Development of an Updated "Traffic Signal Operations Policies and Strategies" Document for the City of Toronto

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ABSTRACT

Congestion of road networks is a persistent problem in almost all large and growing metropolitan areas. In the City of Toronto, a combination of transportation policies and strategies are applied to address congestion issues. One way of mitigating the impacts of congestion is through consistent, safe, and efficient control of traffic signals. Historically, the City’s traffic signal operations were guided by Standard Operating Practices (SOPs) that were inconsistent, incomplete, or out-of-date. A consolidated document to provide guidance to City staff and consultants was not available. To address this gap, a three-member Working Group was established to develop the City's "Traffic Signal Operations Policies and Strategies" document.

The policies and strategies in this document complement and support the broader vision, goals and objectives of the Toronto Official Plan and Transportation Services Division Strategic Agenda, providing guidelines for the City's signal operations while promoting the consistent, safe, and efficient control of traffic signals for all road users. This paper discusses the policy developmental framework and the policy-making process used to develop the policies and strategies of traffic signal operations in Toronto. It also addresses the challenges and sensitive issues that arose during the process.

Keywords: Policy Development, Policy, Strategy, Traffic Signal Operations, Traffic Signals, Signal Timing Policies
INTRODUCTION

Toronto is the largest city in Canada, the capital of the Province of Ontario and the fourth largest city in North America. It is a global centre for business, finance, arts and culture, and home to a diverse population of 2.8 million people. The city is served by a road network with 90 km of province-owned highways, 40 km of City-owned highways, and over 5,600 km of City-owned roads. There are 2,288 traffic signals on the road network.

Prior to World War II, road infrastructure was limited and of poor quality. During the war, gas rationing further restricted car use. Following the war, prosperity, improved inter-urban roads, and urbanization pushed automobile ownership to new levels. The enormous increase in the number of cars increased the demand for new roads. In 1953, the City of Toronto (formerly Municipality of Metropolitan Toronto and referred to as the City hereon in) assumed control of arterial roads and spent much of its budget on roads and highways, such as the Don Valley Parkway (1). The expanded road network encouraged urban sprawl, whereby many of the middle class moved away from the Toronto downtown core to the suburbs.

In the late 1960s, residents who had moved to the suburbs started to move back into the downtown core because of the comparative health of these older neighbourhoods and communities (1). Gentrification allowed the downtown core to become revitalized where it had previously begun to fall into decline. Though the road network was the focus of transportation development in Toronto, there were some improvements to the transit system. The Toronto Transit Commission (formerly Toronto Transportation Commission and referred to as TTC hereon in) took over the existing privately-operated bus routes, initiated new bus routes in the suburbs, made improvements to the downtown surface routes, and opened subway lines (1). In the 1970s, anti-car advocates worked to convince people to take transit, to cycle, or to walk rather than driving, for the sake of their health and the environment (1).

Historically, Toronto's roads served all modes of transportation but provided preferential treatment to vehicles. Today, the City adopts the Complete Streets approach when constructing new roads or reconstructing existing roads (2). The needs of all users, such as people who walk, bicycle, take transit or drive, and people of varying ages and levels of ability are now considered. The goal is to build a city with a well-functioning street network that supports and sustains quality of life in Toronto (2).

Traffic signals are a key component of the road network, controlling the flow of traffic for different users travelling through the road network. As the city’s population increases, greater travel demand creates more traffic congestion and the challenge of deciding how to share the limited road space among all road users. Efficient traffic signal operations assist the mitigation of traffic congestion on the road network. Day-to-day traffic signal operations are managed by the City's Transportation Services Division. There are different units within Transportation Services that are responsible for the various tasks that promote efficient traffic signal operations:

- **Intelligent Transportation Systems Operations (ITSO)** is responsible for the operation of the City's traffic control systems; implementation of signal timing changes, signal modifications, construction timings and special event timings; signal coordination studies; and the development of policies and procedures for signal operations. ITSO's focus is on the system-wide impact of traffic signal operations.

