



STAFF REPORT ACTION REQUIRED

Evaluation and Changes to Pedestrian Priority Phase Signal (Scramble Crossing) at Bay Street and Bloor Street

Date:	February 12, 2015
To:	Public Works and Infrastructure Committee
From:	General Manager, Transportation Services
Wards:	Ward 27
Reference Number:	P:\2015\Cluster B\TRA\PR\pw15001pr.docx

SUMMARY

A pedestrian priority phase or scramble crossing signal was implemented at the intersection of Bay & Bloor in 2010. The purpose of this report is to respond to a motion by City Council to evaluate this signal feature and investigate potential improvements.

Based on the results of the evaluation study, Transportation Services has found modest positive benefits for pedestrians while negative impacts to vehicular traffic have been significant at this location. After consulting with local stakeholders and investigating potential modifications to signal operations at this location, staff have concluded that a pedestrian priority phase signal is not a suitable tool for this intersection and should be removed as soon as practicable.

RECOMMENDATIONS

The General Manager of Transportation Services recommends that:

1. City Council authorize the General Manager, Transportation Services, to remove the Pedestrian Priority Phase signal (Scramble Crossing) at Bay and Bloor and replace it with a signal timing pattern as deemed suitable by the General Manager of Transportation Services, as soon as practicable.

Financial Impact

The financial impact associated with removing the pedestrian priority phase signal heads and signs and re-timing the traffic signal would be approximately \$26,000. All costs are included within the Transportation Services 2015 Operating Budget.

The Deputy City Manager and Chief Financial Officer has reviewed this report and agrees with the financial impact information.

DECISION HISTORY

City Council, at its meeting on October 22, 2007, adopted Public Works and Infrastructure Committee Item PW9.2 entitled “Sustainable Transportation Initiatives: Short-term Proposals”, including Recommendation No. 2d which directed the General Manager of Transportation Services to evaluate and implement a pedestrian priority phase on a pilot project basis at the following intersections:

- Bloor Street and Bay Street;
- Bloor Street and Yonge Street;
- Yonge Street and Dundas Street; and
- Bay Street and Dundas Street.

<http://www.toronto.ca/legdocs/mmis/2007/cc/decisions/2007-10-22-cc13-dd.pdf>

At its meeting held on August 25, 26, 27 and 28, 2014, City Council adopted item MM55.60 titled Bay-Bloor Pedestrian Priority Phase Intersection. The motion requested the General Manager of Transportation Services to provide an updated review on the pedestrian priority phase for the intersection of Bloor Street and Bay Street, give consideration to recommendations arising out of community consultation as to possible modifications to the signal, and to report back on changes to the signal operations.

<http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2014.MM55.60>

ISSUE BACKGROUND

A pedestrian priority phase, also known as a scramble crossing, is a type of signal operation that allows pedestrians exclusive access to the intersection for a portion of the signal cycle. Toronto's choice of pedestrian priority phase operation is designed to reduce pedestrian waiting times and sidewalk crowding, reduce conflicts between pedestrians and vehicles during some portions of the signal, and improve overall safety and walkability for pedestrians.

All modes of transportation compete for space and time within the City's transportation network and Transportation Services staff seek to balance the needs of all users by distributing the available space and time using a context-sensitive approach. Generally speaking, prioritizing pedestrians at a pedestrian priority phase signal comes at the cost of reducing vehicular traffic capacity due to reduced 'green' time per signal cycle. Pedestrian priority phase signals are a unique tool for addressing localized pedestrian transportation issues and should be used appropriately.

Pedestrian priority phases were implemented at three intersections in Downtown Toronto: Bloor & Bay (installed November 3, 2010), Bloor & Yonge (installed October 9, 2009) and Yonge & Dundas (installed August 28, 2008). A fourth pedestrian priority phase at Bay & Dundas was not implemented by Transportation Services due to the expected significant negative impact on vehicular traffic, including transit.

COMMENTS

There are three types of pedestrian priority phase operations and Toronto uses the model which provides pedestrians with exclusive access to a signalized intersection (north-south, east-west or diagonal) as well as the ability to cross concurrent with parallel moving traffic. This pedestrian priority phase type was selected as it provides full accessibility for those with visual impairments while reducing pedestrian wait times and crowding.

A comprehensive evaluation was completed of all three pilot pedestrian priority phase locations and, in the case of the Bay-Bloor scramble, staff updated the traffic delay data following the completion of road construction in the area, the installation of a second traffic light north of the intersection, and the addition of new residential buildings. Results of the initial evaluation were also provided to the Downtown Toronto Operations Study project team for their review. The analysis was based on the following performance metrics:

- Utilization of diagonal crossing option;
- Intersection safety;
- Corner crowding conditions and pedestrian delay;
- Vehicular delay and traffic diversions;
- Impact on greenhouse gas emissions and fuel consumption; and
- User feedback.

In addition, a number of signal modifications were investigated with the aim of improving overall performance.

An evaluation conducted by the Pedestrian Projects Unit with the support of the Traffic Management Centre and Traffic Operations, has found that:

- Compared to the other pedestrian priority phases in downtown Toronto, this intersection has the lowest volume of pedestrians as well as the lowest ratio of pedestrians to motorized users. Moreover, while pedestrian volume peaks in both mid-day and evening rush hours at the other pedestrian priority phases, the intersection of Bay & Bloor does not serve a high volume of pedestrians until the afternoon.

- A relatively lower percentage of users (16% on weekdays and 12% on weekends) take advantage of the diagonal crossing opportunity at Bay & Bloor compared to the other two pedestrian priority phases in downtown Toronto.
- The pedestrian priority phase signal has slightly reduced pedestrian delay by 8% and corner crowding between 11-13%, but not to the same extent as at the other pedestrian priority phases.
- Overall intersection delay for vehicles has more than tripled in the evening peak period - which also results in increased greenhouse gas emissions and fuel consumption.
- Sideswipe collisions have more than doubled while rear-end type collisions at the intersection have increased by 50%, likely due to increased driver frustration.

While prioritizing walking is a goal of the City's Official Plan and the Walking Strategy, the installation of the pedestrian priority phase at the intersection of Bay & Bloor has offered only modest benefits to pedestrians and comes at a significant cost to motorized modes of transportation. As well, the new traffic signal recently installed at Bay & Cumberland is expected to take some of the pedestrian crossing demand away from Bay & Bloor. Compared to the other two pedestrian priority phase intersections, this one is physically wider (and it has not been found feasible to make it smaller to reduce crossing distances, given priority measures provided for both transit vehicles and cyclists), further amplifying the costs compared to the benefits. The following sections of the report provide background and details on the findings of the evaluation study.

Evaluation Results

Intersection User Profile

Compared to the other two pedestrian priority phase signals in Toronto, the intersection of Bay & Bloor has the highest volume of motorized traffic, and the highest ratio of motorized traffic to pedestrians going through the intersection. As illustrated by Figure 1, on a typical weekday about 42,200 pedestrians use the intersection of Bay & Bloor over an eight-hour period, making up about 55% of the overall users. About 38% of users are auto drivers or passengers and 4% are transit riders on the Bay Street bus route.

Additionally, as illustrated in Figure 2, while pedestrian volume peaks in both mid-day and evening rush hours at Yonge & Dundas and Yonge & Bloor, the intersection of Bay & Bloor does not serve a high volume of pedestrians until the afternoon.

Figure 1 - Daily Volume of Users at Intersections with Pedestrian Priority Phases

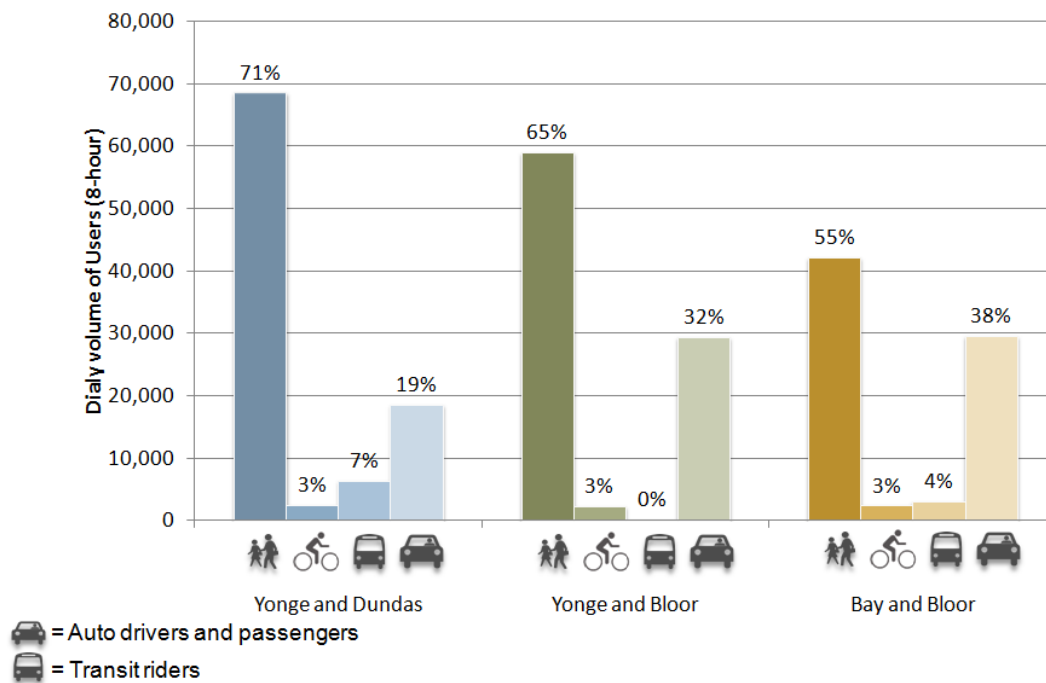
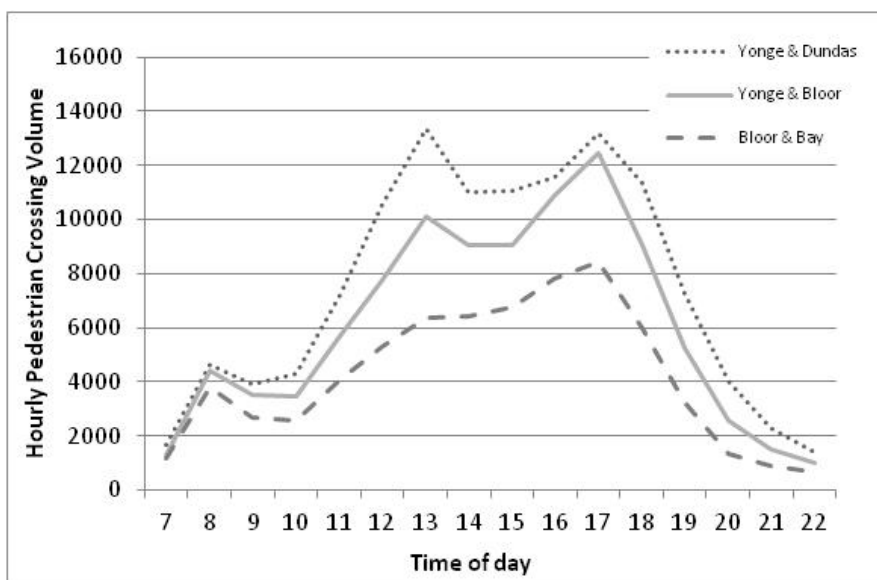


Figure 2 - Weekday Hourly Pedestrian Crossing Volume Distribution



There is a significantly smaller volume pedestrian taking advantage of the pedestrian priority phase signal at Bay & Bloor on weekends. Pedestrian activity drops by over 40% on weekends at this intersection. This reduction in weekend pedestrian activity has not been observed at the other two pedestrian priority phase intersections.

Utilization of Diagonal Crossing Option

A relatively lower percentage of users (16% on weekdays and 12% on weekends) take advantage of the diagonal crossing opportunity at Bay & Bloor compared to the other two pedestrian priority phase signals in downtown Toronto. The ratio of diagonal crossings over total crossings during the pedestrian priority phase only is illustrated in Figure 3.

The low level of utilization of the diagonal crossing at Bay & Bloor may be partially explained by the longer diagonal crossing distance (29.1m) as compared to Yonge & Bloor (24.6m) and Yonge & Dundas (22.5m). Figure 4 illustrates the geometry of each of the three intersections, including the conventional and diagonal crossing distances.

Figure 3 - Percentage of Diagonal Crossings

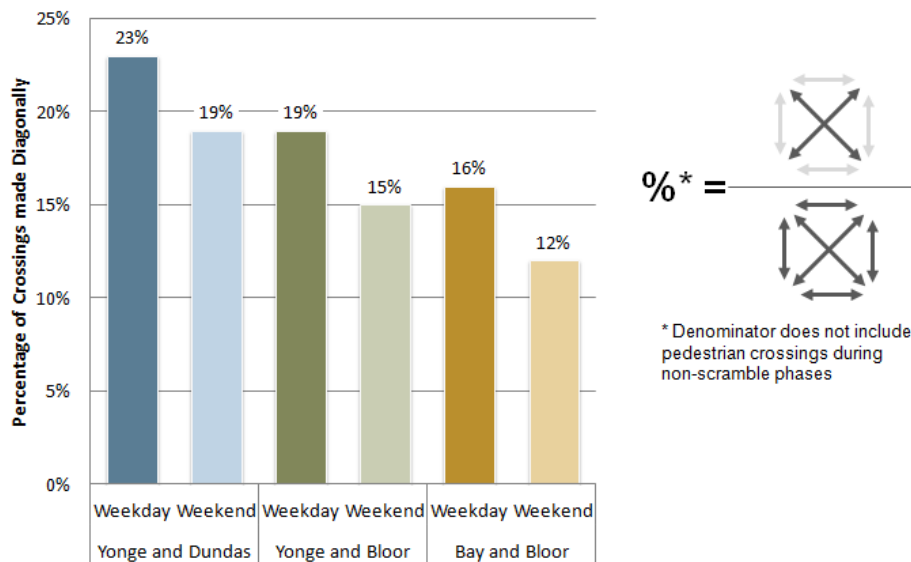
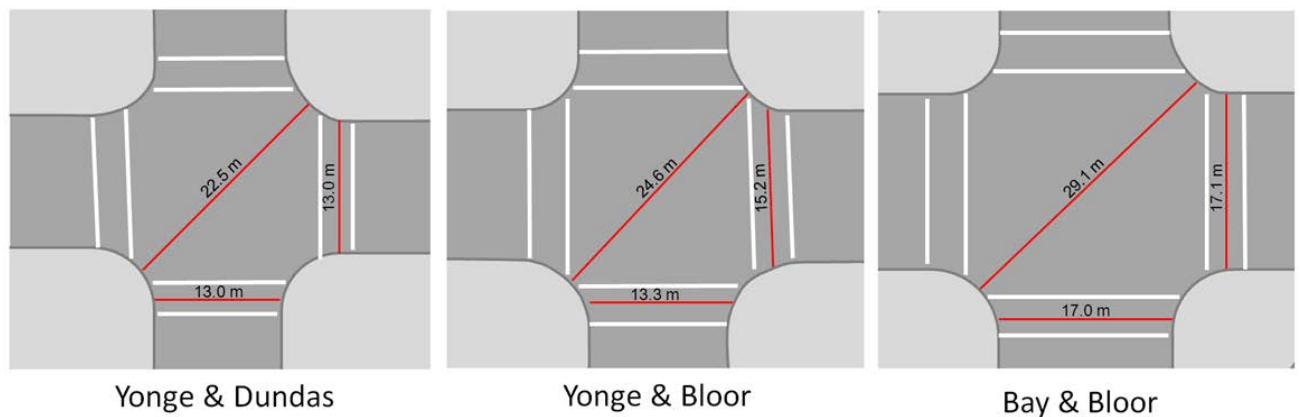


Figure 4 - Crossing Distances at all Pedestrian Priority Phases



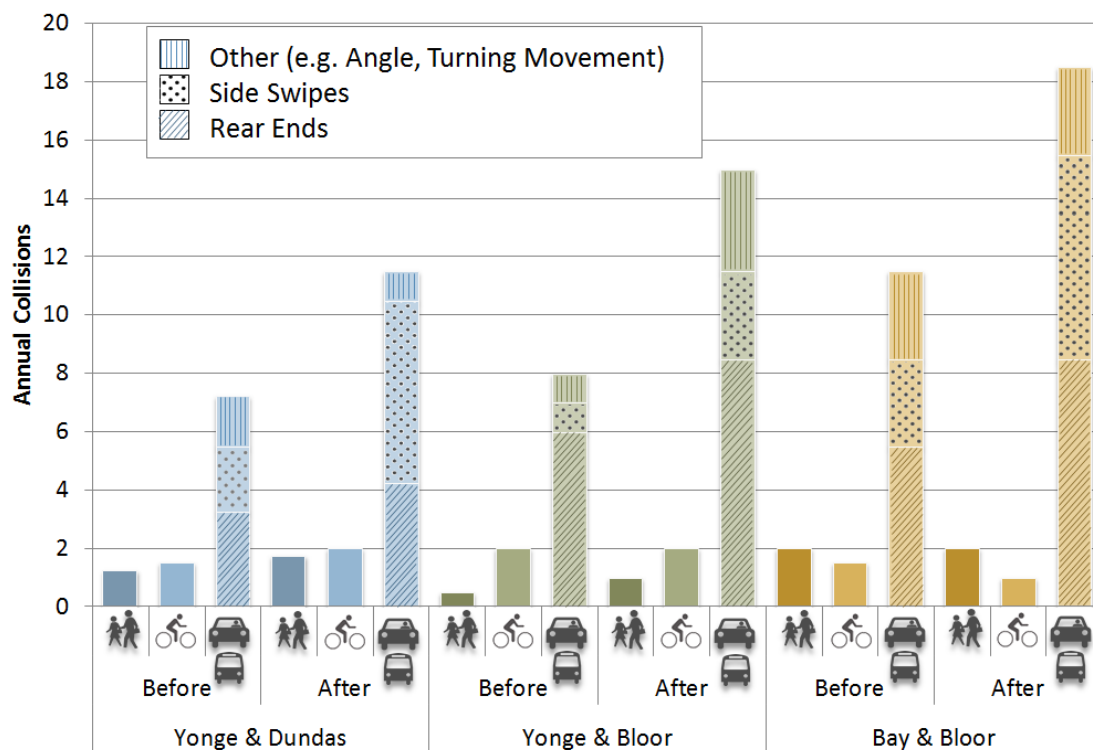
Traffic Safety and Collision History

Pedestrian collisions remained constant at one per year before and after the pedestrian priority phase installation at Bay & Bloor. However, it is not possible to draw strong conclusions about the impact of pedestrian priority phase operation on pedestrian safety based on the limited sample size. Annual collision rates presented in Figure 5 are based on available data from four years before and four years after pedestrian priority phase implementation at Yonge and Dundas and two years before and two years after pedestrian priority phase implementation at Yonge & Bloor and Bay & Bloor.

The number of rear-end and sideswipe collisions noticeably increased at Bay & Bloor since implementation of the pedestrian priority phase. The annual rate of sideswipe collisions went from 3 to 7 and rear-end collisions rose from 6 to 9. While driver frustration may be a factor in this increase, caution is advised in comparing the before-after collision statistics for the Bay & Bloor and Yonge & Bloor intersections. This is due to the different intersection conditions during the construction period of the multi-year streetscape redevelopment before the pedestrian priority phases were implemented.

Severity of injuries has not worsened as the majority of side swipe and rear-end collisions reported have involved no injuries.

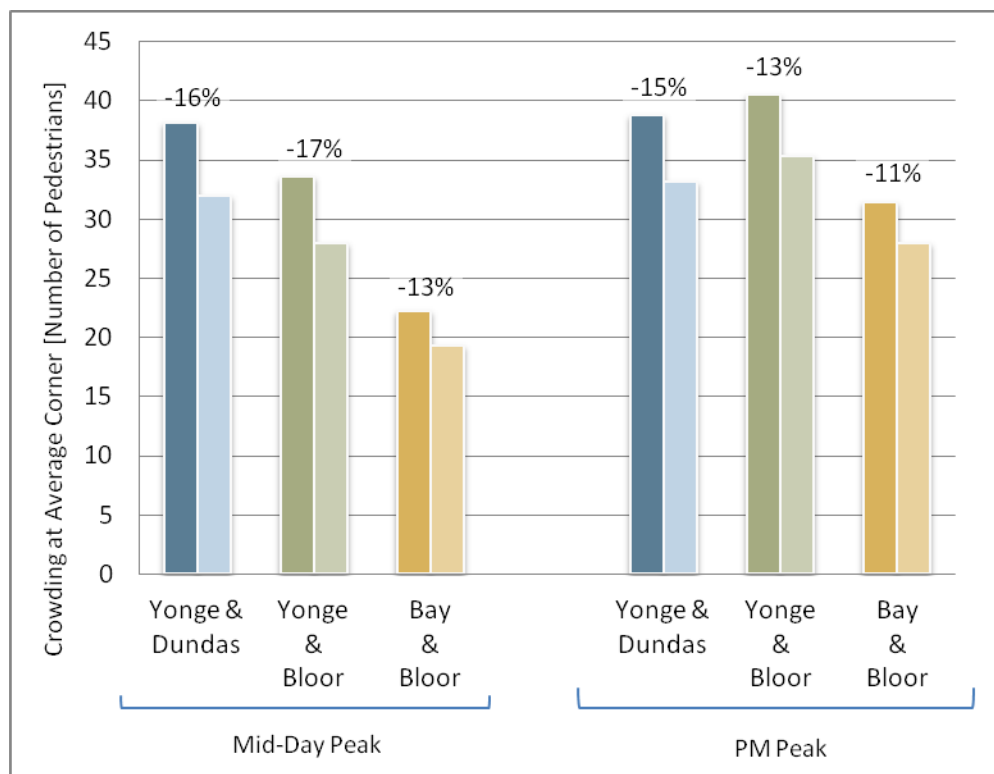
Figure 5 - Historical Collision Rates Before and After Implementation of Pedestrian Priority Phases



Pedestrian Delay and Crowding

Reduction of pedestrian delay and crowding at intersection corners is a key reason for considering the use of this type of pedestrian priority phase. Average pedestrian delay is estimated to have been reduced by eight seconds per pedestrian at Bay & Bloor as a result of the pedestrian priority phase operation. Crowding conditions were not identified as of concern prior to installation of the pedestrian priority phase signal, and this intersection experienced a mild decrease in sidewalk crowding as compared to the other two pedestrian priority phases. Figure 6 illustrates estimated change in corner crowding during the mid-day peak and evening peak hour. Crowding conditions were estimated based on actual pedestrian volumes measured on site and pre-defined signal timing plans.

Figure 6 –Corner Crowding Conditions with and without Pedestrian Priority Phase



Vehicular Delay

In order to allocate a portion of the signal cycle exclusively to pedestrians, the ratio of green time for vehicular movements had to be reduced. Figure 7 illustrates the allocation of signal time to the different mode users in a conventional signal compared to the pedestrian priority phase. In a conventional signal operation, vehicular movements receive the green signal 84% of the time in at least one direction. With the pedestrian priority phase this figure is reduced to 55% in order to provide an exclusive pedestrian signal. Conversely, pedestrians received the WALK or Flashing Don't Walk signal about

42% of the time in total under the conventional signal operation, while this figure is increased to 58% under pedestrian priority phase operation.

Figure 7 - Signal Time Allocation for Vehicles and Pedestrians at Pedestrian Priority Phase compared to a Conventional Signal



The pedestrian priority phase signal at Bay & Bloor has significantly increased delay for drivers and passengers (see Table 1). Overall intersection delay during the morning peak period has gone from about 40 seconds to approximately one and a half minutes. During the evening peak period, overall intersection delay has gone from about a 40 seconds to about two and a half minutes. Most severe delays are observed in the eastbound movement during the evening peak period, where vehicles are delayed close to five minutes on average.

Table 1- Bay & Bloor Vehicular Traffic Operation Performance

Approach		Scenario 1: Conventional Signal	Scenario 2: PPP Signal	
		Approach Delay [mm:ss]	Approach Delay [mm:ss]	Change in Delay [mm:ss]
AM Peak	Eastbound	00:44	02:28	+01:44
	EB-Left	00:37	01:56	+01:19
	Westbound	00:10	00:48	+00:38
	WB-Left	00:18	01:13	+00:55
	Southbound	00:58	01:25	+00:28
	SB-Left	00:54	01:18	+00:24
	Northbound	01:21	01:51	+00:30
	NB-Left	01:36	02:37	+01:01
	Overall	00:41	01:31	+00:50
PM Peak	Eastbound	00:50	04:57	+04:07
	EB-Left	01:28	02:58	+01:30
	Westbound	00:34	03:41	+03:06
	WB-Left	00:43	03:39	+02:56
	Southbound	00:45	01:04	+00:19
	SB-Left	02:25	02:03	-00:22
	Northbound	00:33	00:52	+00:19
	NB-Left	00:40	01:00	+00:20
	Overall	00:43	02:31	+01:48

While all turn restrictions are prohibited at the intersections of Yonge & Dundas (all day) and Yonge & Bloor (peak periods only), several turning movements are permitted at the intersection of Bay & Bloor. Turning vehicles, waiting for a gap in the steady flow of pedestrians to complete their turn, experience significant delays at the intersection of Bay and Bloor. Moreover, turning vehicles cause further delay by impeding other through movement traffic. Removal of the pedestrian priority phase signal at Bay & Bloor will not fully address this issue, in the absence of turning restrictions.

Traffic Diversions

Vehicular traffic volumes on routes nearby the intersections of Bay & Bloor and Yonge & Bloor before and after the implementation of the pedestrian priority phase signal have been analyzed. Results suggest that there is no evidence of traffic diversion to other east-west routes such as Wellesley Street and Davenport Street or other north-south routes such as Church Street and Avenue Road. It should be noted that the above mentioned east-west alternatives do not necessarily provide the same connectivity as Bloor Street, and that Bloor Street may be the only available option to many drivers.

Fuel Consumption and Emissions

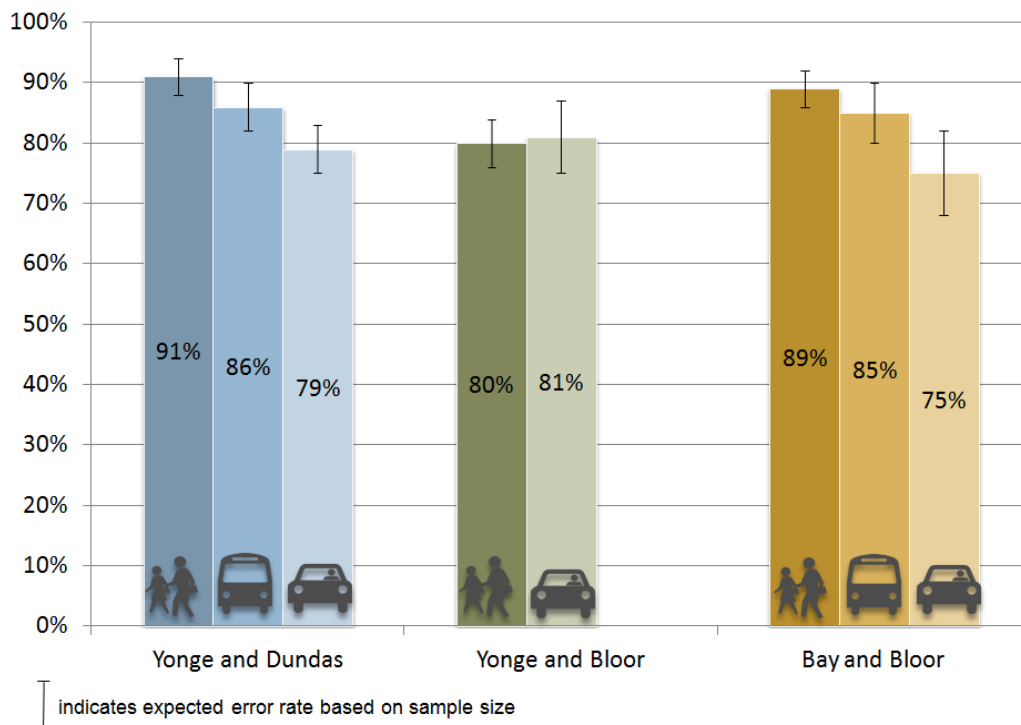
Stop-and-go driving as a result of increased vehicular delay causes an increase in automobile fuel consumption and greenhouse gas (GHG) emissions for conventional vehicles. At the intersection of Bay & Bloor, it is estimated using Synchro traffic modelling software that the additional delay as a result of the pedestrian priority phase has increased GHG emissions and fuel consumption by about 100%. Estimated annualized GHG emissions during the weekday peak periods (two hours of morning peak period and two hours of evening peak period) have gone from 2,800 kg of CO₂ to 5,500 kg. Similarly, fuel consumption for the same time period has gone from 148,000 litres to 292,000 litres.

Any emissions avoided by walk trips are not included in this analysis due to limitations in the available measurement and estimation tools.

User Feedback

There is weaker support for the scramble signal amongst drivers travelling through the intersection of Bay & Bloor compared to the other two pedestrian priority phase operations in the downtown. Support amongst pedestrians, however, is quite high for this intersection. These results are based on a user perception survey of pedestrians, drivers and surface transit riders conducted by Ipsos Reid in October 2011 for all three pedestrian priority phase locations. A total of 2,300 users were surveyed at the three pedestrian priority phase intersections. At the intersection of Bay and Bloor 413 pedestrians, 254 TTC bus riders and 325 drivers were surveyed. Figure 8 illustrates reported level of user satisfaction by each mode user group based on this survey.

Figure 8 Level of support for Pedestrian Priority Phase – Agree that "pedestrian priority phase is a good idea" by mode user



A public consultation meeting was held in July 2013 to discuss proposed changes to the Bay & Bloor intersection including removal of the pedestrian priority phase and reversion of the traffic signal back to a conventional signal. Opinions were evenly divided on the proposed removal of the pedestrian priority phase feature. Additionally, several comments were made at the public event and through 311 submissions to operate the pedestrian priority phase signal differently in order to maintain the pedestrian benefits of the diagonal crossing option while mitigating vehicular traffic issues. Staff have investigated a number of alternative approaches as outlined in Appendix 1, including changes to the type of pedestrian priority phase operation, part-time use of the pedestrian priority phase, addition of advance right-turn signals, and a prohibition of all turns. However, none of the alternatives were deemed a suitable or effective solution at this intersection. Based on the findings, staff have concluded that a pedestrian priority phase signal is not the right tool for the intersection of Bay and Bloor and recommend its removal.

The cost of removal of the pedestrian priority phase is estimated to be \$26,000. This includes staff time for re-timing of the signal and removal of signs and contracted services for removal of road markings and signal head equipment.

The provision of Pedestrian Priority Phase signal operations is an effective tool to promote pedestrian safety and walkability – but do so at the expense of 'green' time for vehicles. Given limited space and time, staff must balance the costs and benefits to all road users (including cyclists, motorists, pedestrians and transit) in making recommendations as to the appropriate use of tools. Based on a full evaluation of the three existing pedestrian priority phase intersections in Toronto, staff have developed guidelines to ensure that the tool is applied appropriately in the right circumstances. In the case of Bay & Bloor, the evaluation reveals that application of a pedestrian priority phase provides modest pedestrian benefits at the cost of significant vehicular delay.

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ATTACHMENTS

Attachment 1: Review of Alternative Pedestrian Priority Phase Operations Investigated

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A public consultation meeting was held in July 2013 to discuss proposed changes to the Bay & Bloor intersection including removal of the pedestrian priority phase and reversion of the traffic signal back to a conventional signal.

The event hosted about 85 participants who submitted 53 individual comment forms in addition to participating in the discussions during the event. In addition about 50 e-mails were received prior to or following the event. Participants represented businesses, residents, cyclists, pedestrians, motorists, and seniors.

There were strong concerns about increased traffic congestion as a result of the pedestrian priority phase operation and an equally strong desire for safe pedestrian conditions. Opinions were evenly divided on the proposed removal of the pedestrian priority phase feature. Several participants raised the need to maintain or improve convenient motor vehicle access for residents and nearby businesses while others wanted to review the full evaluation results before making any changes.

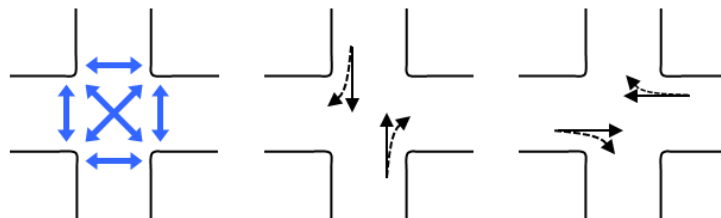
Additionally, several comments were made at the public event and through 311 submissions to operate the pedestrian priority phase signal differently in order to maintain the pedestrian benefits of the diagonal crossing option while mitigating vehicular traffic issues. The next section of this report addresses the feasibility of these options.

Given the significant increase in delay to vehicular traffic staff investigated the following alternatives for the intersection of Bay & Bloor with the aim of partially alleviating delays while maintaining the pedestrian priority phase feature.

A) Operating the signal as Type 1 Pedestrian Priority Phase

A Type 1 pedestrian priority phase would allow pedestrians to cross in all directions during the exclusive pedestrian phase; however it would prohibit all pedestrian crossings during both the vehicle North-South and East-West phases of the signal. This would eliminate the need for turning vehicles to yield to crossing pedestrians and avoid backing up the curb lanes, resulting in improved vehicular traffic operations.

Type 1 of Pedestrian Priority Phase Operations



Limiting pedestrian crossings to the scramble phase alone would provide even less crossing time opportunity for pedestrians than with a conventional signal, thus extending the pedestrian wait times up to one minute and 20 seconds and introducing potential crowding issues at corners with limited space. Longer wait times are not only an inconvenience for pedestrians, but also a safety concern as pedestrians grow impatient while waiting and are more likely to cross against their signal. Because there is not a steady volume of right and left turning vehicles at all four corners, pedestrians would observe gaps in turning traffic, violate their signal, cross with parallel moving traffic and risk being hit by a turning vehicle. Studies of this type of scramble operations have shown that this negative impact outweighs the positive benefits of the scramble.

Additionally, this mode of pedestrian priority phase operation poses crossing challenges for blind and visually impaired pedestrians who use the sound of parallel-moving vehicles and pedestrians as a cue to keep them headed in the right direction. The City of Calgary receives numerous complaints from the vision impaired community about challenges they face in using their Type 1 pedestrian priority phase.

For the reasons above, this alternative is not recommended.

B) Operating two Type 1 Pedestrian Priority Phases in one cycle

In order to address the corner crowding and long wait time issues with a Type 1 pedestrian priority phase, the possibility of providing a pedestrian priority phase after each vehicle phase was investigated. Under this operation pedestrians would be prohibited from crossing during the vehicle phases, but a pedestrian priority phase would be provided after the vehicle north-south phase, and again following vehicle east-west phase.

While this approach might be reasonable at a much smaller intersection with turn restrictions - due to the diagonal length of the Bay & Bloor crossing, this signal operation would increase the signal cycle time to about 140 seconds. This is well above the cycle length of other conventional signals along Bloor Street. The longer cycle time would cause more significant delays to both east-west and north-south vehicular movements than those experienced today with the current pedestrian priority phase operation. This would also make signal coordination very ineffective. It is worth noting that the vehicular demand along both Bloor and Bay Streets does not allow for shorter vehicle phases than the current amount.

For the reasons above, this alternative is not recommended.

C) Operating the Pedestrian Priority Phase part-time

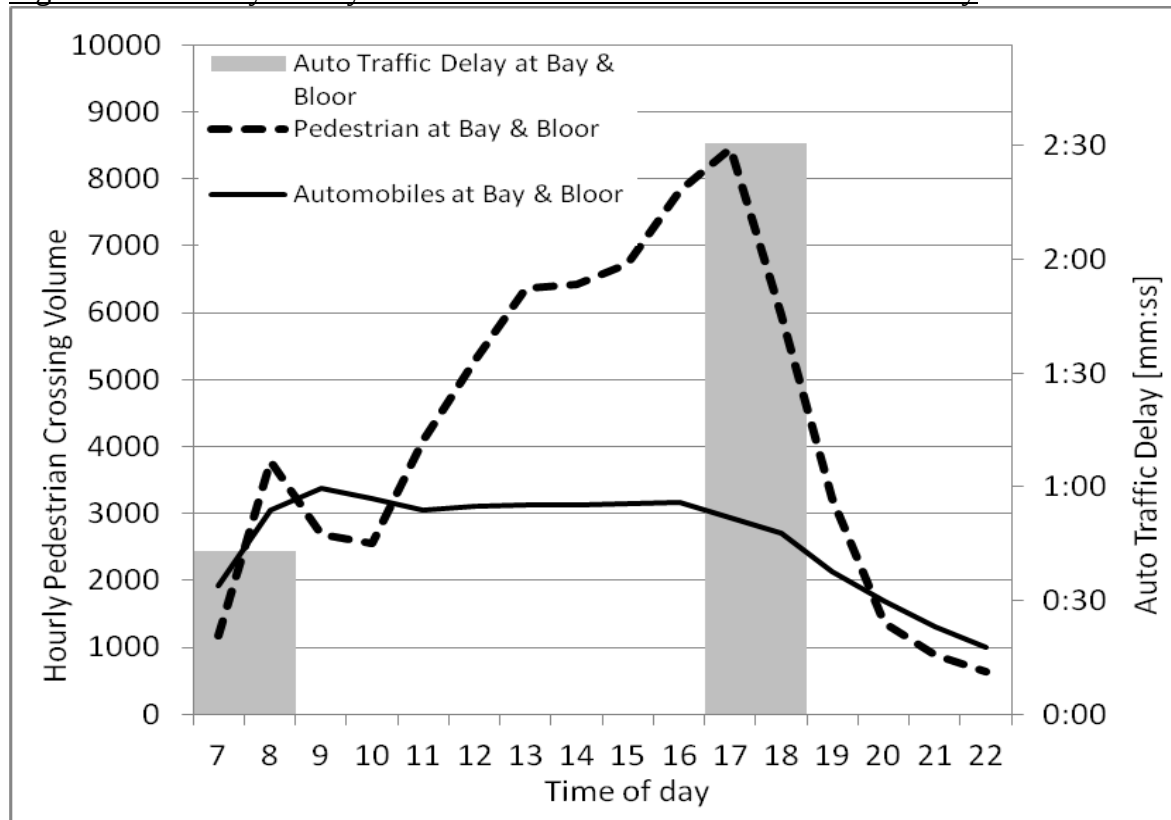
Since pedestrian demand is only high during the afternoon at Bay & Bloor, the option of only operating the pedestrian priority phase during peak pedestrian times was investigated. Under this approach, the operation would revert back to a conventional signal without an exclusive pedestrian phase during pedestrian off-peak times.

One of the challenges with this alternative is that pedestrian volume at the intersection peaks during the evening rush hour, which is the same time that vehicles are experiencing the worst traffic delays. Figure 9 illustrates the distribution of pedestrian and vehicular volumes at Bay & Bloor over the course of the day. While vehicular traffic volumes are more or less steady between eight AM and five PM, evening delays are significantly longer. This is directly related to the higher volume of pedestrian crossings at this time, and turning vehicle conflicts, which significantly reduce curb lane capacity. Given the pedestrian volume distribution over the course of the day a part-time operation of the pedestrian priority phase would only 'turn-off' the pedestrian priority phase feature at night time. This would not address major concerns with vehicular delay at the intersection during the evening rush hour.

Another concern with this approach is the safety implications of operating the signal differently at different times of the day. It is possible that pedestrians would assume that crossing diagonally is an option during the times that the pedestrian priority phase is inactive, leading to potential safety issues. While users are expected to follow traffic signals and signage, consistency in operation would reduce risks and liability. As well, proximity to the Yonge-Bloor pedestrian priority phase operation might also present a challenge to users if they were not programmed in the same manner.

For the reasons above, this alternative is not recommended.

Figure 9 - Weekday Hourly User Volume Distribution and Vehicular Delay



D) Provision of advance right-turn signals

Right turning vehicles, particularly those travelling westbound turning northbound and travelling southbound turning westbound are observed to experience delays and cause major delays to through vehicles at the intersection. As noted earlier, the steady flow of pedestrians means that only a couple of vehicles can complete their right turn during each phase. As such, the option of providing an advance right turn signal was investigated for these movements.

An advance right turn signal requires an exclusive right turn lane in order to separate through and right turning vehicles. Without this separation, the right turn signal time is underutilized by the higher ratio of through traffic in the curb lane. Providing an exclusive right turn lane in addition to the two through lanes and one left turn lane is not possible at this intersection due to physical constraints. Furthermore, it is not recommended to reduce the through capacity of the intersection by converting the curb lane to an exclusive right-turn lane.

For the reasons above, this alternative is not recommended.

E) Prohibiting all turn movements

As illustrated in this report, one of the main causes of vehicle back-up at this intersection is the delay experienced by right-turning vehicles as they wait to find a gap in the flow of pedestrians. Exclusive left turn lanes are provided for all intersection approaches at Bay & Bloor, and with dedicated left turn signal phases provided in some movements. These phases reduce green time for through traffic, causing increased delays.

The option to fully prohibit all left and right turn movements was considered. The prohibitions would ultimately prioritize through vehicular traffic as opposed to those accessing the area. There was a strong lack of support for such prohibitions expressed by local business and residents who worry that such restrictions would further reduce their level of access.

For this reason, this alternative is not recommended.