Chapter 4: Conclusions

In the previous chapter, results of the data analysis were discussed in terms of the entire data set, and also with reference to certain types of collisions. In Part II of this report, which follows this chapter, the statistical characteristics of each collision type are presented in detail. In order for the reader to digest these pieces of information, it will be helpful to try to synthesise the many separate findings. The implications of some key findings are discussed here, and the problems they seem to highlight are related to appropriate countermeasures. Finally, some recommendations are offered, regarding priorities for responding to the various issues identified. The success of this study will ultimately depend upon the extent to which the information it provides can be translated into actions that increase safety for cyclists.

4.1: Discussion of Key Findings

In this type of study, findings emerge in the form of deviations from the statistical norm, when the characteristics of a particular sub-set of the data differ from those of the larger sample. Such findings do not tell us directly 'what happened,' or what should be done about it. Instead they provide clues about the kinds of problems that may have contributed to the occurrence of the collisions. A few collision types seem to exhibit similar characteristics, suggesting common underlying problems. In trying to understand the relationships between crash configurations and their statistical characteristics, the reader may interpret the study's numerous findings according to their knowledge, experience and areas of expertise. To facilitate this process, the findings are discussed here in the context of what we understand about cycling and driving behaviour in Toronto's urban environment.

Age-Related Findings

The findings pertaining to the age of the cyclists and drivers involved in different kinds of collisions are important for several reasons. In addition to telling us about "what is happening

to whom," they often point out underlying behavioural factors that could play a role in the collisions. Results indicating that an age group is disproportionately involved in a particular kind of collision suggest that factors related to characteristics peculiar to that group probably play a role. While such factors often apply to other age groups as well, and other factors may also be involved, these findings help us to identify factors that are likely to be most significant, which can lead to ideas for countermeasures.

Some of these age-related findings are clearly linked to exposure. For instance, the under-representation of cyclists under age fifteen in 'dooring' collisions is probably a result of their reluctance to cycle on downtown arterial roads (where such collisions tend to take place). The high involvement of young cyclists in sidewalk-related collisions is probably due largely to the fact that children are more likely to ride on sidewalks — as they are allowed and often encouraged to do. Their less-developed judgement, bicycle handling skills, and awareness of traffic hazards may have played a role as well. The number of very young children injured by reversing motorists seems surprisingly high, until we note that many of these collisions took place on residential driveways. While their small size makes children more difficult for motorists to detect when reversing, and lack of awareness of this kind of hazard may have played a role, exposure is likely the main factor accounting for their over-representation.

Some age-related findings suggest we focus on features other than exposure. For example, elderly drivers (over sixty) are over-represented in collisions in which they turned left across the paths of on-coming cyclists, yet it is highly unlikely that elderly drivers make left turns more often than other drivers. It is much more likely that this finding is a function of aspects of this age group that might affect their driving ability, such as less-acute vision or reflexes. Of course, not every driver involved in such a collision is elderly, but this finding implies that similar problems might also affect other drivers. Indeed, we find that darkness was a frequent factor in such collisions involving drivers *under* sixty. The key issue seems to be that left-turning motorists sometimes have difficulty detecting on-coming cyclists. Anything that might increase drivers' ability to detect on-coming cyclists before turning across their path should help reduce collisions of this type.

By providing clues about possible contributing factors, age-related findings can thus highlight a wide range of problems. They can also be very useful in the development and delivery of safety messages tailored to specific audiences. For example, a driver-focused safety message about 'dooring' might be most effective if it is designed to appeal to the "thirty-something" demographic. School programs should focus on issues most relevant to young cyclists, such as the hazards associated with cycling on the sidewalk. Cyclist-training courses, which are offered at various levels, can deliver detailed information about the problems faced most often by cyclists in certain age groups or with particular travel patterns. Driver training courses can also inform drivers about specific problems to watch out for.

Motorists' Detection of Cyclists

Darkness is not a factor in most collisions, since most cycling activity takes place in daylight. However, the disproportionate involvement of darkness in some collision types can highlight more fundamental problems. There are at least four stages in the "detection" of a cyclist: the motorist's expectation of encountering other vehicles (specifically bicycles), the effort taken to look for them, the actual detection of a moving object, and the recognition of that object as a cyclist travelling along a potentially conflicting path. Darkness, poor visibility, and inconspicuous appearance can hinder the last two stages of this process.

For the types of collisions in which a motorist's intended manoeuvre involves the possibility of crossing the path of on-coming traffic (motorist left-turn, drive-out at controlled intersection, exiting an on-street parking spot), darkness was found to be over-represented. In such situations, drivers typically scan in the direction they would expect on-coming vehicles. Any difficulty in detecting and recognising cyclists could be aggravated by darkness or poor visibility. While this would explain the over-representation of darkness in these kinds of collisions, it is very likely that the motorists' ability to detect and recognise cyclists was also a factor during daylight. Anything that might increase cyclists' visibility would help prevent collisions of these types.

This contrasts with situations in which motorists would not expect to come into conflict with *motorised* traffic (motorist right-turn, right on red, entering on-street parking, opening a car-

door, etc.). It should not be surprising that darkness was not found to be a frequent factor in situations like these, where drivers may not feel a need to scan for potentially conflicting vehicles. Counter-measures to collisions like these should focus primarily on increasing drivers' awareness of the need to watch for cyclists. Infrastructure enhancements (prohibiting right-turns at red lights, installing bicycle lanes next to on-street parking) also may reduce the potential for some of these conflicts at particular locations. In many cases, cyclists can avoid putting themselves in positions where drivers may not anticipate conflicting traffic.

Drivers who *expect* to encounter cyclists are able to detect and recognise them more readily, so increasing drivers' awareness of cyclists has great potential to reduce collisions. The fact that many cyclists do not take steps to make themselves more visible at night suggests that they may not be fully aware of how inconspicuous they can be to drivers. Their small size and the absence of a full-sized pair of headlights make bicycles more difficult to see than other vehicles, especially for drivers accustomed to looking primarily for motor vehicles. When cyclists mix with heavy traffic in darkness, they become even more difficult to spot among the larger vehicles and bright headlights. Although the law requires the use of lights when cycling in dark conditions, most bicycles sold in Canada are not equipped with lights as standard equipment. High quality light systems are expensive and easily stolen, while inexpensive light systems can be unreliable. Reflectors provide little benefit in some of the collision configurations discussed above, since the motorist's headlights would not be aimed directly at the cyclist.

Increasing cyclists' conspicuity can be achieved in several ways. Bicycle lanes can provide a consistent and predictable space for cyclists, making them somewhat easier to detect. Some cities use special markings and/or coloured pavement to highlight conflict zones and to remind drivers to look out for cyclists. On roads without bike lanes, the CAN-BIKE program teaches that cyclists can make themselves more visible by their position on the road. Often, the cyclist can increase the likelihood of early detection by riding further out from the curb. Bright clothing can help, especially in situations where the cyclist's lateral motion across the driver's field of view is slight (as when a cyclist approaches a driver head-on or from behind) or is within the driver's peripheral zone. A loud horn may also be useful in some circumstances. In general, cyclists should never assume that motorists are aware of their presence, and should cycle defensively, especially in conditions of darkness and poor visibility.

Sidewalk Cycling

One of this study's more surprising findings is the degree to which sidewalk cycling is involved in Toronto's car/bike collisions. While some types of collisions never involve sidewalk cycling ("Motorist Overtaking…" and "Dooring" incidents, for example), of those that can occur while the cyclist is riding on the road *or* the sidewalk, over half involved sidewalk cycling.

Sidewalk cycling presents a complex problem, putting cyclists in potential conflict with both pedestrians and motorists. Before considering measures to prevent these types of collisions it is important to understand who is involved, where these collisions occur and what crash types are common. Young cyclists are over represented in sidewalk cycling crashes. This is to be expected, since children are encouraged to ride on the sidewalk until they are old enough and have acquired the necessary skills and experience to ride safely on the road. Bicycles with wheels 24 inches in diameter or smaller (typically ridden by young cyclists) are allowed on sidewalks in Toronto.

In addition to young cyclists who are legally using the sidewalk, many adults ride on the sidewalk, for a variety of reasons. For some, the sidewalk is simply a convenient way around an obstacle, such as a heavily congested stretch of a narrow road. Furthermore, there are many locations in Toronto where even experienced cyclists may feel unsafe, or at least very uncomfortable, on the road. Some view the sidewalks as a safer alternative. The road environment in Toronto's suburban areas can be especially hostile to cyclists, where high-speed arterial roads with heavy traffic are sometimes the only practical cycling routes. With very little pedestrian traffic, sidewalks on many of these streets can be appealing to cyclists. This would explain the finding that sidewalk-cycling collisions are more prevalent in the city's outer areas.

Sidewalks are intended to provide a safe facility for pedestrians to use, separate from vehicular traffic. Unfortunately, just as some drivers appear to underestimate the amount of space a cyclist may need to feel safe on the road, some cyclists apparently do not appreciate the threat they pose to pedestrians. The Motor Vehicle Accident Report form does not capture bicycle-pedestrian collisions, so this study is not able to shed any light on the relative frequency of such incidents. While most complaints about sidewalk cyclists originate in central areas of the city, where pedestrian traffic is heavy, few bicycle/motor-vehicle collisions involving sidewalk

cycling are reported in these areas. Nevertheless, this study's findings suggest that many cyclists do not appreciate the significant risks they themselves face when riding on the sidewalk.

Sidewalk-cycling collisions can be separated into two classes: those in which motorists would not expect anyone to cross their path (ride out from sidewalk at intersection, mid-block, lane or driveway) and those in which cross-traffic can be expected, where the motorist would be prepared to stop (drive out at controlled intersection, right turn on red, and those involving regular right- and left-turns). Collisions in the first group are primarily the result of cyclist's actions, and must be addressed primarily through methods of improving the skills, judgement, and awareness of cyclists. Collisions in the second group may also be reduced by these methods, but are also amenable to measures aimed at improving drivers' awareness of cyclists, as well as improvements to geometric and operational aspects of intersections.

Many of the sidewalk-cycling collisions occurred when a cyclist crossed a lane or a driveway as a motorist drove out, or crossed an intersection within the crosswalk area (which is prohibited under the Ontario Highway Traffic Act) as a motorist approached the intersection. A cyclist riding on the sidewalk, even at a moderate speed, can enter the field of view of a motorist approaching an intersection (or exiting a lane or driveway) much more suddenly than would a pedestrian. On suburban arterial roads with few pedestrians, cyclists can comfortably travel at relatively high speed on the sidewalk. High motor vehicle speeds and plentiful commercial and residential driveways increase the potential for collisions.

The sidewalk cyclists involved in Type 1 collisions (Drive out at controlled intersection) may have had the expectation that approaching drivers would to come to a stop before entering the crosswalk area (as required by the Highway Traffic Act). Those involved in Type 2 collisions may have expected drivers exiting lanes and driveways to stop before crossing the sidewalk (as required by local by-laws). However, studies have shown that drivers often "roll" through intersections, especially when preparing to turn right, while looking mainly to their left for on-coming traffic[35] (as do many cyclists). Even if a driver does come to a complete stop before proceeding, cyclists riding across the road within the crosswalk area (in violation of the H.T.A.) may enter the conflict zone too quickly for the driver to avoid.

[35] Summala *et al*, 1996

For a police officer investigating the scene of such a collision, circumstantial evidence is generally sufficient to indicate that the cyclist was riding on the sidewalk. Ascertaining the motorist's actions, however, may depend on statements from the parties involved and any witnesses. Similarly, sidewalk cycling is something that is unmistakably indicated by the MVA report diagrams, but only a few MVA reports noted explicitly that the driver did not stop properly. Still, it seems likely that these kinds of collision would have been far less frequent had all the motorists stopped properly, and had all the cyclists stopped or slowed to a walking pace before entering the roadway. Altering these kinds of driving and cycling habits should be the focus of enforcement and education campaigns.

It is impossible to say whether fewer collisions would have occurred overall if all the cyclists had been riding on the roadway. A study of Toronto commuter cyclists suggests that cyclists who frequently use sidewalks tend to have higher crash rates, even on roadways, than cyclists who always ride on the road.[36] Simply advising (or forcing) these cyclists to use the roads could result in more on-road collisions, which tend to yield more serious injuries (see Fig. 3.13). Enforcement will never eliminate sidewalk cycling as long as cyclists feel unsafe using the road. An effective long term strategy must be based on creating a safer and more comfortable road environment for cyclists, and helping motorists and cyclists understand how to share the road more safely.

Regional Differences in Collision Patterns

The combination of problems described above (sidewalk cycling and improper stopping) seems to have played a role in roughly 20% of all collisions, and was most common in the following crash types: Drive Out at Controlled Intersection, Drive Out from Lane or Driveway, and Right Turn at Red Light. These kinds of collisions were more likely to occur in suburban areas of the city, and tended to involve young cyclists. Several other types, including Motorist Overtaking and 'Dooring' collisions (both of which only affect cyclists riding on the road), were more likely to occur in the central area, and tended to involve adult cyclists. When developing educational messages as counter-measures to these types of collisions, it may be most effective

[36] Doherty, Aultman-Hall and Swaynos, 2000

to address different messages towards adult, commuter cyclists downtown, and to school age children in the outer areas. Drivers also need to be aware of the different safety issues in these different areas. Area-specific traffic enforcement strategies and different kinds of infrastructure treatments should also be considered in these very different urban environments.

Severity of Different Collision Types

Ranking the different types of collisions using a combination of frequency and injury severity suggests that the crash types causing the most harm (that is, the largest number of more-severe injuries and fatalities) tend to involve mainly adult cyclists riding on arterial roads, and are most common in the city-centre. These include Motorist Overtaking, 'Dooring,' and Motorist Left-Turn Facing Cyclist crash types. Drive Out at Controlled Intersection is also very frequent, and tends to be nearly as harmful, but occurs more evenly across the city. This information should be used to guide enforcement and public education strategies, as well as infrastructure improvement programs.

A few other crash types, while less frequent, tend to result in severe injuries when they do occur. These include the Cyclist Left Turn types, and some of the Ride Out types. Since these are collisions in which the cyclist's actions are the primary cause, there is real potential for cyclists to take steps to avoid them. Cyclist training courses should provide information on these issues, as well as addressing ways that cyclists can anticipate and avoid the more frequent dangers mentioned above.

4.2: Potential Countermeasures

Three important types of countermeasures are available to address the many factors that can contribute to collisions: "bike-friendly" infrastructure and policy enhancements; education and promotion; and police enforcement. Each approach is effective in addressing particular kinds of problems, and each has its limitations. To achieve the best results in increasing cycling safety and promoting the use of bicycles, all three must be used in combination. Each method is discussed below, with reference to some of the issues identified in this study.

Infrastructure Improvements

One of the key components of the Toronto Bike Plan is a 1,000-kilometre bikeway network, which is to be implemented over the next decade. The network will include various types of facilities and spot improvements to make travel by bicycle easier and safer. The impact of bicycle lanes and paths on overall safety is the subject of debate, but it is clear that the cities with the highest levels of bicycle use and the lowest injury rates are those that have provided plenty of "bicycle-friendly" infrastructure. Apart from the inevitable problems that can be expected when two very different modes of transportation must share traffic lanes that are often wide enough for only one of them, it is difficult to link the collision data to specific infrastructure deficiencies. However, as discussed in the previous chapter, this study has identified a few locations that deserve attention. It has also provided information that may help to determine appropriate treatments. Further analysis is expected to highlight additional "hot-spots."

Improvements such as bike lanes and wide curb lanes could reduce the number of "Motorist Overtaking" and "Dooring" collisions, by encouraging drivers to give cyclists more space. It is generally easier for motorists and cyclists to share the road when separate lanes are clearly defined. Bike lanes and bike paths do not eliminate interactions between cyclists and motorists at intersections, where many other kinds of collisions occur. However, the presence of bicycle lanes can serve to remind motorists to be alert for cyclists, and they can also channel cyclists into a more predictable and visible position on the road. For cyclists not comfortable mixing with traffic, they provide a better alternative than the sidewalk, and thus may reduce the incidence of sidewalk cycling and its associated problems. Where separated bike paths run parallel to the roadway, careful attention must be paid to intersection design, to avoid similar kinds of problems. Implementing left turn signal phases, prohibiting right turns on red lights, or adding separate traffic signals for bikes, also can eliminate several kinds of conflict.

Infrastructure improvements in the central area, where much of the city's cycling activity takes place, can be expected to benefit a large number of cyclists, pedestrians, and motorists. Although Toronto's roads were not designed for bicycles, this is changing gradually, especially with the roll-out of the Bike Plan. Still, it is a real challenge to provide dedicated bicycle facilities in a densely built city. Along many of the arterial roads most heavily used by cyclists,

there is not enough space within the right-of-way to provide separate bicycle facilities without taking space away from other uses. Even if there was community support for eliminating the on-street parking in some areas, the presence of streetcar tracks limits the potential for re-distributing lane space on many key downtown routes.

In general, therefore, a combination of safety countermeasures must be employed. The new Official Plan advocates re-allocating space for the more vulnerable road users. New design approaches must be tested, and implemented where feasible. Infrastructure enhancements must be accompanied by programs to improve the skills and awareness of drivers and cyclists, and to target enforcement where it can be most effective in reducing collisions and injuries.

Education and Public Awareness

In European countries with high levels of bicycle use, such as Germany, Denmark, and the Netherlands, most parents are able to pass on their own cycling knowledge and experience to their children, and schools provide rigorous instruction in road safety. In contrast, many North American cyclists did not have cycling parents to learn from, and learned little about cycling in school. While nearly everyone 'knows how' to ride a bike, relatively few cyclists really understand the extent to which they can reduce the danger by improving their awareness of traffic hazards, and by taking simple measures to avoid risks. Furthermore, while most European drivers also cycle, and frequently interact with cyclists when driving, many North American drivers rarely encounter cyclists on the road, and have little or no experience cycling in traffic.

The first step in preventing collisions is knowing how and why they usually happen. With this information, cyclists and drivers are better able to anticipate the actions and errors that can lead to collisions, and take steps to avoid them. There are many methods by which the knowledge gained by this kind of study can be delivered effectively. Public awareness campaigns are able to target specific audiences, and can focus on specific issues. Driver and cyclist training courses can provide more detailed and comprehensive information, and can improve both skills and awareness.

Specialised training can be particularly beneficial to cyclists, since riding a bicycle safely in mixed traffic demands certain skills that are not critical to safe driving. The cyclist must not only choose (as must the motorist) which lane to use, but they must also decide which portion of the lane to occupy. While motorists can be fairly certain that other drivers will not attempt to drive beside them in the same lane, cyclists must be prepared to share their lane with other vehicles. If the cyclist feels the lane is not wide enough to share safely, he or she can try to prevent motorists from 'squeezing past' by positioning themselves in a way that forces overtaking motorists to change lanes — called "taking the lane." On the other hand, a cyclist may decide to overtake a slower-moving motor vehicle on the left or the right, and must anticipate the motorist's intentions in order to pick the safer alternative. At the same time, cyclists must be constantly aware of road surface conditions that do not cause problems for motorists, such as streetcar tracks, pot-holes, sewer grates, and debris. While keeping an eye out for all these potential hazards, cyclists can never assume that the motorists around them have detected their presence, or that they will react to their presence predictably. The skills required to deal with these factors and ride safely in traffic are usually acquired gradually, with increasing cycling (and driving) experience, but many of them can also be taught. For these reasons it is important to identify education and training issues appropriate for cyclists of various age, experience, and skill levels.

Many of the issues discussed above are poorly understood by non-cyclists, and so there is also potential for much improvement in the way motorists interact with cyclists on the road. For example, the issue of lane-sharing needs to be more uniformly understood, especially as it applies to overtaking and right-turning motorists. Driver training courses and the Province's Drivers Manual could deliver this kind of information. Greater awareness of these issues could also help police officers — many of whom have little cycling experience — in making more thorough, balanced assessments of collisions involving cyclists.

Enforcement of Traffic Regulations

Enforcement of traffic laws, by itself, has limited potential to achieve lasting results. An enforcement 'crack-down' with significant resources applied can produce short-term changes in behaviour, but is generally not sustainable. Enforcement can be more effective when it

complements educational strategies, and focuses on the kinds of behaviour that contribute most frequently to collisions and injuries. In this regard, the findings of this study should help police develop effective traffic-enforcement campaigns. For example, while there may be a perception that many cyclists recklessly disobey stop-signs and traffic signals, the collision data indicates that less than 3% of collisions involve a cyclist failing to stop at a controlled intersection. Enforcement campaigns targeting cyclists rolling through stop-signs may result in large numbers of tickets being issued, but their effectiveness in improving traffic safety is questionable. Enforcement that focuses on driving and cycling infractions that are linked to collisions can be expected to yield better results, in terms of improving safety, than campaigns that simply target infractions that are easy to enforce. For instance, the importance of using bicycle lights at night should be communicated through well-advertised promotion and enforcement campaigns.

While rolling stops by cyclists *on the roadway* appear to have contributed to very few collisions, the same cannot be said for cyclists using the sidewalk. Riding quickly along the sidewalk not only increases the risk of collision at intersections, it can also threaten the safety and comfort of pedestrians. Some police officers are reluctant to ticket cyclists for simply being on the sidewalk, perhaps because they feel that cyclists are better off on the sidewalk than on a busy road. To be effective in reducing collisions and injuries, any enforcement campaigns aimed at sidewalk cycling should focus on cyclists riding into pedestrian crosswalks, and on behaviour that can frighten and endanger pedestrians. Targeting motorists who roll through intersections is also likely to achieve more significant results in terms of improving safety, and would benefit both cyclists and pedestrians.

The limitations of enforcement are apparent when one considers that the most easily enforced and frequently ticketed cycling offences (rolling through a stop sign, not having a bell) rarely result in collisions. On the other hand, some of the driving infractions that frequently result in collisions and serious injuries (unsafe passing, opening a door without checking for traffic, failing to yield the right-of-way) are difficult to enforce unless a collision actually occurs. This would suggest that these offences should be treated very seriously when they are implicated in collisions, so that drivers become more aware of the potentially serious consequences.

4.3: Next Steps

The primary purpose of this study is to analyse bicycle-motor vehicle collisions in Toronto in order to better understand who they're happening to, where they are happening, and what actions and behaviours lead to collisions. This study also raised many questions about the interactions between cyclists, motorists, and the road environment. Further analysis of the data may answer some of these questions, while others will require more information, from a variety of sources.

The most important question still to be answered is what can we do to prevent bicycle-motor vehicle collisions. It is not the purpose of this report to lay out an exhaustive counter-measures program. However, having identified some of the key issues that emerge from the collision data, and some of the potential countermeasures that may be used to address them, it is possible at this point to make some suggestions regarding next steps for action. Specific countermeasures will be developed and implemented in consultation with the Toronto Cycling Committee and in co-operation with the City departments and agencies which share responsibility for road safety.

Developing, Implementing and Evaluating Specific Countermeasures

The most complex and potentially most rewarding task ahead will be to develop specific counter-measures for preventing collisions. Countermeasures will include a combination of infrastructure enhancements, education and enforcement. Different collision types will require different countermeasure approaches. For example, 'dooring' collisions occur primarily on narrow downtown arterial streets with busy commercial activity and high-turnover curb-side parking. Many of these routes also support streetcar tracks, and some sections have fairly narrow sidewalks. Making infrastructure changes is very challenging in this environment. However, given that these collisions are concentrated in a relatively compact area, there may be other creative ways to make drivers and cyclists more aware of the problem.

There are too many collision types to tackle all at once. In order to allocate resources effectively, a process needs to be established, involving transportation and planning staff, the

Toronto Police Service and the Cycling Committee, to identify priorities and to develop a countermeasure strategy. Priorities can be set based on factors such as the following:

- which crash types are most frequent and result in the most severe injuries;
- which crash types are most preventable by countermeasures; and
- which measures will be most sustainable over time.

Making the Information Available

Perhaps the most urgent task is to make the findings of this study available, both internally and to a wider audience. It is important that staff and consultants responsible for the design of transportation facilities are aware of any collision data that may affect their design decisions. Professionals involved in investigating collisions and responding to bicycle crash victims (such as Police officers, legal and insurance personnel) should have knowledge of Toronto's bicycle crash data. Many other groups, including those promoting cycling, those working to improve road safety and to reduce injuries in general, and cyclists themselves, could benefit from the information contained in this report. Finding effective ways to deliver this information to those who can make use of it will involve several tasks, from making it available in hard copy, posting it on the City's web-site, and making group presentations.

Some of the study's findings have already been incorporated into the City's CAN-BIKE training materials, to ensure that Toronto cyclists are learning about Toronto-specific issues. Going further, information for parents, on the kinds of collisions that happen to young cyclists and simple steps for preventing them, would be very helpful. Other audience-specific safety information can be targeted to adult cyclists, professional drivers, and the general driving public.

The database compiled for this study contains a wealth of information that can be extracted through specific queries, and it will continue to provide information about bicycle/motor-vehicle collisions as new questions are posed. For example, examination of collisions that occurred on or near a bike lane may illuminate safety issues peculiar to these facilities, which could influence design. This exercise might also provide evidence about the effectiveness of bicycle lanes in increasing safety. Another analytical approach will be to sort the data not by crash type, but by variables such as roadway classification, with a view to identifying

problems associated with certain types of roads, or other variables. Individuals and organisations interested in specific aspects of road safety may have suggestions for such approaches, and should be encouraged to formulate specific research questions.

Identifying High Collision Locations/Corridors

A key aspect of determining countermeasure priorities — especially potential infrastructure treatments — will be the identification of collision "hot-spots." As mentioned earlier in the report, the study succeeded in identifying a few such concentrations, and it is quite possible that others will show up when more collision records are mapped. Geographic analysis can be done quite quickly, and can be used to isolate clusters of collisions, which can then be examined in further detail. One goal would be to identify potential sites for geometric analysis and/or conflict studies, with the hope of finding ways to address location-specific problems.

Routine coding of bicycle/motor-vehicle collisions by typology

Transportation Services staff currently review all motor-vehicle collision reports involving pedestrians and cyclists, to verify the accuracy of the data. A simplified coding process based on the knowledge gained through this study could be included as part of the verification process, allowing collision type frequency data to be collected routinely. High-quality data on car/bike collisions would then be available for ongoing analysis, in order to monitor trends in cycling collisions. However, it should be noted that part of this exercise will be to determine whether collecting and analysing additional data adds value to the development and evaluation of specific collision countermeasures, and that there is merit in collecting additional data.

Investigating other sources of bicycle crash data

As noted elsewhere in this report, many bicycle crashes are not reported to police, and so are not captured by this type of study. It is important to gain as comprehensive an understanding of local cycling safety issues as possible, in order to effectively address the most significant problems. To complement the current study, hospital and ambulance records of cycling-related

injuries could be examined. This would provide information on the kind of injuries sustained in incidents that are not reported to police, including collisions between cyclists and pedestrians, and single-bicycle crashes. It would allow us to confirm whether motor-vehicle collisions do in fact represent the most significant safety hazard for Toronto cyclists, as we currently believe. Hospital records likely will not tell us much about how and where such incidents happened, though.

A survey of cyclists could also shed light on collision reporting rates, and on the proportion of all bicycle crashes and injuries that result from interactions with motor-vehicles. Collecting exposure data as well as crash histories would allow the calculation of crash rates, at least on a rudimentary level. A survey might also provide valuable personal insights into the causes of some crashes, perhaps including the role of surface conditions or other treatable aspects of the City's cycling facilities. Other mechanisms should be developed to facilitate the collection of information, from cyclists, on hazardous locations.

The collision data can tell us where collisions are most frequent, but by itself it does not provide any indication as to whether these locations are particularly hazardous, or simply heavily used by cyclists. Although we have a good general understanding of the routes that are important to Toronto cyclists, detailed bicycle traffic counts are vital to providing a more accurate assessment of the safety of these routes. Along with on-going analysis of collision patterns, the collection of comprehensive bicycle volume data will also provide a basis for evaluating the effectiveness of programs to enhance the safety and popularity of bicycle use.