- **District Traffic Operations (DTO)** is responsible for signal warrant analysis, development of signal phasing for new traffic signals, developing updates to existing signal
timing plans and the development of construction timings. The four DTOs' focus is on the traffic signal operations at the local level.

- **Traffic Plant Installation and Maintenance (TPIM)** is responsible for design, installation and maintenance of all electrical traffic control devices (traffic signals, pedestrian crossovers, flashing beacons).

- **Intelligent Transportation Systems Capital Projects Planning and Delivery (ITSC)** is responsible for planning, procurement and project management of large-scale ITS projects to improve Toronto’s road network.

- **Electrical Maintenance Contractor (EMC)** is the traffic signals maintenance contractor retained by the City to provide maintenance services to the traffic control devices for a predetermined period, normally four years.

In Ontario, municipal governments receive limited provincial and federal funding for their traffic signal operations. Traffic signals on Toronto’s road network are owned, managed, and funded by the City, with the exception of 55 traffic signals that are in close proximity to the provincial highways. These 55 traffic signals are owned by the Province of Ontario but managed by the City under an agreement with the provincial Ministry of Transportation (MTO). The MTO is responsible for approving any operational changes and providing funding for any equipment upgrades.

Historically, traffic engineers make decisions based on user expectation and complaints, which may not represent best practices or the agency’s policy (3). In order to promote consistent, safe, and efficient control of traffic signals for all road users in Toronto, a Working Group was established within ITS to develop the “Traffic Signal Operations Policies and Strategies” document that would provide guidance for the City's signal operations. The Working Group consisted of three City staff who collectively have over 50 years of experience in traffic signal operations and traffic control systems. Over a 12 month period, the Working Group reviewed all existing documentation and reached out to stakeholders. The Working Group also reviewed procedures and practices followed by municipalities in Canada and United States. The Working Group ensured that the proposed document would support the broader goals and objectives of the Toronto Official Plan (4) and Transportation Services Strategic Agenda (5). ITS is the custodian of the “Traffic Signal Operations Policies and Strategies” document.

**ADMINISTRATIVE STRUCTURE OF THE CITY OF TORONTO**

The City of Toronto's administrative structure, known as the Toronto Public Service, consists of a City Manager and three Deputy City Managers who oversee 44 City divisions (6). The City Manager is the most senior official in the City's administrative structure and is accountable to the Toronto City Council, the governing and legislative body of the City. In addition to providing guidance and advice to the 44 member City Council, the City Manager also coordinates the work of the City divisions and is responsible for delivering programs and services to the public. There are three City divisions that are involved with the building, operation and improvement of Toronto's road network:
1. **Transportation Services** – This division is responsible for all aspects of Toronto's road network including expressways, streets, bridges, traffic signs, street name signs and traffic signals to sidewalks and street furniture (6). The division also handles traffic operations, right-of-way by-law enforcement and right-of-way maintenance (6).

2. **City Planning** – This division manages the growth and physical form of the city (6). Since the road network is an element of the physical form of the city, City Planning activities impact the growth and evolution of the road network.

3. **Engineering and Construction Services** – This division provides specialized services such as engineering design, construction, management, development engineering review and engineering and control surveying (6).

An understanding of the responsibilities of each division and their relation to different aspects of the road network provided the Working Group context for how the "Traffic Signal Operations Policies and Strategies" document should be developed and how it would be used.

**RATIONALE FOR DEVELOPING THE TRAFFIC SIGNAL OPERATIONS POLICIES AND STRATEGIES FOR TORONTO**

Many agencies do not have written policies for their signal timing operations (3). However, it is a worthwhile undertaking to develop signal timing policies that follow regional and local community transportation goals and objectives (3). The Working Group decided to create a document that addressed both policies and strategies. Policies are courses or principles of action adopted or proposed by a government, party, business, or individual (7). They are statements of intent in plans or guidelines of the government that influence the decision-makers. Strategies are high-level plans of action or approaches designed to achieve a major or overall goal (7). Policies and strategies typically go hand-in-hand, where policies provide the principles and strategies provide the high-level approach for achieving the overall goal. There are three types of policies (8):

- **Broad Policy** – Policy that enunciates government-wide direction.
- **Sector Policy** – Policy developed for particular sector or area of concern (i.e. transportation sector).
- **Operational Policy** – Policy that guides decisions on programs and project selection or provides high-level guidance for operational decisions.

These policies can be placed in a hierarchy (Figure 1). The broad policy is the high-level policy that provides a clear vision or "big picture" for the government. It is supported by different sector or issue-area policies that address different areas of concern. When these sector policies are implemented collectively, they help to achieve the overall vision. These sector or issue-area policies are supported by operational policies that guide decisions of specific programs or operational functions of a sector. These are more specific policies that provide general guidelines for specific operations or programs that address a specific area of concern of the sector.
FIGURE 1 Hierarchy of policy types.

In Toronto, City Planning is responsible for the growth and physical form of the city. City Planning developed the Toronto Official Plan (referred to as the Official Plan hereon in) that was approved by the City Council in 2002 and updated in 2010. The Official Plan is the broad policy that provides the "big picture" vision for shaping Toronto's collective future (4). It provides overall guidance for City divisions to achieve a unified goal for successful city-building. As a part of city-building, the road network plays a crucial role. In conformity with the Official Plan, Transportation Services developed a Strategic Agenda (referred to as the Agenda hereon in) to provide a roadmap to guide its work towards the common goals of delivering a safe, efficient, and effective transportation system that serves residents, businesses, and visitors. The Agenda acts as the sector strategic and policy plan that helps division staff understand the importance of their daily activities and establish appropriate priorities (5).

Prior to the development of the "Traffic Signal Operations Policies and Strategies" document, traffic signal operations were governed by practices that were not documented, or were not current. In compliance with the Official Plan and the Agenda, ITSO developed the "Traffic Signal Operations Policies and Strategies" document that would act as the operational strategic and policy plan that promotes consistent, safe, and efficient control of traffic signals for all road users in Toronto.

THE POLICY DEVELOPMENTAL FRAMEWORK

The policies and strategies of Toronto's traffic signal operations were developed following a hierarchical policy developmental framework (Figure 2). Each component of the framework is described in this section.
FIGURE 2 Hierarchical policy developmental framework used to develop Toronto's Traffic Signal Operations Policies and Strategies.

Toronto Official Plan
The Official Plan is the broad policy that provides a road map to Toronto's future, providing the basis for building a city-wide consensus around change. Transportation policies need to encourage transit, walking and cycling over private automobile use and ensure the movement of people and goods as the number of businesses, employees and residents increase (4). Ways to reduce car dependency could be through creative and flexible management of urban growth, or examination of existing transportation modes to create policies and programs that emphasize the use of public transit, walking and cycling over automobile travel. These policies should not only address the physical infrastructure of the City’s transportation system, but also have complementary policies that make more efficient use of this infrastructure to support the goal of reducing car dependency throughout the city (4). For example, cycling can be encouraged by improving the safety of cyclists through the design and operation of streets and through education and promotion programs. Ultimately, the City needs to move towards a more sustainable transportation system where transit, cycling and walking are attractive alternatives to using the car (4). In a mature city like Toronto, especially in the downtown core, there is little space available for the expansion of transportation capacity. Therefore, emphasis must be placed on making better use of the existing capacity to efficiently move people throughout the city (4). This can be achieved by giving priority to streetcars and buses on city roads and promoting mixed use development that increases opportunities for living close to work, while encouraging walking and cycling for local trips.

The goal is not to eliminate the use of automobiles altogether, but rather, to present more attractive alternatives for travelers so they have more options when traveling within the city. Thus, the needs of the different road users – pedestrians, cyclists, transit riders, and vehicle drivers, need to be balanced when creating transportation policies. The policies must also address
the safety of all road users, such as minimizing traffic infiltration on adjacent neighbourhood streets.

**Transportation Services Strategic Agenda**
The Transportation Strategic Agenda is the sector policy and strategy that complements the Official Plan’s transportation policies. The vision of the Agenda is for Transportation Services to become “an international leader in the design, operation, and management of municipal transportation systems that meet the needs of all users” (5). The vision is supported by five goals (5):

- **Safety** – Enhance transportation safety for all users.
- **Mobility** – Improve the operations of our road network for all modes.
- **Liveable Streets** – Deliver streets that serve people.
- **Infrastructure** – Provide quality infrastructure as a foundation for Toronto's vitality.
- **Operations** – Provide excellent, efficient, and sustainable service to all customers.

Each goal is supported by numerous objectives to guide the efforts to achieve the vision. The purpose of a transportation system is to enhance mobility of all users of the network by improving the operations. There are different ways to improve operations, such as enhancing and expanding the walking and cycling networks, supporting operations of high-quality transit services, implementing cost-effective strategies to mitigate congestion, and providing new innovative services to support mobility for users of all modes. However, safety is also paramount to the Division. It is achieved through programs and policies that reduce injuries and fatalities for users of all modes of travel.

In compliance with the Official Plan, Toronto needs to move towards a more sustainable transportation system. The Agenda's goal of delivering streets that serve people and designing for liveable streets is in tandem with this vision. This is achieved by advancing a Complete Streets approach to balance the needs of all users and ensuring an attractive, accessible, sustainable, and properly managed public realm. The transportation system needs to be maintained in a state of good repair and infrastructure needs to be properly managed in the public right-of-way.

**Traffic Signal Operations Policies and Strategies**
The high-level vision for the city and its road network provides guidance when creating the "Traffic Signal Operations Policies and Strategies" document. The purpose and guiding principles of the "Traffic Signal Operations Policies and Strategies" document were developed in compliance with the Official Plan and the Agenda. The Plan and Agenda provide guidance for the development of specific policies and strategies pertaining to different aspects of traffic signal operations.

The "Traffic Signal Operations Policies and Strategies" document is the operational policy that outlines policies and strategies from administrative-related items to technical elements that pertain to traffic signal operations. Its purpose is to provide guidance on various signal operations practices to promote consistent, safe, and efficient control of traffic signals within the city for all road users (9). It is driven by the following guiding principles (9):

- To ensure safety of all users of the road.
To encourage person throughput.

To encourage walking.

To minimize vehicular delay.

To encourage transit usage.

To encourage cycling.

Typically, policies are created by policy makers who have limited experience with the technical complexity of implementing the strategy associated with a specific policy. This poses a challenge for practitioners if an agency’s established policies are not fully understood by staff, or the staff may not recognize that the policy was established (3). To address this potential drawback when developing the "Traffic Signal Operations Policies and Strategies" document, the Working Group was established within ITSO to bring technical expertise to the table while addressing the "big picture". ITSO staff are both the practitioners and policy makers for traffic signal operations policies and strategies, thus closing the gap between policy creation and implementation.

Three versions of the document were created, each for a different audience. First, a 150-page Technical Report was developed to document all the research conducted in developing the Report. The audience for the Report are City staff and stakeholders who are interested in the technical background used to develop the policies and strategies. This report is restricted to City staff and is posted on the City's intranet. The Technical Report was used to develop the 70-page "Traffic Signal Operations Policies and Strategies" document that summarizes and details each policy and strategy. The audience for this document are consultants, external agencies, and internal staff who are involved with the day-to-day activities of traffic signal operations and planning. The third document is the 5-page Executive Summary which provides a summary of the major policies covered in the "Traffic Signal Operations Policies and Strategies" document. Its purpose is to provide senior management, elected officials and the public with a high-level overview of the "Traffic Signal Operations Policies and Strategies" document. Both the “Traffic Signal Operations Policies and Strategies” and Executive Summary documents are posted on the City's Internet site.

**Standard Operating Practices**

Following the development of the "Traffic Signal Operations Policies and Strategies" document, a consolidated document became available to guide traffic signal operations. The next step will be the updating of existing Standard Operating Practices (SOPs) and the creation of new SOPs to provide guidance for implementation of the policies enshrined in "Traffic Signal Operations Policies and Strategies" document.

**THE POLICY-MAKING PROCESS**

Often, agencies do not have written policies for their signal timing operations. However, it is a worthwhile undertaking to develop signal timing polices that follow regional and local community transportation goals and objectives. As suggested by the United States Federal Highway Administration (FHWA), agencies should use signal timing policies to guide the development, operation, and maintenance of their signal system (3). In Toronto, we decided to expand the scope to include all aspects of traffic signal operations, not just signal timings. Also, our document included both policies and the associated strategies for implementation. This
approach addressed all levels of traffic signal operations from the local level to the corridor level to the network level.

A context sensitive approach was used when developing the policies and strategies document. This approach considers local, regional and provincial transportation policies and strategies, particularly the Ontario Traffic Manual (OTM), the City's Official Plan and the Transportation Division’s Strategic Agenda. The policy-making process involved five steps (Figure 3):


2. **Literature Review** – Review existing SOPs that historically guided the City's traffic signal operations and conduct literature review on standards, legislation, and best practices. This helps to establish existing policies and strategies and propose policies and strategies to close any gaps.

3. **Stakeholder Engagement** – Engage stakeholders for comments and suggestions on the draft Technical Report.

4. **Committee Review** – Seek direction on contentious items that arose during the stakeholder meeting and seek approval of the policies and strategies from the Safety and Mobility Committee (SMC) of Transportation Services. This Committee meets every month to discuss traffic operations issues and to develop standard harmonized practices for the City’s transportation system.

5. **Approval** – Seek document approval from senior management.


Steps 1 to 4 were followed to create the Technical Report. After the Committee Review, the "Traffic Signal Operations Policies and Strategies" and Executive Summary documents were created and all three versions of the traffic signal operations policies and strategies were submitted to senior management for review.

**Purpose and Guiding Principles**

The Working Group reviewed the visions, goals, and objectives of the Official Plan and the Agenda to establish the purpose and the guiding principles of the proposed document. This helps to provide guidance when developing new policies and strategies and reviewing existing ones for different aspects of traffic signal operations. It was recognised that the proposed document could
not take precedence over the Official Plan or the Agenda but would be supportive of visions, goals, and objectives of Official Plan and the Agenda.

**Literature Review**

Next, the Working Group reviewed the existing SOPs for consistency and relevancy to today's transportation conditions. These SOPs detailed the existing practices and processes that were used for different aspects of traffic signal operations, guiding the City’s operations. Though some were inconsistent, incomplete and out-of-date, the existing SOPs provided an indication of the policies and strategies that were in place. For example, a SOP on closely-spaced traffic signals that dates back to 1995 was reviewed. Although the concepts are sound, some of the results are no longer applicable to current conditions. A SOP on accessible pedestrian signals (APS) was developed in 2009, but has not been updated to reflect new technology that was implemented after 2009. Another SOP that described clearance intervals for left-turn signal operations still described the use of a flashing green ball for protected left turns, even though the City discontinued that practice three years ago when all flashing green balls were replaced with left turn green arrows. Each SOP was thoroughly reviewed and inconsistencies were identified for future studies.

Research was also conducted on standards, legislation, and best practices for signal operations. As recommended by the FHWA, there should be implicit or explicit direction to use the latest national and local standards available relating to signal timing and operations along with good engineering judgement within all signal timing policies (3). The standards that were reviewed and referenced include the Ontario Traffic Manual (OTM) Books 7, 12 and 15; