Bike Lanes, Edge Lines, and Vehicular Lane Widths

DISCLAIMER

This document provides information about the law as it pertains to on-road bicycle facilities on City of Burlington streets. This information is designed to help the City make informed decisions respecting bicycle planning and design matters. The reader is cautioned that the legal information presented herein is not the same as legal advice, which is the application of law to an individual's specific circumstances. To the best of our knowledge, this information is accurate and complete. However, we recommend that the City consult with their Legal Department to obtain professional assurance that our information, and the City's interpretation of it, is appropriate to particular situations in Burlington.

The authors of this document are not lawyers and the material presented herein is not, nor is it intended to be, a legal opinion or advice.

1.0 INTRODUCTION

Marshall Macklin Monaghan Limited (MMM) in association with Intus Road Safety Engineering Incorporated (Intus), are pleased to present the findings of the Burlington Edge Line, Bike Lane and Vehicular Lane Width Study. In response to the growing popularity of cycling both as a recreational activity and as a utilitarian mode of transportation, the City of Burlington has taken a progressive approach in determining the best alternatives to provide its citizens with safe cycling routes.

1.1 BACKGROUND

MMM and Intus were retained by the City to assist staff in evaluating current on-road bike facilities, and to provide assistance in reviewing the City's existing bike lane standards for these facilities. The City's objective is to proceed with the findings of this study and to implement recommendations to encourage the development of safe on-road cycling routes.

Since late 2002, the City of Burlington has been considering the issue of placing either on-road bike lanes or edge lines on Harvester Road. In a series of reports to Committee and Council, City staff consistently recommended:

… that the lanes on Harvester not be narrowed to allow for 0.7 metre edge lines for on-road cyclists, but that bike lanes be added when the roadway is widened to accommodate a five lane cross-section as identified in the current 2002-2011 Capital Budget and Forecast.

Ultimately, the staff recommendation was not adopted by Council. Instead, Council elected to retain a qualified consultant to assess the experience gained in other municipalities with respect to edge lines and minimum vehicular lane widths. This report discusses the safety and operational issues related to bike lanes and edge lines, also known as "urban shoulders", including a comprehensive evaluation of collision data and case law. Urban shoulders are defined by a solid white longitudinal pavement marking that is placed near the right edge of the road that is intended to delineate the right edge of the travelled way for motorized traffic.

The central questions to be answered with this consulting assignment are:

- Should Harvester Road be provided with bicycle lanes, wide curb lanes or urban shoulders within its current geometry?
- Is the City practice of providing urban shoulders that are less than the City's retrofit bike lane standard of 1.3 metres, both appropriate and safe?
- How is the City currently proceeding in terms of the installation of additional bike lanes, urban shoulders and vehicular lane widths and are the City's existing bike lane standards appropriate and safe?

The City's 1997 Multi-Use Pathways and Bikeway Plan recommends that on-road bike lanes be a minimum of 1.5 metres (including the gutter area) in areas of new construction. A retrofit standard was also recommended whereby the existing vehicle lanes would be reduced to a minimum width of 3.0 metres to provide 1.3 metre bike lanes (including the gutter area). The City has placed edge lines along sections of arterial roads, such as Plains Road and Upper Middle Road, that delineate between 1.0 and 1.2 metres between the curb lane and curb face. The pavement between these edge lines and the curb is not designated as a bike lane since it does not meet City bike lane standards. These "urban shoulders" are intended to provide additional space for on-road cyclists. The narrower vehicle lanes also tend to reduce the speed of vehicular traffic. To accommodate the urban shoulders along these roadways, the width of the through lanes has been reduced to 3.0 metres.

The bike lane dimensions discussed in this report include the gutter area.

1.2 APPROACH

An approach was developed to guide the review of the materials available for this study. This approach was comprised of several facets, including the review of background information and a review of standards used in various jurisdictions, which are outlined herein.

1.3 REVIEW & CONSOLIDATION OF EXISTING INFORMATION

A series of background materials, specific to the urban area of Burlington, were compiled, consolidated and reviewed in order to gain a better understanding of existing

conditions, proposed capital projects and planning initiatives. The background information review included:

- 1997 Multi-Use Pathways & Bikeway Plan;
- Maps containing existing and proposed on and off-road bike routes;
- Road right-of-way information;
- Type of traffic control at intersections;
- Average daily traffic volumes (ADT's) on key roads;
- Speed limits; and
- Other relevant planning documents.

2.0 SAFETY ANALYSIS

A significant portion of this exercise was to gain a better understanding of the safety aspects of providing bicycle facilities within roadway corridors. Accordingly, a separate safety assessment has been completed which examines common safety issues, road authority responsibility, collision data and case law.

2.1 WHAT CAN WE LEARN FROM THE COLLISION DATA, THE CASE LAW AND THE PROFESSIONAL GUIDELINES?

The lack of collisions and law suits concerning bicycle facilities, or the lack of facilities, does not automatically imply that the current system is "safe". Although collisions are the normal measure of safety, collisions have a degree of randomness associated with them, and dangerous conditions do not always produce collisions. For example, if an icy patch of road does not cause a collision, we do not conclude that the icy condition is "safe". We know from past experience and research that ice increases collision potential, and it is a condition that warrants proportional action.

Relating this logic to the provision of a 1.0 metre "urban shoulder" on Harvester or any other City road, the question becomes, is a 1.0 metre urban shoulder a condition that is potentially dangerous? The short answer is "yes". The reason for this is as follows: cyclists and motorists may incorrectly interpret the urban shoulder as a full width bicycle lane. This may increase collisions since motorists will assume that sufficient width is available to pass cyclists without changing lanes. The contention that this unsafe condition will result in more collisions is based on two well-developed human factors principles.

Firstly, the difference between the urban shoulder and the bicycle lane is that the urban shoulder lacks intermittent signs and markings. In interpreting the visual scene presented to the driver, the road itself is a much more powerful message than the associated traffic control devices. Therefore, the lack of signs is a very subtle visual cue that is likely to be overwhelmed by the presence of an edge line. Furthermore, while travelling at 60 km/h, the motorist will assess the space between the edge line and the curb as "the same" regardless of the subtle changes in width of a bike lane versus an urban shoulder.

Secondly, there is a general human factors principle of "expectancy" which indicates that an urban shoulder is an unsafe condition. One of the key principles in traffic control and operations is consistency. By providing road users with consistent conditions, and treating similar roads with similar remedies, the driving task becomes safer because drivers know what to expect. Most municipalities that have urban shoulders mark them as bicycle lanes. Thus, the expectancy is that all urban edge lines delineate bicycle lanes. By providing a few "orphan" urban shoulders, the City has violated driver expectancies, which may lead to driver errors and increase collisions. The confusion is exacerbated by the City's practice of changing from a solid edge line to a "skip" pattern on approaches to intersections and major driveways as specified for bicycle lanes in the TAC "Bikeway Traffic Control Guidelines". Edge lines are always solid and never applied in a "skip" pattern (such as with lane or continuity lines). The current configuration of the edge lines on Upper Middle Road and Plains Road are such that they are interpreted as bicycle lane lines, and not simply edge lines.

The City does not encourage cyclists to use the urban shoulder since no bicycle lane signs or markings are provided. However, they do provide urban shoulders as "additional space for on-street cyclists". Clearly, the use of this space by cyclists is foreseeable by the City. It is also foreseeable, as shown in the previous discussion, that this condition increases the collision potential for cyclists. As a result, it is recommended that the City not mark edge lines on Harvester Road until the width of Harvester can be increased. In addition, it is recommended that the City discontinue this practice on all of their streets.

It is important to point out that the guidelines are not simply randomly selected dimensions that have been provided because a minimum is required. The guidelines are well thought out by a group of diverse transportation professionals, and are applicable in the majority of cases. Much research, experience and judgement have been distilled in the guidelines, and ignoring them is a perilous act unless the deviation is founded on sound logic and reasoning – either a substantially different base condition/assumption, or an intervening research result is required. Recognition of the potential to violate minimum standards is clearly visible in the Safety Review of Highway 407:

Minimum standards represent a lower limit (minimum width, for example). Designers should not go below these minimums without explicitly justifying why. [PEO, 1997]

The City has wisely decided not to mark bicycle lanes that are less than their retrofit standard of 1.3 metres wide. In the instances where less than 1.3 metres is available, the City practice has been to mark an urban shoulder. While the City does not promote these urban shoulders as bicycle facilities, there is a safety concern associated with this practice. Will the cycling community and the driving population perceive the shoulders as bicycle lanes and create an unsafe condition?

As part of a Professional Development Seminar on the Planning and Design of Bikeways, which was sponsored by the Hamilton and Toronto Sections of the Institute of Transportation Engineers, Ms. D. Edwards, Assistant Corporate Counsel for the Regional Municipality of Hamilton-Wentworth presented on the subject of Municipal Liability for

Bikeways. Her presentation covered the basic considerations of enabling legislation for establishing bikeways. She also endorsed the concept that exposure to legal liability is a consequence of assuming a responsibility of providing for public transport and, by default, owing others a "duty of care". Ms. Edwards suggests that legal liability may be minimized by a municipality if they:

- Follow current design standards and guidelines as well as generally accepted engineering principles in the design of the bikeway;
- Ensure design concepts comply with all applicable laws and regulations;
- Place clear signs at appropriate locations on bikeways regarding important design and operational matters, such as warning of curves or potential dangers;
- Establish, implement, monitor and document a reasonable system of inspection and repair of bikeways;
- Maintain proper insurance coverage; and
- Refrain from making specific comments about the "safety" of bikeways, especially on bike maps that are printed by the municipality.

It should be noted that Ms. Edwards was providing generic information for educational purposes, and was not providing legal advice, or speaking of any particular situation.

2.2 DO THE COLLISION RECORDS SHOW A DIFFERENCE IN SAFETY?

The usefulness of Ontario collision data is limited in terms of assessing the impacts of cycling facilities on cyclist safety as well as influencing the design of these facilities. The standardized motor vehicle collision report form does not capture infrastructure information in sufficient detail to determine which cycling features are present at collision locations. Furthermore, collisions involving cyclists tend to be relatively infrequent. For instance, according to 2001 Ontario collisions statistics, 2,395 cyclists and 234 bicycle passengers were involved in a motor vehicle collision. That is 1.7 percent of all involved persons. The infrequent occurrence of cycling collisions and the random nature of collisions make it difficult to draw any sound, scientific conclusions respecting cyclist safety.

Despite the inability to extract any meaningful conclusions respecting cycling safety and facility design, the collision data does indicate that regardless of facility design, a motor vehicle-bicycle collision usually results in a major injury or casualty. The data is supported by the laws of physics which indicate that the protection offered to motor vehicle occupants through seat belts, engineered crumple zones, air bags and the like, make it reasonable to assume that cyclists have a much greater risk of being killed or injured if they are involved in a motor vehicle collision.

2.3 HAVE THERE BEEN ANY LEGAL REPERCUSSIONS?

This particular review centres on the provision of bicycle lanes and the requisite widths of these lanes. Therefore, the ensuing discussion will be based on facility planning and design, and will omit any discussion on maintenance and operations.

The current guidelines respecting bike lane width indicate that in retrofit situations, the City of Burlington is providing bike lanes that are less than the minimum width. This situation raises some concern about the City's exposure to legal liability.

A search of case law using the Canadian Legal Information Institute (CanLII) revealed that there is no Ontario case law with respect to municipalities or the province defending actions for damages related to insufficient bicycle lane width. However, there was a single case related to a municipality defending an action related to cycling facilities. In the case of Lauricella v. Hamilton (City of) heard before the Ontario Superior Court of Justice, there is an interesting and particularly relevant slant provided on the issue of bicycle ridership. In this case, the plaintiff was riding a bicycle on Melvin Avenue in the vicinity of the bridge over the Red Hill Creek Expressway when she lost control and crashed. The plaintiff was riding on the walkway even though City of Hamilton legislation prohibited her from doing so. The City argued that no duty of care existed to cyclists on walkways since cyclists would be travelling in a prohibited area. The trial judge disagreed, stating:

> "I find that the evidence supports the conclusion that the condition and configuration of the roadway on Melvin Avenue heading east across Red Hill Creek was such that it would intimidate cyclists and cause them to use the sidewalk across the bridge….Given the foregoing facts, it was reasonable and foreseeable that a cyclist wishing to cross the Red Hill Creek bridge would access the walkway to do so. I find that Lisa Lauricella's decision to use the walkway, and her use of it were reasonable under the circumstances and that the defendant owed her the same duty it owed any reasonable user of the walkway, namely to keep the walkway in a reasonable state of repair."

While the facts of the Lauricella v. Hamilton case differ from the issue of bicycle lanes or edge lines on Harvester Road, there is a parallel of principles. The central theory relied upon by the judge is that a condition existed (the intimidation of using Melvin Avenue) that would make another activity attractive and foreseeable (riding on the walkway). Curiously, dismounting and walking across the bridge, which seems like an equally reasonable action was not apparently considered or discussed in this case.

2.3.1 DISCUSSION OF SAFETY IMPACTS

The literature review indicates that there is a lack of information respecting the safety impacts of bike lane width. The bulk of research on bike lane safety focuses on cyclist-

motorist separation as an unproven collision surrogate, and has determined that it is total width (curb lane plus bike lane) and not bike lane width alone that determines the cyclist-motorist separation. The research suggests that wider total widths increase separation distance (proven), and therefore increase safety (unproven). In the end, there is relatively little information in the research on the minimum width of a bike lane, but some research suggests that 0.9 metres (excluding gutter) is acceptable.

The aggregate collision data indicates that, in general, cyclist collisions are relatively rare, and that "motorist overtaking cyclist" collisions are a small proportion of all cyclist collisions. As a result, a more detailed collision analysis was undertaken to assess the safety impacts of the 1.0 to 1.2 metre wide bike lanes that had been installed on Plains Road between Spring Gardens Road and King Road, and on Upper Middle Road between Headon Road and Appleby Line. The periods for which the collision data was made available for the analysis are as shown in **Table 1.**

TABLE 1: Time Periods for Collision Data Used in the Analysis

Location	Period	Start Date	End Date	Years
Plains Road	Before	May 1, 1998	May 1, 2001	3
	After	May 1, 2001	May 1, 2004	3
Upper Middle Road	Before	July 1, 1999	July 1, 2002	3
	After	July 1, 2002	May 1, 2004	1.8

Since cycling collisions are relatively rare events, a straight review of cyclist-involved collisions is not likely to yield any statistically significant conclusions. Nonetheless, the frequency of cycling collisions and the collision rates on these road sections have been examined to determine the overall safety performance of these roads. In addition, the collision analysis also examines the changes in mid-block collision patterns. For example, mid-block is the location that is most likely impacted by the addition of bike lanes. Overall, the measures of safety are:

- Collision rates (mid-block with unsignalized intersections included);
- Collision severity distribution;
- Number of cycling collisions; and
- Collision patterns (categorical analysis).

Only mid-block collision data is used in the severity and categorical analyses, since collisions at intersections are typically not influenced by the presence or absence of bike lanes.

It should be noted that the above collision analysis is limited by the before-after observational nature of the study design. Neither Plains Road nor Upper Middle Road have been static except for the re-marking to accommodate bike lanes during the analysis period. There are several confounding variables that may influence the number and types of collisions occurring on these streets. For instance, the former installation of a red light camera for eastbound Upper Middle Road at Walkers Line, or the implementation of a

Community Safety Zone on Plains Road are additional "treatments" that may have influenced the collision records.

The collision frequencies and rates for the "before" and "after" periods of both roads are shown in **Table 2**.

TABLE 2: Collision Frequencies and Rates for 1.0 m Wide Bicycle Lanes

Location	Period	With Unsignalized Intersections*		Without Unsignalized Intersections		# of Cycling Collisions Per Year
		Collisions Per Year	Collision Rate**	Collisions Per Year	Collision Rate**	
Upper Middle Rd	Before	8.0	0.5	6.3	0.4	2
	After	11.7	0.6	7.8	0.4	0
Plains Rd	Before	6.0	0.4	3.7	0.3	0
	After	7.7	0.5	5.3	0.4	2

* Signalized intersections are routinely excluded from collision analyses of road sections.
** collisions/million vehicle kilometres travelled

While the number of collisions per year has increased from the before to the after periods, the collision rates have remained relatively stable. This is an indication that the increase in collision frequency is likely due to an increase in traffic volume rather than degradation in the level of safety on either of these roads. Still, in terms of collision analysis, this sample size is relatively small and conclusions are at least in part speculative. Nonetheless, a collision rate of less than 1.0 is typically considered to be acceptably safe.

The number of cycling collisions is too small to draw any conclusions on the impact that 1.0 to 1.2 metre wide bike lanes may have on cycling safety along these roads. Still a more in-depth look at the individual cycling collisions reveals that two of the four cycling collisions occurred at intersections, which are not likely assisted or disadvantaged by the bike lanes. Further, the two mid-block collisions were: an angle collision and a collision associated with a vehicle turning into a driveway. These are also collisions not typically caused or prevented by the width of the bike lanes present.

A before-after analysis of the collision severity on Upper Middle Road and Plains Road where the bike lanes were installed indicates that the collisions in the "after" period tended to be more severe than in the "before" period as outlined in **Table 3**. However, a statistical analysis of this data using a Chi-squared test for categorical differences, indicates that at a 95% level of confidence, there is no statistical difference in the before and after severity distributions. In other words, the slight increase in collision severity is likely due to chance, and not the addition of the bike lanes.

TABLE 3: Collision Severity

Collision Severity	No. of Collisions (%)	
	After	Before
Fatal	0 (0)	0 (0)
Injury	9 (30)	6 (20)
PDO	20 (67)	23 (77)
Non reportable	1 (3)	1 (3)
Total	30 (100)	30 (100)

Another potential negative safety impact associated with the 1.0 to 1.2 metre wide bike lanes is an increase in collisions due to the narrower motor vehicle lanes. These collisions would typically take the form of sideswipe and head-on collisions resulting from motorists failing to maintain their lane. A categorical analysis of the before-after collision data for both Upper Middle Road and Plains Road indicate that the addition of the 1.0 to 1.2 metre bike lane is coincident with a decrease in the proportion of "rear-end" and "single motor vehicle – other" collisions, and an increase in the proportion of "turning collisions", as shown in **Table 4**.

TABLE 4: Collision Distribution by Impact Type

Impact Type	# of Collisions (%)	
	After	Before
Angle	3 (10)	3 (10)
Approaching	1 (3)	0 (0)
Other	2 (7)	3 (10)
Rearend	11 (37)	14 (47)
Sideswipe	3 (10)	3 (10)
SMV Other	3 (10)	6 (20)
Turning	7 (23)	1 (3)
Total	30 (100)	30 (100)

Again, a statistical analysis of these data indicate that any differences in the collision/impact type between the "before" and "after" periods are likely due to chance (at a 95% level of confidence).

In conclusion, the analysis of the limited collision data indicates that the 1.0 to 1.2 metre wide bike lanes, and the associated narrower motor vehicle lanes cannot be shown to have increased collisions, or collision severity, or changed the collision patterns on the subject streets. In other words, according to these data the 1.0 to 1.2 metre wide bike lanes have not significantly increased or decreased the safety of these streets.

3.0 FACILITY TYPES / DESIGN GUIDELINES

The City of Burlington has taken a very proactive approach providing a wide range of cycling facility types, including the use of bicycles on City sidewalks. Each of these

components have their own set of minimum design parameters that guide their implementation.

3.1 BIKE LANES

A bike lane is a facility located in the travelled portion of the roadway and is designed for one-way cyclist traffic. Bike lanes are typically located on urban streets and are denoted by pavement markings plus the appropriate signage identifying the bicycle lane as part of the range of cycling facilities provided by the City of Burlington.

On an urban roadway cross-section, a solid line identifies a bicycle lane adjacent to the curb. Bicycle and diamond symbols to denote the reserved lane are applied on the pavement within the lane, together with bike lane signage. The preferred minimum design width for a bike lane in an urban area without on-street parking is 1.5 m from the face of curb. This is consistent with both MTO and Transportation Association of Canada (TAC) guidelines[1]. These guidelines also state that in constrained rights-of-way or for short segments, a reduced width of 1.2 m (including gutter) may be acceptable for bike lanes. When the available lane width narrows below 1.2 m, bike lane signs and pavement markings should cease, with a "Bike Lane Ends" sign posted. Lane widths less than 1.2 m should not be designated or signed as bike lanes.

A signed route is an on-road bicycle route denoted with signage, and is a common cycling facility found in municipalities across Ontario. Cyclists using a signed route must share the road with motor vehicles. On multi-lane roads where traffic volumes exceed the recommended threshold for this type of facility where a bike lane is not feasible, a wide curb lane should be considered, as discussed in Section 3.4. Streets should typically only be signed as on-road bike routes if there is adequate pavement width to safely accommodate both motor vehicles and cyclists, or when adequate sight lines and an appropriate Average Annual Daily Traffic (AADT) volume exist. Otherwise, alternative routes should be investigated or bike lanes installed when the opportunity presents itself at a future date.

A schematic illustration of a typical signed route in an urban area with a wide curb lane is provided in **Figure 1**. Wide curb lanes can range from 4.0 to 5.0 metres in width, however, the preferred design width for a wide curb lane is 4.25 m. Although a wide curb lane is not a formal bike lane, experience and observations have shown that cyclists tend to ride in this lane, in instances where on-street parking is permitted, the width of the wide curb lane should be closer to 5.0 metres. This will allow cyclists to safely pass parked vehicles on the left side without conflicting with vehicles in the adjacent travel lane. The proposed bicycle route marker is the TAC standard for signed bicycle routes.

[1] Ontario Traffic Manual, Book 11 – Pavement, Hazard and Delineation Markings, MTO, 2000 (Figure 39) *and* Geometric Design Guide for Canadian Roads, TAC, 1999. (TAC Table 3.4.6.2)

Figure 1 - Bicycle Route Marker

Source: Bikeway Traffic Control Guidelines for Canada – Transportation Association of Canada (TAC) – Dec. 1998

3.2 EDGE LINES

Municipalities are often confronted with road segments along proposed bike routes whereby it is difficult to accommodate a bike lane or a paved shoulder due to physical or budget constraints. The most appropriate application of edge line treatments is along rural roadways that provide an adequate amount of run-off space such as a gravel shoulder at the edge of the pavement for a cyclist to recover should they be forced off the road by a passing motor vehicle. In these instances, edge lines (pavement markings) should be provided to mark the edge of the motor vehicle lane and to delineate as much additional shoulder or "lane" width as possible for cyclists to use. On roads where sight lines are also an issue because of the horizontal or vertical curvature of the road, additional cautionary signs may be warranted to restrict passing manoeuvres. Although it is usually a controversial issue, the reduction of speed limits may be another alternative when a particular road segment experiences high motor vehicle volumes (AADT's) and/or commercial vehicle traffic.

Along urban roadways, the application of pavement markings as edge lines does not provide sufficient space or necessarily provide adequate "comfort" to cyclists. Since these roadways usually have barrier curbs, additional safety concerns are raised, whereby cycling can become a more hazardous activity. Except for controlled access highways, cyclists are allowed on all other roadways in Ontario. From a safety and liability perspective, the City of Burlington should not encourage bicycle use on roadways with non-standard bicycle facilities. Under urban conditions, where exclusive bike lanes cannot be accommodated, wide curb lanes should be provided to create a safer cycling environment. As stated previously in this section, edge lines are more appropriate under rural conditions and not on heavily travelled urban arterial roads.

3.2.1 WIDE CURB LANES VERSUS EXCLUSIVE BIKE LANES

The curb lanes of some major arterial roads are designed to have sufficient width to accommodate shared vehicular and bicycle traffic, as illustrated in **Figure 2**. It is generally agreed, however, that delineated bikeways provide safer conditions for cyclists and motorists. They also encourage bicycle use by broadening the range of ages and skill levels for residents and visitors who are then able to safely use a road for bicycle travel. Bike lanes are particularly important on arterials that typically have higher operating speeds, such as the major arterial roads in the City of Burlington. The focus of implementation considerations should be on exclusive bike lanes, and not wide shared lanes, for the purposes of safety and design efficiency. The following sections discuss the width considerations of exclusive bike lanes for rural and urban road sections.

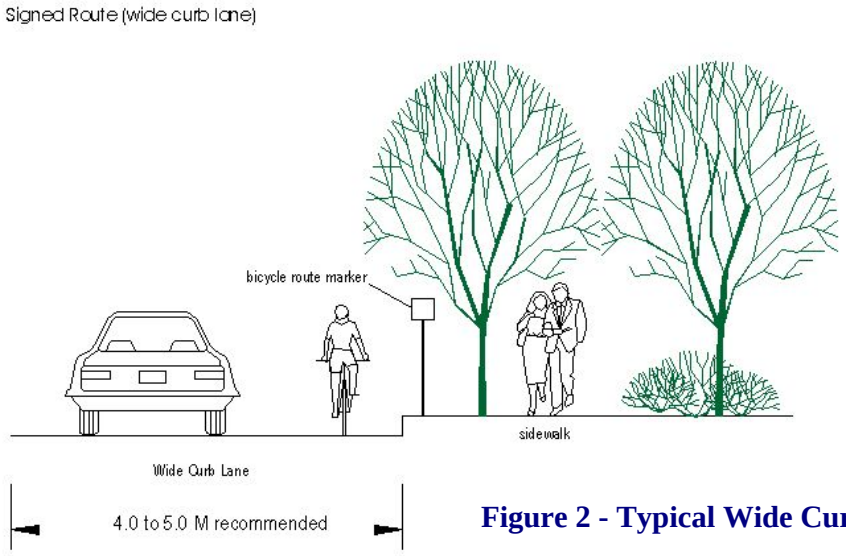


Figure 2 - Typical Wide Curb Lanes

3.2.2 RURAL ROAD SECTIONS

Delineated bikeways can be provided on a rural road section through the use of a paved shoulder. **Figure 3** illustrates a typical rural section bikeway facility. Based on bike characteristics, the preferred shoulder width for a rural section with bike lanes is 1.5 m to 2.0 m. An additional 0.5 m to 2.0 m should be allowed for extra shoulder width that can be used for motor vehicle and bike manoeuvring.

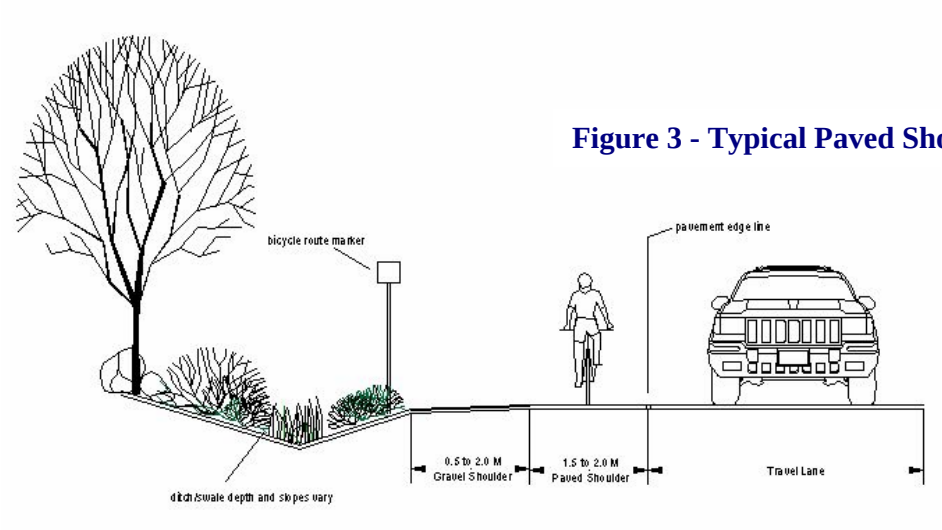
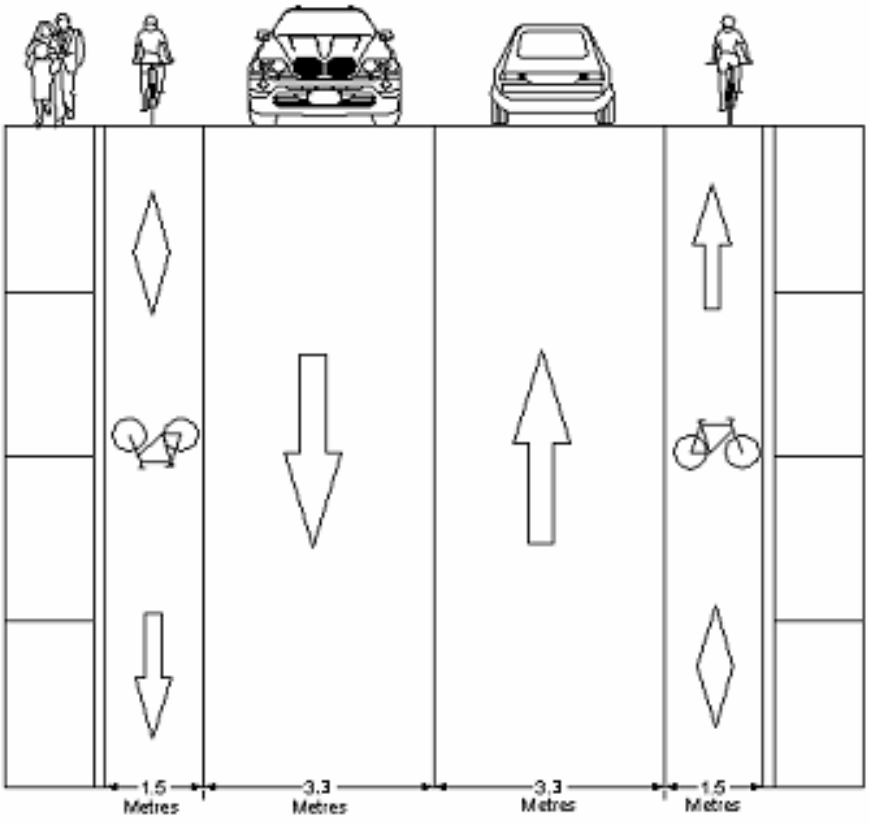


Figure 3 - Typical Paved Shoulder

3.2.3 URBAN ROAD SECTIONS

Urban sections are typified by a defined curb and catchbasin system for stormwater drainage. A delineated bike lane is accommodated on an urban road section as an additional lane adjacent to the curb lane. A bike lane is delineated from a vehicular lane through the use of pavement markings and signage. The preferred minimum design width for a bike lane in an urban section without on-street parking is 1.5 m from the face of curb. A typical urban section with bike lanes is shown in **Figure 4**.

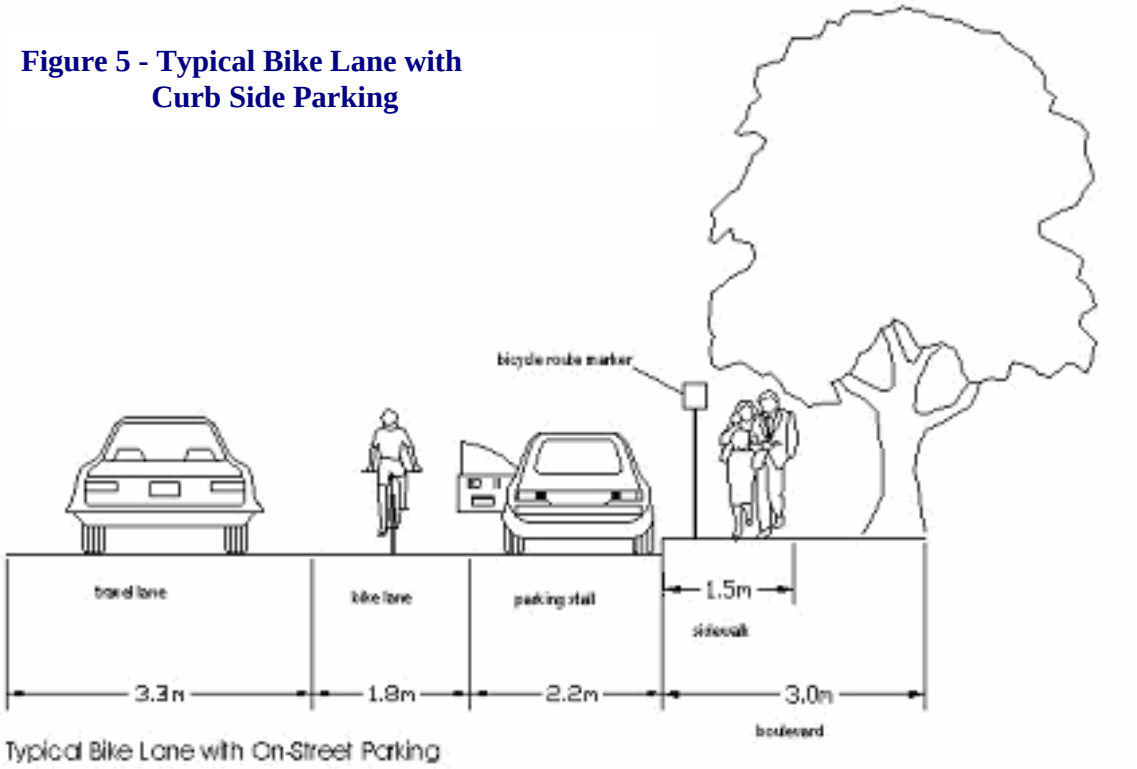


(Note: 1.5 m includes the gutter)

Figure 4 - Typical Bike Lane

Some of the major arterials in the City Burlington act as the "main streets" of major commercial or employment corridors. Examples of these arterials include Brant Street and Lakeshore Road. On-street parking may be necessary in these higher density nodes to accommodate the parking demands associated with these type of land uses. The design of bike lanes on urban sections with on-street parking should consider the impact of opening car doors, which may cause collisions between parked vehicles and cyclists if the car doors open into the travelled portion of the bikeway. These urban sections can accommodate bikeways by providing a minimum 1.8 metre wide bike lane and minimum 2.2 metre wide curb-side parking stall, as illustrated in **Figure 5**.

Figure 5 - Typical Bike Lane with Curb Side Parking



3.4 RETROFITTING URBAN ROADS

Retrofitting guidelines based on quantitative measures could be used to develop criteria for the selection of appropriate facility types for bikeway routes. The key factors that should be considered when implementing a bikeway facility on a particular roadway are based on a set of minimum design criteria that are associated with a number of factors. These include:

- Number of travel lanes;
- Average Annual Daily Traffic (AADT) volume;
- Speed ($\leq$ 60 km/h); and
- Threshold volume of cyclists (40 bikes /day).

When establishing thresholds for the application of bikeway design standards, the preferred design should always be assumed for planning purposes and determining road right-of-way widths. Minimum design standards should only be considered in challenging areas where there is no option for road widening or for an alternate route. The most common way to retrofit a roadway with a bikeway facility is to provide wide curb lanes which can be achieved through re-striping. Typically, remarking is implemented when a roadway receives a new pavement overlay or during the spring pavement marking program. This latter option is only a consideration if the existing lane markings are significantly obliterated over the winter months.

Good engineering/planning judgement should be used when making a final decision on what type of bikeway facility should be installed. The current City retrofit standard prescribes a minimum of 1.0 metre of asphalt plus a gutter width of approximately 0.3 metres for a total of 1.3 metres.

3.5 COMPARISON OF DESIGN STANDARDS

In order to appreciate the various design standards discussed above, it is useful to compare these standards with those employed by other municipalities and government agencies in Ontario, across Canada, the United States and Internationally. The matrix in **Appendix A** compares the various standards for bike lanes, motor vehicle, plus wide curb and shared lane widths under urban conditions. A total of 26 jurisdictions were included in this matrix.

The findings from the research conducted indicate that bike lanes are generally between 1.2 and 1.8 metres in width with few exceptions. Where bike lanes are less than 1.2 metres, it has been stated that wide curb lanes be required. Motor vehicle lane widths range between 3.0 and 3.5 metres, with some variations above and below this standard. In terms of wide curb and shared travel lanes, this standard was found to be generally between the 4.0 and 4.6 metres. Also, shared bike/parking lanes generally range between 4.0 and 4.5 metres. Finally, no additional information was found regarding edgeline treatments than what was discussed in section 2.2.

As the findings clearly illustrate, there is flexibility in the widths that can be provided within road rights-of-way to encourage bicycle use. Of the sources researched, only the Cities of Saskatoon and Hamilton, the District of Langford, B.C., plus Denmark provide a classification system using quantifiable measures. For example, AADT and roadway speed limit are typically used. Although these measures are good indicators in assisting practitioners in determining specific thresholds and the type of on-road bike facilities to implement, good engineering/planning judgement should also be used.

4.0 EVALUATION

4.1 HARVESTER ROAD

Each roadway in the City of Burlington that is being considered for retrofitting with bicycle lanes should take into account the guidelines discussed in Section 3.4. For the purposes of this report, MMM and Intus have focused attention on Harvester Road. However, this does not imply that the context under which this study has been based should be limited in any way to this roadway only.

In regard to Harvester Road, City staff have determined that narrowing the vehicular through lanes to 3.0 metres would provide a 1.0 (including gutter) metre urban shoulder on each side of the road. Staff do not recommend creating an urban shoulder since narrowing the through lanes is perilous because:

• There is no separation between opposing streams of traffic;
• The proportion of truck traffic is relatively high; and
• Narrowing the lanes would not produce a minimum width 1.3 metre bike lane as per the City retrofit standard.

In the end, the City has a written policy that bike lanes should be a minimum width of 1.5 metres (including the gutter) for new construction, and 1.3 metres (including the gutter) for retrofit locations whereby the existing vehicle lanes are reduced to a minimum width of 3 metres. Although the City has implemented urban shoulders that are less than 1.3 metres through narrowing the vehicular lanes to 3.0 metres, there is no formal/written policy supporting this practice.

What are other municipalities doing with respect to bike lanes, edge lines, and vehicular lane widths?

Since each road authority is capable of developing their own design guidelines, it is not practical to list and review all of the available guidelines. Therefore, we have reviewed both national and provincial design guidelines, and those developed by the cities of Ottawa and Toronto. The national and provincial design guidelines are worthwhile to examine because the typical guideline development process involves "upper tier" guidelines being developed prior to municipalities adopting or adjusting these guidelines for their own use. The cities of Ottawa and Toronto are two of the most popular and progressive cycling cities in Ontario. Hence, it is also appropriate to examine their guidelines.

The national and provincial documents used to establish the appropriate guidelines are the Transportation Association of Canada's Geometric Design Guidelines for Canadian Roads, the Ontario Traffic Manual Book 11 – Pavement, Hazard and Delineation Markings, and the Ontario Geometric Design Standards for Ontario Highways

For urban, four lane roads with traffic volumes and speeds similar to Harvester Road, the design guidelines are as shown in **Table 6**.

TABLE 6: Minimum Recommended Widths for Arterial Four-lane Roads (60 km/h) with Average Daily Traffic of 15,000 vehicles

Feature	Width (metres)		
	TAC	Ontario	City of Burlington
Vehicle Lane	3.3 to 3.5*	3.5	3.3 (minimum 3.0 m for retrofit locations)
Bike Lane	1.5 to 2.5	1.8	1.5 (1.3 m for retrofit)
Urban Shoulder	N/A	N/A	1.0
* Constrained retrofit project, exclusive of gutter			

With respect to shoulders, the national and provincial guidelines note that urban roads are not normally provided with shoulders except in the instance of freeways and other high

speed roads. Shoulders are intended to either provide a recovery area for errant vehicles, refuge for stopped or disabled vehicles, and lateral support of the pavement structure. While a 1.0 metre shoulder would provide an additional area of recovery for errant vehicles, it is insufficient to be a refuge area, and is not required for lateral support on an urban cross-section.

4.2 WHAT SHOULD BE DONE ON HARVESTER ROAD?

The options that should be considered to provide suitable width for bicycle lanes on Harvester Road are:

1. No action be taken on re-marking or widening Harvester Road in the interim;
2. Reconstruct Harvester Road to provide standard width bicycle lanes; or
3. Reconfigure Harvester Road as a three-lane street with one vehicular lane and one bicycle lane in each direction, plus a centre two way left turn lane.

These options are detailed in the following paragraphs.

Harvester Road is a four lane east-west arterial that has a posted speed limit of 60 km/h. The traffic volumes provided by the City indicate that the AADT along Harvester Road is in excess of 15,000 vehicles. Truck percentages at key intersections along Harvester/Plains Road vary between 3 and 5 percent.

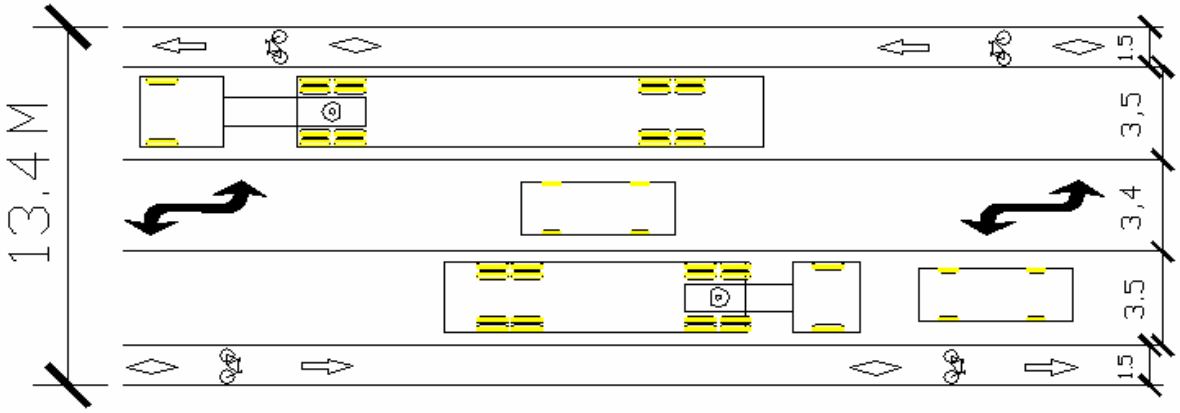
Due to the high traffic volumes plus the mix of truck traffic experienced on Harvester Road, the introduction of an urban shoulder is not suitable for this roadway. As mentioned previously, the current bike lane retrofit standard in the City of Burlington is 1.3 metres (1.0 metre bike lane with a 0.3 metre gutter). The narrowing of Harvester Road to provide 1.0 metre urban shoulders in both directions does not meet this retrofit standard and is, therefore, not an appropriate alternative.

There are options available to explore that are worthy of further examination in order to implement bikeway facilities on Harvester Road. The first option is a “do nothing” alternative, whereby cyclists continue to share the road with motorists. This can be reinforced by providing share-the-road signs along Harvester Road. The second option involves the widening of Harvester Road as part of any resurfacing or reconstruction plans for this roadway.

Figure 7 illustrates the third option whereby the conversion of Harvester Road from a four-lane cross section to a two-lane cross section plus a centre two-way left turn lane and bike lanes. Vehicular lanes would range between 3.5 and 3.7 metres in width, while the centre two-way left lane would range between 3.0 and 3.4 metres in width. Bike lanes would be 1.5 metres in width measured to the face of curb. This option should be examined from a traffic operations perspective, where traffic volumes permit and the level of service is not significantly compromised, this option would be appropriate along sections of Harvester Road.

Harvester Road - Option 3

Convert Harvester Road into a 3-lane cross-section with a 3.0 to 3.4 metre centre two-way left lane and 3.5 to 3.7 metre travel lanes, and provide a 1.5 metre bike lane in both directions



5.0 CONCLUSIONS

The City design guidelines provide minimum widths that are less than those provided in national and provincial documents. These widths should be adjusted, where appropriate, to comply with national and provincial guidelines. The City should immediately discontinue the practice of painting edge lines on curbed municipal streets where the width of pavement between the edge line and the curb face is less than the current minimum width specified for a bicycle lane according to City guidelines. While the current City retrofit and reconstruction bike lane standard is acceptable, the City should use caution in regard to the exposure in which this standard is applied.

It is important to note that the dimensions provided in the foregoing paragraphs are design guidelines and not design standards. Although the difference in wording is subtle, the implications are significant. The term “standard” is generally meant to imply a guarantee of quality. In transportation terms, if a minimum standard is met or exceeded then there is an inference that the facility will provide a guaranteed level of service or be acceptably safe. This is simply not the case. The myriad of factors that affect safety cannot be incorporated into a single dimension that can be applied universally.

The transportation profession is moving away from the term “standard” and has replaced it with the term “guideline”. This latter term implies that the feature or dimension listed in the guideline is a strongly worded suggestion, which in most cases would be desirable to provide. The use of a guideline is meant to encourage the designer to consider the

specifics of each application, and not to unilaterally select a dimension simply because it is documented in a particular publication.

5.1 RECOMMENDATIONS

The following recommendations regarding City policy regarding bike lane standards are:

1. The City's New Construction Bike Lane standard of 1.5 m (including the gutter) is acceptable;
2. The City's Retrofit Bike Lane standard of 1.3 m (including the gutter) is acceptable, however these exposure of this practise should be monitored to provide supportive statistics;
3. Do not provide edgelines on urban shoulders that are less than 1.3 m (including the gutter). In instances where this practice is applied, the existing edge lines should be allowed to fade and maintain a wider curb lane; and
4. The use of 3.0 metre vehicle lane widths is acceptable and is used in other jurisdictions as illustrated in Appendix A.

The recommended options that should be considered to provide suitable width for bicycle lanes on Harvester Road are:

1. No action be taken on re-marking Harvester Road in the interim; and
2. Reconstruct Harvester Road as part of the future planned widening to provide standard width bicycle lanes.