers who exceed the speed limit. More uniform vehicle speeds (i.e. lower variance in speeds around the mean speed) are regarded as less likely to cause conflict.

To be successful, the introduction of variable speed limit signing would need to be accompanied by appropriate levels of enforcement and publicity to ensure that drivers understand that there is a significant risk of detection and penalty (an approach which has been successfully used in the introduction of Victoria’s Speed Camera Program).

- increase speed enforcement, targeting the small number of dangerous drivers who exceed the speed limit significantly.

- modify the design of the road and the roadside to induce drivers to travel at speeds more appropriate to the type of land use and to the potential conflict with pedestrians. In particular, measures such as narrowing road pavements/widening footpaths, constructing medians, and “streetscaping”, tend to influence driver behaviour and bring about lower speeds, by conveying to drivers that they are passing through an environment where road use by vehicles should be equitably shared with pedestrians.

More innovative, perceptual countermeasures could also be developed for use in this type of environment. Measures which influence driver sensory perception, such as visual patterns and surface treatments providing a tactile and/or audible stimulus, have been shown to be effective in reducing vehicle speeds. (Fildes and Jarvis, 1994). While such measures have been used in different types of conditions to those being investigated here, they have the potential to be developed into cost-effective pedestrian crash countermeasures along urban arterial roads.

### 4.1.4 Provide a Better Level-of-Service to Pedestrians at Traffic Signals

Improving the level-of-service provided to pedestrians by intersection and pedestrian operated signals will encourage greater use of, and compliance with, traffic signals by pedestrians and hence safer crossing movements than can otherwise occur. This countermeasure approach conforms with the National Road Safety Strategy which “seeks to redress existing inequities through targeting disadvantaged and vulnerable road users”. Significant improvements to the level-of-service can be made by:

- reducing signal cycle times and hence average delay to pedestrians;

- permitting late introduction (and re-introduction) of pedestrian walk phases for pedestrians who arrive after the commencement of the corresponding green phase for vehicles, rather than having to wait almost a full cycle of the signals;

- extending pedestrian walk times. This is especially important to pedestrians in the high risk (young, older and intoxicated) pedestrian categories. There are many school children and older pedestrians for whom traffic signals offer the only safe access to tram, train and bus services and to carry out other daily activities. If longer pedestrian walk times and more frequent introduction of pedestrian phases add unacceptably to existing delays to motorists, this practice could still offer substantial road safety benefits if limited to non-peak traffic conditions.
As described in Section 3.6, observations of pedestrian behaviour at some signalised intersections suggest that, under some signal phasing arrangements, pedestrians may incorrectly infer that it is "safe" to cross even though signals applicable to them are red. The installation of flashing signal displays (e.g. "PEDESTRIANS MUST WAIT FOR WALK SIGNAL") to supplement existing displays at relevant intersections may help to reinforce the need for pedestrians to comply with the signals at critical times in the cycle. These targeted displays would be activated only at high risk times in the cycle and could be an integral part of existing pedestrian walk signals. As such they would reinforce in the minds of pedestrians that non-compliance is especially risky during certain periods in the cycle. Implications on the capacity of existing signal controllers to provide this facility needs consideration, as does monitoring and evaluation of this measure to ensure beneficial effects on pedestrian safety.

In some special cases, the opportunity also exists to provide intersection signal phasing which more effectively separates pedestrians and vehicles. Fully controlled right-turn phases are an example of providing time-separation between right-turning vehicles and conflicting pedestrian movements.

4.1.5 Provide More Pedestrians Signals
It was noted in Section 3.4 that pedestrians typically use the shortest and/or quickest route to cross, and show a definite reluctance to walk substantial distances to use pedestrian signals or other facilities provided. While this form of pedestrian behaviour is common in locations such as strip shopping centres, and would probably continue to some degree, even with additional signals and fencing, there are other pedestrians who rely upon and will continue to use pedestrian facilities in a safe and proper manner. These pedestrians should not be denied safe crossing facilities because others continue to accept the risks involved in crossing busy arterials at hazardous, uncontrolled locations.

This circumstance is especially relevant to school-aged children and older pedestrians whose judgement and decision-making abilities in traffic are limited by age-related factors. Furthermore, older pedestrians often lack the agility to safely negotiate busy arterial road traffic and so rely heavily on the provision of safe crossing facilities. This issue will assume greater prominence as Victoria's population continues to age.

By providing more pedestrian signals at closer intervals, pedestrians, especially those in higher risk categories, will benefit directly from the more convenient signal placement.

4.2 ROAD/PHYSICAL ENGINEERING
The following countermeasure options involve changes to the physical environment of the road and roadside, along routes with a demonstrated risk of pedestrian crashes.

4.2.1 Reduce Road Widths and Widen Footpaths
Section 3.1 highlights the finding that roads with high pedestrian crash frequencies were typically wide and/or multi-lane routes, characterised by complex traffic conditions, situated in areas of high pedestrian activity. Where road function permits, reductions in road width, desirably through the widening of footpaths, can be expected to substantially reduce the risks to pedestrians crossing arterial roads. Narrower roads present a less demanding traffic environment and expose pedestrians to risk for shorter durations, a situation which is particularly important for the high risk pedestrian categories, especially
older pedestrians, who take longer to cross and whose judgements and decision-making in traffic deteriorate with age. Kerb extensions, a specific form of road narrowing, would be expected to assist young pedestrians who, because of their typically smaller stature, rely for their safety on adequate sight distances between themselves and drivers.

As mentioned in Section 4.1.3, narrower roads/wider footpaths tend to induce lower vehicle speeds, adding further to the crash reducing potential of this countermeasure.

4.2.2 Provide Medians

In order to address the risks associated with the linearly distributed nature of pedestrian crossing demand within strip shopping centres and along arterials in general, it is recommended that medians be provided throughout hazardous sections of arterial roads. The key feature of medians in these circumstances is their ability to provide assistance to pedestrians over their entire length, rather than in the limited way that localised treatments do (e.g. pedestrian signals). As described in Section 3.5, medians may be able to provide safety benefits to older pedestrians in particular, largely because of their tendency to simplify the crossing task in busy, complex traffic environments.

Medians need not necessarily be raised and some innovative treatments, involving painted or textured pavements with raised pedestrian refuges at intervals, have been used in several locations in Melbourne and elsewhere in Australia.

A median could be defined between the two inside rails of tram tracks, in the form of a painted or textured pavement. Pedestrians need concentrate on only one direction of traffic at a time when crossing, and can wait on the median in greater safety than is presently possible. The definition of the median could be further strengthened with tactile lane line markings, raised reflective pavement markers or internally illuminated bollards to discourage motorists from the identified hazardous practice of overtaking queued vehicles by crossing the centre line. It should be noted, however, such markers may present safety problems for pedestrians, especially older pedestrians who are less agile and at greater risk of tripping on the markers in their haste to cross.

It should be noted that the majority of pedestrians involved in crashes were struck from the right suggesting that they would not have reached a median if one had existed. It could be argued, therefore, that medians will not assist pedestrians in this situation. However, providing a median enables pedestrians to concentrate on one direction of traffic at a time and so cross in two stages, if required. This greatly simplifies the task for pedestrians and, as a result, should substantially improve safety.

The provision of a median as described is likely to reduce vehicle travel speeds, further enhancing safety for pedestrians.

By marking out a median in this form, the main travelling lane will shift laterally to the left (by, perhaps, half a metre), resulting in a narrowing of the kerbside lane. As a consequence, the narrower kerbside lane is less likely to be straddled and used as a travelling lane when parking is permitted. Therefore pedestrians emerging from between parked cars will be able to wait to cross in a less vulnerable position.

The provision of medians raises a unique problem along Melbourne's many arterial roads served by trams. While there is minimal space for a pedestrian to wait on the median
when two trams attempt to pass simultaneously, this situation would be relatively rare and therefore should not hinder implementation where there would be net safety benefits. With appropriate training and, if needed, regulation, tram drivers would be required to slow on the approach to such situations and not proceed until the risk to pedestrians has passed. Tram drivers already face this type of situation and have to exercise this form of caution to prevent a pedestrian/tram collision.

The particular benefit of medians in commercial environments is the safer crossing opportunities provided throughout the length of the commercial development, in accordance with the distributed nature of pedestrian crossing demand. That is, pedestrians generally wish to cross throughout the length of a commercial area rather than at a specific point(s). Median treatments meet pedestrian needs in this respect.

4.2.3 Install Fencing and Other Barriers
Route investigations show that a majority of pedestrian crashes involved pedestrians struck from the right or near-side, either directly or while emerging from in front of parked/stationary vehicles. Many crashes of this type occurred on the approaches to, but not at, traffic signals, while pedestrians were crossing between queuing vehicles. In general, pedestrians appear to have been at fault in such accidents.

The erection of pedestrian fencing either side of intersection or pedestrian operated signals for at least 20 metres (i.e. the distance within which it is illegal for pedestrians to cross), would encourage pedestrians to cross at signals rather than at nearby locations made hazardous to pedestrians by the frequent queuing of vehicles on roads which typically have multiple lanes in each direction. While the presence of side streets and driveways necessitates breaks in the fencing, and hence limits its effectiveness, fencing may still reduce the incidence of pedestrians crossing at risky locations. Arrangements which direct hotel patrons to safer crossing points should be given high priority. Consideration could also be given to fixing signs in prominent positions on pedestrian fences, warning pedestrians of the risks involved (e.g. “Pedestrian Hazard - Please Cross Only During Green Signal”). In areas with a high ethnic component to the population, these signs could also be produced in the major local languages other than English, and could include an image of the green walk symbol.

In some location types, alternative barriers to fencing may be used, both for aesthetic reasons and to achieve greater compliance from pedestrians. Barriers in the form of garden beds, raised planter boxes, outdoor seating, etc., may realise higher levels of compliance from pedestrians because they appear as natural elements of the streetscape, rather than as overt attempts to redirect pedestrians from their most convenient path. Practical examples are given in “Sharing the Main Street” (RTA, NSW and FORS, 1993).

Either as a stand-alone measure or in conjunction with the erection of fencing or other barriers, extensions to parking restrictions on the approach and departure sides of intersection and pedestrian operated signals are also recommended where sight distances, between pedestrians and drivers, present a hazard to pedestrians.

4.2.4 Provide Skid Resistant Pavements
Well-worn road surfaces were common along the high pedestrian crash frequency routes investigated. Such surfaces are likely to exhibit poor skid resistance for vehicles braking
to avoid a conflict with pedestrians. High volumes of heavy vehicles accelerate the damage to road pavements.

To improve the braking capabilities of vehicles on both wet and dry surfaces, and hence reduce the risks of severe impacts with pedestrians, segments of arterial road which are hazardous to pedestrians could be resurfaced with a skid resistant pavement material. The potential effectiveness of this countermeasure type could be enhanced beyond its fundamental purpose of improving vehicle braking performance, if developed to include a unique stimulus that drivers would become conditioned to associating with areas of high pedestrian activity. Surfaces that are unique in terms of their colour, or their tactile or noise characteristics may help to alert drivers to the changing road circumstances, highlighting the need for lower speeds and greater attention to the driving task.

The use of this type of countermeasure may be limited on routes with tram tracks set in concrete. There is a practical concern about a possible unbalanced effect of the countermeasure on vehicle braking stability, especially where vehicles travel with the tyres on one side of the vehicle on the concrete surface and the tyres on the other side in contact with the skid resistant pavement.

4.2.5 Improve Street Lighting

The presence of licensed premises appears to be an important factor in a substantial number of pedestrian crashes, with pedestrian crashes potentially related to alcohol occurring in the vicinity of hotels, night clubs and restaurants.

Some of the measures described in Section 4 will assist intoxicated pedestrians to some degree, however, pedestrians with high BAC’s (e.g. >0.15 g/100 ml) are unlikely to respond to treatments requiring sound judgement on their part. That is, intoxicated pedestrians can be expected to have a limited ability to cross roads in a responsible and safe manner, particularly if crossing alone. Countermeasures which depend more on the driver than the pedestrian may be preferable in the case of alcohol-affected pedestrians.

The provision of high-illumination street lighting in areas of high pedestrian activity, in combination with a high presence of licensed premises or other known risk factors, would offer drivers a better chance of avoiding intoxicated pedestrians at night, because pedestrians would be able to be seen more readily and sooner. While many of the routes characterised by intoxicated pedestrian crashes already have street lighting to ‘normal’ standards, it may be necessary to provide street lighting to a much higher level, given the markedly reduced capabilities of intoxicated pedestrians.

AUSTROADS Guide to Traffic Engineering Practice Part 12 - Roadway Lighting (1988) provides a general guide to roadway lighting standards and practices applicable to traffic routes and to a lesser extent, to local collector and minor streets. The Guide emphasises that roadway lighting design and practice is based on well established principles, experience and economic considerations. However the associated warrants and standards need to be applied with flexibility and judgement to account for the wide variation in site, traffic and environmental conditions which occur in practice.

In discussing road safety benefits, the AUSTROADS Guide refers to a UK study by Scott (1980) which looked at the effect on accidents of varying the quality of lighting on dry two-lane roads in 30 miles per hour speed limit areas. Scott’s study, among other things,
showed a strong relationship between average road surface luminance and dark-to-day accident ratio in the range of average luminance values of 0.5 to 2.0 cd/m². It was estimated that an increase of 1.0 cd/m² resulted in a 35% decrease in the dark/day accident ratio. Scott's results confirm the belief that a diminishing return occurs for average luminance values greater than 2 cd/m².

The AUSTROADS Guide refers to the relevant Australian Standard, AS 1158 - SAA Public Lighting Code (1986) which provides various categories of lighting level against typical applications. While the lighting standards at each of the locations investigated were not determined with certainty, they are believed to fall below the maximum lighting category (A1), leaving significant scope for upgrading within the established guidelines.

4.2.6 Create an Appropriate Streetscape

The form of roadside development offers one of the most promising opportunities for improving driver behaviour (current Victorian speed zoning guidelines are largely based on the nature of abutting development). By creating a streetscape that clearly signifies to drivers that pedestrian conflicts are likely to be encountered, drivers can be encouraged to travel at speeds more compatible with the conditions. Streetscapes which reduce carriageway widths and create a more confined feeling for drivers are more likely to produce lower vehicle speeds. The removal of unnecessary street furniture that may conceal a pedestrian from a driver's view is also desirable.

"Sharing the Main Street" (RTA, NSW and FORS, 1993) presents numerous examples of streetscapes appropriate for strip shopping developments, not only for enhancing the development, but to create an environment visually consistent with the type of land use.

4.3 BEHAVIOURAL CHANGE

The following countermeasure options aim to bring about a positive behavioural change in the high risk categories of drivers and pedestrians.

Unlike road environment countermeasures, behavioural countermeasures are not fully effective in reaching, or indeed influencing, pedestrians and drivers using a particular route, nor can their effects be lasting in the same way that a median, for example, can provide safety benefits all day, every day, for all pedestrians using a location. These inherent differences between behavioural change countermeasures and physical improvements can be expected to be reflected in their relative levels of effectiveness.

A variety of measures is proposed to raise the awareness of both pedestrians and drivers to pedestrian crash risks and safe forms of behaviour for given environment types. Countermeasures which are generic in nature are preferred because of their potential to reduce crashes on a larger scale.

4.3.1 Pedestrians

- educate all users of a particular route (including non-English-speaking residents) about the specific risks pedestrians face. Traffic safety pamphlets could be distributed to surrounding schools, businesses and shops, homes (and Housing Commission flats where present), the Public Transport Corporation and staff/management of organisations such as St. Vincent de Paul and the Brotherhood of
St Lawrence. Where applicable, pamphlets would be presented in English and other major languages of the area, to assist recent migrants with pedestrian safety;

- **place posters or signs on the outside of, and within, trams and/or buses servicing the route.** Also, signs could be placed on tram and bus shelters along the route to encourage safe crossing behaviour during high risk traffic times. Painting trams and buses with pedestrian safety messages is a potentially effective medium for targeting road users along a hazardous route (this medium is already used for commercial advertising purposes on both trams and buses);

- **target local hotels and pubs to introduce (more effective) alcohol intervention programs for patrons.** Under these programs, alcohol servers would be educated and trained to be more responsible by limiting the amount of alcohol served to patrons. Also, encourage the use of coin-in-the-slot breath testing machines in local licensed premises to enable patrons (both pedestrians and drivers) to regulate their drinking in accordance with their Blood Alcohol Concentrations.

### 4.3.2 Drivers

- **develop, in conjunction with the Public Transport Corporation, road safety training programs for tram drivers and safer passenger boarding and alighting arrangements.** Such programs would:

  (a) provide further help to tram drivers in avoiding collisions with pedestrians, and

  (b) include operational strategies to ensure more orderly passenger boarding (and alighting) arrangements to reduce the risk of passengers being struck by other traffic, and could also involve a critical review of the design, operation and regulations associated with tram safety zones and tram stops generally. This countermeasure option aims to reduce crash risks resulting from passengers taking undue risks while alighting from trams or crossing roads to avoid missing an approaching tram (measures such as the recent fitting of warning signs which protrude from the sides of trams when they are stopping, are likely to have a beneficial effect on crash risk;)

- **warn drivers about the hazardous nature of specific routes to pedestrians.** This might be achieved by erecting "Pedestrian Black Spot" signs at either end of, and within, the relevant road section. Signs could take the form of conventional static signing or dynamic, possibly variable message signs, similar to those being installed on Melbourne's Freeways to advise motorists of road works ahead, traffic delays, alternative routes, etc..

- **produce and distribute pedestrian safety videos** targeted at local residents (especially of Housing Commission flats) and employees of local industries and large commercial/business premises in surrounding areas. These videos would address the common crash characteristics of the target route, and would highlight major hazards and corresponding behaviours to counter them. This initiative is conceptually similar to the "Safe-Routes-to-School" model, but with a target group(s) to match the major crash characteristics of the route.
4.4 POLICE ENFORCEMENT

There are a number of countermeasure options based on police enforcement of road user behaviour. It should be noted that at present, Police enforcement of pedestrian compliance with road traffic regulations is significantly hindered by pedestrians not being required to provide proof of identity to Police officers. This, and other considerations, such as the adequacy of existing penalties as a deterrent to unsafe behaviours may warrant revision.

The main options for undertaking police enforcement of pedestrian and driver behaviour include targeting:

- hazardous routes during the high risk times of day and days of week;
- dangerous overtaking behaviour by drivers during congested periods;
- pedestrian compliance with intersection and pedestrian operated signals;
- safe crossing behaviour by intoxicated pedestrians;
- driver compliance with speed limits, especially during high pedestrian risk periods.

Increased enforcement would be an alternative countermeasure in locations where pedestrian fencing or other barrier types are not suitable.

4.5 VEHICLE-BASED COUNTERMEASURES

Although there are few vehicle-based countermeasures that can be applied at specific locations, the following options have been identified:

- modifying the frontal design of vehicles to improve compatibility with pedestrians in impacts have been shown in some Australian and international research to have potential to significantly reduce the severity of pedestrian injuries;
- requiring or encouraging daytime running lights on vehicles passing through hazardous pedestrian areas may raise pedestrian awareness of risks while crossing;
- discouraging or preventing the use of tinted windscreens would assist driver vision of pedestrians at night and in other low visibility conditions;
- given the high direct involvement of trams in many pedestrian crashes, developing and fitting energy absorbing cushions or other similar devices to both ends of trams, to substantially reduce the severity of impacts with pedestrians.
5. ECONOMIC EVALUATION

As part of the investigation of pedestrian safety problems and development of countermeasures along various routes, the road and traffic engineering countermeasures were evaluated in terms of their economic worth. The detailed results of these individual route evaluations are included in the corresponding route reports. Section 5 provides an overview of these evaluations.

Only the road safety benefits of individual countermeasures have been included in the economic evaluation, with impacts on traffic capacity/delay being addressed in Section 4 in a qualitative manner. In most cases, estimates of the effectiveness of specific countermeasure options in reducing pedestrian casualty crashes are not reliably known from past research, mainly because they have not been used and/or evaluated in such circumstances. Consequently, the economic evaluations were carried out by calculating separate Benefit to Cost Ratios (BCR’s) and Net Present Worth values (NPW’s), for a range of assumed levels of effectiveness.

Assumptions made in the evaluations are documented in related reports by Corben et al. (1993 and 1994). These assumptions are based on a system developed to evaluate the Transport Accident Commission’s Accident Black Spot Program, implemented in Victoria during 1992/93 and 1993/94. The major assumptions relate to the use of an eight percent discount rate, the average costs of crashes of given severity, capital and recurrent costs of treatments and the lives of individual treatment types. The results, which are summarised in Table 5.1, are expressed in terms of the lowest and highest estimates of BCR and NPW for the five locations investigated in detail. Where the particular treatment was applicable to one location only, a point estimate is given.

In summary, the results of the economic evaluation indicate that virtually all proposed countermeasures would be economically worthwhile even at modest levels of effectiveness. Only in the case of the skid resistant pavement countermeasure, at an estimated effectiveness of 10%, is the estimated economic worth marginal. In most other circumstances, the treatments would deliver extremely attractive economic benefits, well in excess of costs. If applied at other Melbourne locations having like-crash problems, the road safety and economic benefits would build quickly ensuring early reductions which can be readily sustained in the longer term.
## Table 5.1 Economic Evaluation of Road Environment Countermeasures

### SUMMARY OF NET PRESENT WORTH AND BCR VALUES

<table>
<thead>
<tr>
<th>Recommended Treatment</th>
<th>Predicted % red. in ped. cas. crashes</th>
<th>NPW ($ ,000)</th>
<th>BCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian Delineation</td>
<td>10</td>
<td>115 -243</td>
<td>6.8 - 12</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>250 - 509</td>
<td>14 - 23</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>385 - 776</td>
<td>20 - 35</td>
</tr>
<tr>
<td>Ped. Op. Signals</td>
<td>5</td>
<td>71 - 181</td>
<td>2.6 - 5.2</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>184 - 405</td>
<td>5.3 - 10</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>411 - 852</td>
<td>11 - 21</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>638 - 1,299</td>
<td>16 - 31</td>
</tr>
<tr>
<td>Pedestrian Fencing</td>
<td>5</td>
<td>63 - 176</td>
<td>2.3 - 4.1</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>177 - 435</td>
<td>4.5 - 8.3</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>404 - 953</td>
<td>9.1 - 17</td>
</tr>
<tr>
<td>Street Lighting</td>
<td>10</td>
<td>202 - 505</td>
<td>9.2 - 39</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>316 - 764</td>
<td>14 - 58</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>-45 - 56</td>
<td>0.8 - 1.3</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>23 - 189</td>
<td>1.1 - 1.9</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>90 - 322</td>
<td>1.5 - 2.5</td>
</tr>
<tr>
<td>Skid Res. Pavement</td>
<td>10</td>
<td>-24 - 197</td>
<td>0.9 - 1.8</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>203 - 644</td>
<td>1.8 - 3.6</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>430 - 1,091</td>
<td>2.7 - 5.4</td>
</tr>
<tr>
<td>Variable Speed Limit</td>
<td>5</td>
<td>222 - 257</td>
<td>110 - 130</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>445 - 516</td>
<td>220 - 260</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>893 - 1,034</td>
<td>450 - 520</td>
</tr>
<tr>
<td>Mod. sig. cycle times</td>
<td>10</td>
<td>471</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>733</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>989</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>1,507</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>555</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>882</td>
<td>9.8</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>1,209</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>1,864</td>
<td>20</td>
</tr>
<tr>
<td>Roadway Width Reduction</td>
<td>10</td>
<td>555</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>882</td>
<td>9.8</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>1,209</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>1,864</td>
<td>20</td>
</tr>
<tr>
<td>Reduce Number of Lanes</td>
<td>10</td>
<td>555</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>882</td>
<td>9.8</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>1,209</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>1,864</td>
<td>20</td>
</tr>
</tbody>
</table>
6. NEW AND IMPROVED SOLUTIONS FOR HIGH PEDESTRIAN CRASH FREQUENCY ENVIRONMENT TYPES

Section 6 is concerned with the difficulties of treating long-standing pedestrian crash problems, where the implementation of potential solutions has been impeded by competing objectives. While the emphasis of the study was on generic road and traffic engineering countermeasures, behavioural and, to a lesser extent, vehicle engineering measures have also been considered.

6.1 BACKGROUND AND AIMS

Past efforts to reduce the number and severity of pedestrian crashes in high pedestrian crash frequency environments have often been impeded by conflicting objectives, such as commercial, other land use and/or traffic flow objectives. For example, there are many situations where lengths of pedestrian fencing in strip shopping centres would effectively direct pedestrians to safer crossing facilities, but such measures are frequently not implemented because of commercial pressures to preserve on-street car parking.

The continual pressures to implement annual programs of engineering improvements within budget and on time make it difficult for those responsible for negotiating final design agreements, to resolve such complex, often intractable issues. As a result, less effective approaches are sometimes adopted.

This phase of the study aimed to identify and develop practical, innovative and effective solutions to commonly encountered pedestrian safety problems where conflicting interests impede satisfactory treatment.

A wide range of measures was considered, including initiatives aimed at behavioural change, land use and traffic planning, and road/traffic engineering improvements. If an approach which is balanced in terms of safety, commercial objectives, traffic movement objectives, etc., can be developed, there is considerable potential to treat a sizeable portion of urban pedestrian crashes - a long standing problem, for which few practical and cost-effective solutions have been available.

6.2 THE PROCESS

The development of innovative approaches was explored through the use of a group of experts in relevant fields. Members of the group were asked to think innovatively in generating possible solutions, outside of the traditional boundaries where appropriate. Discussion teams were formed to generate and critically consider potential solutions to three or four issues assigned from a list of ten commonly encountered pedestrian safety problems identified during the course of the study.

The authors would like to acknowledge the valuable insights provided by the following people who participated in this phase of the study:

Mark Allan, Urban Design - Melbourne City Council
Leigh Booth, Victoria Police
6.3 POTENTIAL SOLUTIONS

This section describes, for each main problem type, the potential solutions identified through the above process. For some issues, discussion groups also addressed and described some of the concerns and impediments to developing effective treatments. Where relevant, they have also been reported below, in the form of a description of the nature of the problem.

One attractive suggestion was that more effort should be made to actually ask pedestrians what they want and what they would use, rather than deciding on measures which may fail because of lack of acceptance and support by pedestrians.

6.3.1 Linear Type Treatments

Issue 1 - Difficulties in providing linear type treatments where land use and hence pedestrian activity are also linearly distributed along arterial routes

The Nature of the Problem
Traffic flow objectives and long cycle times of the SCATS signal system tend to create delays (up to 2 minutes) for pedestrians, raising the question as to whether pedestrians are commonly overlooked in traffic management considerations. There is also a tendency to look to traffic signals to provide the total solution to pedestrian needs. A lack of knowledge about available alternatives, which may be more cost-effective, exacerbate this situation. Treatments tend not to address the linear nature of pedestrian crossing demand, nor emphasise the importance of matching solutions to the characteristics of pedestrians and the environment.

Other difficulties in providing solutions relate to the various forms of treatment costs (e.g. capital cost and impacts on traffic flow) and the ability to justify expenditure.

Potential Solutions
- include requirements for pedestrian safety at the planning stage or take opportunities to incorporate solutions when streetscape improvements are being made. This is preferable to having to justify remedial works/improvements at a later stage, after crash problems have become evident;
• capitalise on rare opportunities, such as the construction of Melbourne’s City Link project, to implement significant traffic management improvements, including redirecting vehicles to alternative (safer) routes and downgrading the traffic carrying function of routes hazardous to pedestrians;

• provide suitable replacement parking arrangements, especially for commercial use, so that options which would otherwise be rejected become acceptable;

• raise community awareness of the pedestrian safety problem;

• develop regulations which more effectively consider pedestrians.

6.3.2 Medians Along Tram Routes

Issue 2 - Difficulties in providing medians along tram routes and/or along highly saturated arterial roads

The Nature of the Problem
Tram operators have a concern about encouraging pedestrians to stage their crossing movements between the tram tracks. The concern relates to the possibility of crash risk being transferred from pedestrian/vehicle to pedestrian/tram (e.g. two trams simultaneously passing a pedestrian waiting on a “median” between the tracks).

In some circumstances, medians may limit access for turning vehicles, may limit access to parking by, for example, preventing U-turns and/or can affect arterial road capacity where lanes are lost or narrowed.

Potential Solutions
• take opportunities during tram infrastructure works (e.g. Brunswick Street, Fitzroy) to widen the distance between the inside rails, to enable improved pedestrian refuge/median designs to be provided;

• use skid resistant material to form medians between the inside rails of tram tracks, in recognition of the use made of this area by motorcycle Police on emergency duty.

6.3.3 Reducing Carriageway Width

Issue 3 - Loss of parking and/or traffic capacity when wishing to improve pedestrian safety by reducing carriageway width

The Nature of the Problem
The main negative impacts of carriageway width reduction include effects on local businesses, due to reductions in available loading zones and customer parking, and loss of amenity in surrounding areas due to extraneous traffic diverting to local streets. There were some initial concerns expressed about the effectiveness of carriageway width reduction in reducing pedestrian crashes. It was also suggested that traffic capacity losses should be estimated in quantitative terms as they may not be proportional to reductions in carriageway width. To help in deciding on the importance of losing some on-street
parking spaces, it would be helpful to also know whether pedestrian crashes occur during clearways.

Potential Solutions

- use both lane width reduction and carriageway width reduction to slow traffic;

- re-route traffic to safer roads, including bypasses and ring roads where appropriate, to alleviate capacity problems (successful rural and metropolitan examples exist);

- remove fairway restrictions, if necessary, to enable the removal of a lane;

- consider offsetting lane reductions from say, four to three lanes, by introducing peak period contra-flow arrangements, with the middle lane being used by either direction, depending on time of day and peak traffic flow directions (note, however, that the current study identified contra-flow operation as a major contributing factor to pedestrian crashes at one of the six locations investigated (Johnston Street between Hoddle Street and Wellington Street);

- consider using Puffin or Pelican crossings to improve pedestrian safety where loss of traffic capacity is an important consideration (note that an evaluation of the trial use of Puffin and Pelican crossings by ARRB showed that any benefits due to these devices accrued to drivers and were of an operational nature only);

- modify parking restrictions associated with mail boxes, e.g. change to loading zones, to offset loss of on-street parking;

- convince traders that losing some parking may actually benefit their trade. However, given the reluctance of local business communities to accept losses in on-street parking, there is need to publicise successful strategies, such as Swanston Street, Melbourne, Camberwell Junction, Acland Street, St. Kilda and Puckle Street, Moonee Ponds. There is, however, a lack of evaluation data on crash effects, speeds and effects on commercial performance;

- influence longer term outcomes in strip shopping centres and other high risk areas by local government planners developing strategies for strip shopping centres, with new and existing developments being subject to “safety impact assessments/statements”;

- develop a menu of pedestrian measures, based on this study, AUSTROADS’ Guide to Traffic Engineering Practice - Pedestrians (1995) and Peter Cecil’s work in the City of St. Kilda, which gives a local government perspective to providing for pedestrians;

- develop municipal pedestrian safety strategies such as has been done in the CAD of Melbourne (refer also to the former Shire of Bulla’s Safe Living Program for information on pedestrian safety measures and strategies). This approach could be extended to include Geelong and other provincial centres, and could be initiated through an approach to the Municipal Association of Victoria.
6.3.4 Pedestrian Fencing/Barriers

Issue 4 - Loss of parking when erecting fencing or other pedestrian barriers

Potential Solutions
• erect pedestrian fences on approaches to intersections for only the length of exclusive left turn lanes. This will not affect parking provision as parking is not permitted in these zones anyway;

• erect pedestrian fencing on medians where applicable. Preference should be given to fence types that are aesthetic (e.g. designed to allow plants to be grown beside or over them) so that they become a natural part of the streetscape, and are not perceived by pedestrians as intentional barriers causing inconvenience to pedestrians;

• design fencing to progressively reduce in height on the approach to the location where pedestrians cross, to ensure more favourable sight distances. Care should also be taken to avoid hazards to vehicle occupants if the fencing is struck.

6.3.5 Safer Vehicle Speeds

Issue 5 - Developing techniques for achieving safer vehicle speeds within high pedestrian activity areas along arterial roads

Potential Solutions
• influence driver perception of the environment by using a "package of measures", such as:
  * kerb extensions
  * tree planting
  * public lighting
  * distinctive road pavement colour and texture
  * gateway type treatments
  * reduced lane widths
  * medians or refuges
  * general signage (illuminated at night)
  * compatible forms of parking
  * speed limits and supporting limit signs (possibly time-based);

• target speed enforcement and supporting publicity;

• evaluate the effectiveness of laser speed enforcement technology in, say, Brunswick Street, Fitzroy.

6.3.6 Traffic Signals

Issue 6 - Pedestrians crossing between queued or slow moving vehicles (typically on the approaches to traffic signals), Issue 7 - Long traffic signal cycle times and hence poor pedestrian level-of-service, Issue 8 - Poor pedestrian compliance with traffic signals and with road traffic regulations generally
The Nature of the Problem
Because of the strong inter-relationship between these three issues and the potential solutions tend to address more than one of the issues, the discussion group chose to consider them collectively.

Potential Solutions
- reducing signal cycle times (within co-ordinated signal systems) has been found in trials to reduce the degree of queuing and may therefore have safety benefits for pedestrians. In addition, shorter cycle times should encourage greater compliance by pedestrians. The balance between pedestrian and vehicle needs should be adjusted to better reflect local circumstances;

- consider the use of SCATS technology to create traffic free zones during periods of high pedestrian usage, and promote the concept with drivers and pedestrians;

- install pedestrian barriers in the length of no standing zones to direct pedestrians away from locations of frequent vehicle queuing. In some instances no standing zones, and hence fencing, could be extended to enhance the effectiveness of the barriers;

- provide pedestrian refuges and kerb outstands to encourage pedestrians to cross at preferred locations;

- increase the number of pedestrian facilities in accordance with the nature of the roadside development (e.g. commercial - more, residential - less);

- improve tram safety zones by lengthening, widening and providing shelter;

- redesign the road network to minimise conflict between cars and pedestrians;

- provide advance stop line at signals, which effectively act as wider pedestrian cross-walks;

- provide skid resistant pavements to reduce the incidence and severity of collisions, especially where vehicle queuing is common;

- use different road surfaces to provide changes in audible, visual or tactile stimuli for drivers;

- provide public education programs (e.g. posters/notices in public transport and commercial premises);

- focus education programs on pedestrian safety:
  * in schools throughout pre-school to year 12 levels;
  * hotels, restaurants and other licensed premises;

- initiate media campaigns through TAC, Community Road Safety Council, etc., targeting cultural/ethnic groups;

- undertake co-ordinated enforcement activities, including:
* education of enforcement personnel;
* consistent attention to all road users;
* strict enforcement of posted speed limits in areas of high pedestrian activity;
* high visibility and publicity of police presence.

6.3.7 Distances Between Crossing Facilities

Issue 9 - Excessive distances between pedestrian crossing facilities

The Nature of the Problem
There is a need to better understand what influences pedestrian preferences and crossing behaviour, and identify what factors, such as land use types, shops of interest on both sides, public transport services and other site-specific generators, determine pedestrian crossing points. In particular there is a need to better understand the perceptions of pedestrians about their environment and how this influences the distances they are prepared to walk to use a crossing device.

Potential Solutions
• consider the use of more crossings, either regulatory or informal crossing types, depending on the local circumstances;

• promote the use of tram safety zones to determine appropriate distances, develop a formula based on numbers of pedestrians, vehicle flows, location of tram stops and other relevant factors.

• improve the level-of-service to pedestrians at signal and other types of crossings. If pedestrians receive a better level-of-service, they may be more willing to walk further to use a crossing device.

6.3.8 Provision for Vulnerable Pedestrians

Issue 10 - Providing for the vulnerability of young (< 16 years), older (> 60 years) and alcohol-affected pedestrians crossing arterial roads

Potential Solutions
• use skid resistant surfaces (e.g. "Shellgrip") to reduce the incidence and severity of pedestrian crashes. Implement through a "Code of Practice" and as a recognised part of maintenance cycles. There are potential road safety benefits for other crash types;

• consider the use of "Key Walk", an initiative being trialed in WA, which allows slower pedestrians, through the use of a key for the traffic signals, to extend walk times to better match their walking speeds;

• place informal crossings more frequently and at closer intervals, as they are less disruptive to vehicle flows than formal pedestrian crossings which, by definition, have legal status;
• improve public/street lighting;

• provide part-time crossings outside pubs and other appropriate locations/premises to increase the likelihood of being used by intoxicated pedestrians ("Staggered" Crossings);

• dwell traffic signals in pedestrian phases when and where there is a high risk of alcohol-related pedestrian crashes to occur (i.e late at night, display red signal to all vehicle movements until a vehicle demand is registered);

• provide part-time speed limits (such as are used in the vicinity of schools) and apply more widely.

6.4 SUMMARY OF MOST PROMISING SOLUTIONS

This section summarises the most promising solutions, with particular emphasis on those with the potential for generic application across the major road networks of Melbourne and Victoria's major urban centres.

6.4.1 Strategic Planning Measures

• develop local government planning strategies for strip shopping centres, to influence longer term outcomes in high risk areas, with new and existing developments being subject to “safety impact assessments/statements”;

• develop a menu of treatments, for use by relevant professions, for the range of common pedestrian crash circumstances;

• develop municipal pedestrian safety strategies, possibly through an approach to the Municipal Association of Victoria.

6.4.2 Road and Traffic Engineering/Management Measures

• influence driver perception of the environment by using a "package of measures", selected from the following:

  * gateway type treatments;
  * tree planting;
  * public lighting;
  * distinctive road pavement colour and texture to provide changes in audible, visual or tactile stimuli for drivers, and in particular to improve pavement skid resistance;
  * narrower lanes and/or carriageways to slow traffic;
  * medians, together with pedestrian fencing where it is desirable for pedestrians to be directed to specific crossing points;
  * kerb extensions, refuges or other informal crossings at more frequent/closer intervals;
  * tram safety zones of more generous dimensions and which provide shelter to passengers;
  * modified traffic signal operation where there is a heightened risk of alcohol-related pedestrian crashes. This might involve traffic signals being operated during periods of low traffic flow to dwell in the pedestrian phases until a vehicle demand is registered;
* part-time speed limits in strip shopping areas and other locations of high pedestrian activity, with accompanying enforcement and publicity;
* pedestrian fencing/barriers in the length of no standing zones to direct pedestrians away from locations of frequent vehicle queuing;
* traffic free zones during periods of high pedestrian activity, created through SCATS technology and promoted to drivers and pedestrians;
* shorter signal cycle times to reduce the frequency and length of vehicle queuing. Shorter cycle times should also encourage greater compliance with signals by pedestrians;
* "Key Walk", to allow slower pedestrians to extend walk times where needed;
* re-route traffic to other safer roads (including bypasses and ring roads where appropriate) to alleviate capacity problems.

6.4.3 Behavioural Measures
* provide public education programs (e.g. posters/notices in public transport and commercial premises) focused on pedestrian safety in:
  * schools throughout pre-school to year 12 levels;
  * hotels, restaurants and other licensed premises;
* initiate media campaigns through TAC, Community Road Safety Councils, etc., targeting cultural/ethnic and other high risk groups;
* investigate and assess the benefits of pedestrian safety improvements and associated parking losses on commercial performance.

6.4.4 Traffic Enforcement
* undertake co-ordinated enforcement activities, including:
  * education of enforcement personnel;
  * consistent attention to all road users;
  * strict enforcement of posted speed limits in areas of high pedestrian activity;
  * high visibility and publicity of police presence;
* evaluate the effectiveness of laser speed enforcement technology in, say, Brunswick Street, Fitzroy.
7. SUMMARY AND COUNTERMEASURE RECOMMENDATIONS

This Section provides a summary of the key pedestrian safety issues identified in this study of hazardous pedestrian areas along Melbourne's arterial roads. A brief overview of the pedestrian crash problem and the common crash circumstances is provided. Recommendations for the implementation and evaluation of generic countermeasures to address common crash circumstances are also made.

7.1 OVERVIEW OF CRASH CHARACTERISTICS

Serious pedestrian crashes have fallen markedly since 1989, reaching 64 fatalities and some 775 reported serious injuries in 1994. The average reduction in reported serious casualties from 1983-1989 to 1990-1994 is 28% and in fatalities 40%. Year-to-date comparisons between 1994 and 1995 show, however, that pedestrians fatalities in 1995 are approximately 25% higher than for the same period in 1994. The estimated social costs of these crashes in Victoria are in the order of $150m per year.

Pedestrian crashes occur most frequently on undivided arterial roads (Struik et al., 1988a). The present study selected, from a VicRoads listing of pedestrian crash data for arterial road links, 58 of the worst links in terms of reported pedestrian casualty crashes per kilometre, over the seven-year period 1987 to 1993. The reported pedestrian casualty crash data for these 58 links, which covered a range of commercial, residential and combined commercial/residential environment types, were analysed to identify major crash characteristics overall, and for each environment type. The major findings were:

- a significantly greater proportion of crashes occurred at mid-block locations (53%) than intersections (46%);
- pedestrian crashes most frequently occurred where there was no traffic control, 75% (only 7% of pedestrians were struck at pedestrian lights or pedestrian crossings);
- Residential environments had a significantly greater proportion of pedestrian crashes occurring at intersection signals (23%) than did all environment types (13%);
- twice as many crashes involved pedestrians being struck from the right, 57%, than from the left, 27%;
- Residential environments had significantly more severe crashes than did other environments, with 60% of pedestrian crashes resulting in a fatality or serious injury (c.f. 50%. for all environments);
- Commercial environments had significantly fewer fatal crashes (2%) than did other environment types;
- a significantly greater proportion of crashes occurred on Fridays than on other days of the week;
• the largest proportion of pedestrian crashes occurred during the afternoon peak-period of 4:00 p.m. to 6:00 p.m.;

• young adults (aged 17-34 years) were the predominant pedestrian age group involved in crashes at all environment types;

• Residential environments displayed significantly fewer crashes involving older pedestrians (aged 65-74 years) than all other environment types;

• a significantly greater proportion of male pedestrians were involved in pedestrian crashes than females (56% and 44% respectively);

• pedestrians in Residential environments were more likely to be struck by trams (12%) than those in Commercial environments (1%). These data do not, however, take account of vehicle or pedestrian exposure.

7.2 COMMON CRASH CIRCUMSTANCES AT HIGH CRASH LOCATIONS

A subset of six of these 58 links with serious pedestrian crash histories were investigated in greater detail, by analysing reported casualty crash data, observing pedestrian and driver behaviour, and relating the results to the road and traffic engineering features of each link. These investigations identified the following common crash circumstances:

Road and Traffic Environment
• roads were typically wide and/or multi-lane routes, characterised by complex, congested traffic conditions, situated in areas of high pedestrian activity.

• arterial roads with only two lanes in each direction also presented serious problems for pedestrians. The presence of parked cars along the kerbside lane restricts a driver’s view of pedestrians emerging from between parked cars onto an area which may be used as a traffic lane;

• pedestrian activity tended to be associated with strip shopping environments, other commercial/business activities, residential land use and/or public transport services.

• congested traffic conditions, in some environments, do not ease at night and may even escalate on Thursday, Friday and Saturday nights, because of increasing night-time activity. Trams add to congestion and, together with other heavy vehicles, restrict a driver’s view of pedestrians;

• pedestrians typically crossed by dodging between lanes of stationary or slow-moving vehicles, and were struck while emerging, by higher speed vehicles encountered in the adjacent lane. Breaks in traffic are scarce and the road crossing task complex and demanding, especially for young, older and alcohol-affected pedestrians.

When Crashes Occur
• pedestrian crashes tend to happen more often during weekdays than at weekends, while afternoon peak traffic periods appear to be the most prevalent crash times;
• about one-third of pedestrian crashes occurred during dark or near dark conditions.

Pedestrian characteristics
• pedestrian age and the involvement of alcohol in crashes tended to vary according to surrounding land use and/or public transport services;

• Housing Commission Flats were often situated near routes/areas with high numbers of pedestrian crashes;

• crashes potentially related to alcohol commonly occurred near nightclubs, hotels and other licensed premises;

• there was a probable association between pedestrian crashes and centres providing support/accommodation for vagrants or homeless people;

• tram involvement was high amongst crashes at some locations, either by striking pedestrians or while pedestrians board or alight from trams.

Pedestrian behaviour
• pedestrians typically use the shortest and/or quickest route to cross and show a definite reluctance to walk far to use pedestrian signals or other facilities;

• pedestrians commonly had police-reported surnames from Asian or Southern European backgrounds. Not being familiar with the English language, some pedestrians may experience difficulties in comprehending traffic signs and pedestrian lantern operations.

Pedestrian movements
• about 57% of pedestrian crashes involved pedestrians struck from the right or near-side, either directly or while emerging from in front of parked/stationary vehicles;

• twenty-seven percent were struck by a vehicle from the left or far-side, indicating that these pedestrians reached at least half way before being struck;

• many crashes occurred on approaches to traffic signals, while pedestrians crossed between queuing vehicles. Police report that fault often lay with the pedestrian.

Traffic signals
• crashes frequently occurred on signalised pedestrian cross-walks, with pedestrians failing to comply with the signals applicable to them;

• at certain signalised intersections, under some phasing arrangements, pedestrians incorrectly inferred that it was “safe” to cross, even though the signals applicable to them were red.

Vehicle speeds
• higher vehicle speeds reduce the time for drivers to avoid conflict with pedestrians and, if struck, the higher energy transfer results in more severe pedestrian injuries;
• for a modest reduction in travel speed from 60 to 55 km/h, a reduction could be expected in the incidence of pedestrian fatalities of around 30% (Mclean et al., 1994);

• the normal urban speed limit of 60 km/h may be excessive for arterial road traffic passing through high pedestrian activity areas.

Road Surface and Markings
• well-worn road surfaces, common along high crash frequency routes, are likely to exhibit poor skid resistance for vehicles braking to avoid conflict with pedestrians;

• lane-markings were faded along some routes, leading to reduced lane discipline by drivers and greater uncertainty for pedestrians about likely vehicle paths.

7.3 GENERIC COUNTERMEASURES

Set out below is a summary of the generic countermeasures considered to have potential for reducing serious pedestrian crashes in selected arterial road environment types. This summary includes some measures identified through the process described in Section 6.2. A number of the traffic engineering/management countermeasures have implications for other performance objectives for the operation of the road system and for land use activities. These implications should be assessed as part of the overall evaluation of the countermeasure proposals.

7.3.1 Traffic Engineering/Management
• review and redefine road function to enable pedestrian-compatible management of road traffic;

• reduce traffic volumes by encouraging/facilitating alternative “safer” routes;

• reduce vehicle speeds by:

  * developing variable speed limit signing, supported with appropriate levels of publicity and enforcement;

  * modifying the design of the road and the roadside, including the use of “gateway treatments” and skid resistant pavement materials distinctive in colour and texture to provide changes in audible, visual or tactile stimuli for drivers;

• provide a better level-of-service to pedestrians at traffic signals, by:

  * reducing signal cycle times and hence average delay to pedestrians;

  * permitting late introduction (and re-introduction) of pedestrian walk phases;

  * extending pedestrian walk times;

  * installing flashing pedestrian warning displays to supplement existing displays at signalised intersections with phasing arrangements risky to pedestrians;
• reduce the degree of vehicle queuing by reducing linked signal system cycle times during high risk periods of the day and week;

• provide more pedestrians signals at closer intervals.

7.3.2 Road/Physical Engineering

• reduce road widths and widen footpaths to simplify the road crossing task and expose pedestrians (especially the young) to risk for shorter durations;

• provide medians to assist pedestrians (especially older pedestrians) over the entire length of a hazardous route, rather than at a small number of localised treatments only;

• install fencing and other barriers to encourage pedestrians to cross at signals rather than at nearby locations of higher risk and extend parking restrictions, where necessary, to improve sight lines between drivers and pedestrians;

• provide skid resistant pavements to improve the braking capabilities of vehicles on both wet and dry surfaces;

• improve street lighting to offer drivers a better chance of avoiding intoxicated pedestrians at night;

• create an appropriate streetscape that clearly signifies to drivers that pedestrian conflicts are likely to be encountered and to encourage drivers to travel at speeds more compatible with the conditions.

7.3.3 Strategic Planning Measures

• develop local government planning strategies for strip shopping centres, to influence longer term outcomes in high risk areas, with new and existing developments being subject to “safety impact assessments/statements”;

• develop a menu of treatments for the range of common pedestrian crash circumstances;

• develop municipal pedestrian safety strategies.

7.3.4 Publicity and Behavioural Change

Pedestrians

• educate all users of a particular route (including non-English-speaking residents) about the specific risks pedestrians face, by distributing traffic safety pamphlets to surrounding schools, businesses and shops, homes (including Housing Commission flats where present), the Public Transport Corporation and staff/management of local welfare organisations;

• place posters or signs on the outside of, and within, trams and/or buses servicing the route. Also, place signs on tram and bus shelters to encourage safe crossing behaviour during high risk traffic times;
• target local hotels and pubs to introduce (more effective) alcohol intervention programs for patrons.

Drivers

• develop, in conjunction with the Public Transport Corporation, road safety training programs for tram drivers and safer passenger boarding and alighting arrangements;

• warn drivers about the hazardous nature of specific routes to pedestrians by erecting “Pedestrian Hazard” signs at either end of, and within, the relevant road section;

• produce and distribute pedestrian safety videos targeted at local residents and employees.

7.3.5 Police Enforcement

• minimise risky driver and pedestrian behaviour along hazardous routes during high risk times of day and days of week, by targeting:

  * dangerous overtaking behaviour by drivers during congested periods;

  * pedestrian compliance with intersection and pedestrian operated signals;

  * dangerous crossing behaviour by intoxicated pedestrians;

  * driver compliance with speed limits.

7.3.6 Vehicle-Based Countermeasures

• modify vehicle frontal design to improve compatibility with pedestrians in impacts;

• require or encourage daytime running lights on vehicles passing through hazardous pedestrian areas, to improve vehicle conspicuity;

• discourage or prevent the introduction of tinted vehicle windscreens to preserve pedestrian conspicuity at night;

• develop and fit energy absorbing cushions to both ends of trams to substantially reduce the severity of impacts with pedestrians.

7.4 ECONOMIC EVALUATION OF ENGINEERING-BASED COUNTERMEASURES

Economic evaluations were undertaken for the principal road and traffic engineering-based countermeasures recommended for use at five of the six locations investigated in detail (countermeasures for the Johnston Street, Collingwood, route were not economically evaluated because of the lack of potential for generic application). In almost all cases, the results of these evaluations predicted very attractive economic returns, with economic benefits estimated to be well in excess of costs, even for modest reductions in pedestrian casualty crashes of the order of 5-10%.
7.5 RECOMMENDED ACTIONS TO IMPROVE PEDESTRIAN SAFETY

7.5.1 Treatment of Specific Hazardous Locations
It is recommended that selected countermeasures be implemented and evaluated at the hazardous routes investigated as part of this project.

7.5.2 Development of a Program for Implementing Generic Countermeasures
It is recommended that high priority be given to developing, implementing and evaluating the following generic countermeasures because of their high potential to improve pedestrian safety in high activity arterial road environments (because little is yet known about the effectiveness of these measures in reducing pedestrian crashes, it is difficult to objectively rank their expected worth):

- reduce vehicle speeds by developing variable speed limit signing or by modifying the design of the road and the roadside;

- reduce road widths, provide medians throughout hazardous sections of arterial roads and, in particular, develop a generic form of median, practical for use along the many Melbourne arterial roads served by trams;

- provide distinctive skid resistant pavements to improve the braking capabilities of vehicles on both wet and dry surfaces and to influence driver behaviour in high pedestrian risk areas;

- improve the level-of-service provided to pedestrians at traffic signals, by reducing signal cycle times, permitting late introduction (and re-introduction) of pedestrian walk phases, extending walk times and, at specific high risk intersections, installing flashing pedestrian warning displays to supplement existing displays;

- install pedestrian fencing or other barrier types on the approaches to and departures from signalised and other pedestrian facilities, to encourage pedestrians to cross at these devices, rather than in the nearby zones of high risk;

- develop high profile publicity programs to educate road users of the hazards to pedestrians crossing Melbourne’s arterial roads, particularly in strip shopping centre environments. Target programs at high risk pedestrian and driver groups;

- develop, in conjunction with the Public Transport Corporation, road safety training programs for tram drivers and safer passenger boarding and alighting arrangements. Use the interior and exterior of trams and tram shelters on hazardous routes to target messages encouraging safe behaviour by both pedestrians and drivers;

- target Police enforcement at unsafe behaviours by pedestrians and drivers, at high risk locations and at high risk times of the day and week;

- develop municipal pedestrian safety strategies, and local government planning strategies for strip shopping centres, to influence longer term outcomes in high risk areas, with new and existing developments being subject to “safety impact assessments/statements”.

PEDESTRIAN SAFETY ISSUES FOR VICTORIA 71
7.6 IMPLEMENTATION

Resolution of the conflicting objectives which characterise high pedestrian activity routes is essential to successfully treating Melbourne's long-standing pedestrian crash problem. The central issue in actually implementing some of these generic countermeasures for serious pedestrian crashes is the incompatibility of some countermeasures with the desire to maximise traffic flow along arterial roads. Unless there is a willingness and commitment by society and responsible agencies to accept some loss of capacity or speed of vehicle movement, which may actually be marginal only and be largely confined to non-peak traffic periods of the day and week, there will be very few genuine opportunities to improve the safety of Melbourne's arterial roads for pedestrians.
REFERENCES:


National Road Safety Research Strategy - Road Safety Research Proposals 1993/94.


# Appendix 1: Listing of Melbourne High Pedestrian Crash Frequency Locations Investigated

## Through Name

<table>
<thead>
<tr>
<th>Category</th>
<th>Location</th>
<th>Location</th>
<th>Pedestrian Safety Issues for Victoria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Commercial</td>
<td>YOUNG</td>
<td>BEACH</td>
<td>DANDENONG</td>
</tr>
<tr>
<td></td>
<td>NEPEAN</td>
<td>PUNTA</td>
<td>TOORAK</td>
</tr>
<tr>
<td></td>
<td>TOORAK</td>
<td>SYDNEY</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>HIGH</td>
<td>HIGH</td>
<td>MURRAY</td>
</tr>
<tr>
<td></td>
<td>DANDENONG</td>
<td>EDWARD</td>
<td>SYDNEY</td>
</tr>
<tr>
<td></td>
<td>CENTRE</td>
<td>HODDE</td>
<td>BRIDGE</td>
</tr>
<tr>
<td></td>
<td>ALBEN</td>
<td>WESTLEY</td>
<td>CENTRE</td>
</tr>
<tr>
<td></td>
<td>DANDENONG</td>
<td>SYDNEY</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>CLARENDO</td>
<td>YORK</td>
<td>CLARENDO</td>
</tr>
<tr>
<td></td>
<td>DRAPEY</td>
<td>HIGH</td>
<td>YOUNG</td>
</tr>
<tr>
<td></td>
<td>BARKLY</td>
<td>COMMERCIAL</td>
<td>MURRAY</td>
</tr>
<tr>
<td></td>
<td>GLENHUNTLY</td>
<td>GEORGE</td>
<td>CHAPEL</td>
</tr>
<tr>
<td></td>
<td>2. Commercial/Residential</td>
<td>HEATHERTON</td>
<td>SPRINGVALE</td>
</tr>
<tr>
<td></td>
<td>RACOURSE</td>
<td>RACOURSE</td>
<td>STUBBS</td>
</tr>
<tr>
<td></td>
<td>ARTHURTON</td>
<td>HIGH</td>
<td>HIGH</td>
</tr>
<tr>
<td></td>
<td>BROWNWICK</td>
<td>JOHNSTON</td>
<td>BRUNSWICK</td>
</tr>
<tr>
<td></td>
<td>CLAYTON</td>
<td>NORTH</td>
<td>CLAYTON</td>
</tr>
<tr>
<td></td>
<td>KINGS</td>
<td>MAIN</td>
<td>MAIN</td>
</tr>
<tr>
<td></td>
<td>SMITH</td>
<td>JOHNSTON</td>
<td>SMITH</td>
</tr>
<tr>
<td></td>
<td>NICHOLSON</td>
<td>BRUNSWICK</td>
<td>LEE</td>
</tr>
<tr>
<td></td>
<td>CASTLEBURY</td>
<td>TOORAK</td>
<td>WILLIAMS</td>
</tr>
<tr>
<td></td>
<td>TOORAK</td>
<td>SMLishments</td>
<td>SMLishments</td>
</tr>
<tr>
<td></td>
<td>JOHNSTON</td>
<td>HIGH</td>
<td>JOHNSTON</td>
</tr>
<tr>
<td></td>
<td>CARLON</td>
<td>CARLON</td>
<td>CHAPEL</td>
</tr>
<tr>
<td></td>
<td>SMITH</td>
<td>HIGH</td>
<td>HYDE</td>
</tr>
<tr>
<td></td>
<td>MALVERN</td>
<td>WILLIAMS</td>
<td>MALVERN</td>
</tr>
<tr>
<td></td>
<td>SWAN</td>
<td>CHURCH</td>
<td>SMLishments</td>
</tr>
<tr>
<td></td>
<td>FITZROY</td>
<td>ACCLUD</td>
<td>FITZROY</td>
</tr>
<tr>
<td></td>
<td>MAROONDAN</td>
<td>COMMERCIAL</td>
<td>MAROONDAN</td>
</tr>
<tr>
<td></td>
<td>COMMERCIAL</td>
<td>COMMERCIAL</td>
<td>FISHER</td>
</tr>
<tr>
<td>3. Residential</td>
<td>FLEMINSTON</td>
<td>ST KILDA</td>
<td>ST KILDA</td>
</tr>
<tr>
<td></td>
<td>KINSAWAY</td>
<td>COMMERCIAL</td>
<td>HUME</td>
</tr>
<tr>
<td></td>
<td>BOUNDARY</td>
<td>GAPNEY</td>
<td>SYDNEY</td>
</tr>
<tr>
<td></td>
<td>BRUNSWICK</td>
<td>ROYAL</td>
<td>ROYAL</td>
</tr>
<tr>
<td></td>
<td>NOLAN</td>
<td>ST KILDA</td>
<td>ST KILDA</td>
</tr>
<tr>
<td></td>
<td>ELIZABETH</td>
<td>ROYAL</td>
<td>ROYAL</td>
</tr>
<tr>
<td></td>
<td>COLLEGE</td>
<td>ROYAL</td>
<td>ROYAL</td>
</tr>
<tr>
<td></td>
<td>HODDE</td>
<td>JOHNSTON</td>
<td>HODDE</td>
</tr>
<tr>
<td></td>
<td>ST KILDA</td>
<td>ST KILDA</td>
<td>ST KILDA</td>
</tr>
<tr>
<td></td>
<td>HODDE</td>
<td>ST KILDA</td>
<td>ST KILDA</td>
</tr>
<tr>
<td></td>
<td>WILLIAMS</td>
<td>COMMERCIAL</td>
<td>COMMERCIAL</td>
</tr>
<tr>
<td>4. Bayside</td>
<td>NEPEAN</td>
<td>NEPEAN</td>
<td>UNNAMED</td>
</tr>
<tr>
<td></td>
<td>NEPEAN</td>
<td>NEPEAN</td>
<td>BONIO</td>
</tr>
<tr>
<td></td>
<td>NEPEAN</td>
<td>NEPEAN</td>
<td>BALCOMBE</td>
</tr>
<tr>
<td></td>
<td>NEPEAN</td>
<td>NEPEAN</td>
<td>BALCOMBE</td>
</tr>
<tr>
<td></td>
<td>NEPEAN</td>
<td>NEPEAN</td>
<td>WHITE</td>
</tr>
<tr>
<td></td>
<td>NEPEAN</td>
<td>NEPEAN</td>
<td>MCGILL</td>
</tr>
<tr>
<td></td>
<td>NEPEAN</td>
<td>NEPEAN</td>
<td>FITZROY</td>
</tr>
<tr>
<td></td>
<td>JACO</td>
<td>JACO</td>
<td>JACO</td>
</tr>
</tbody>
</table>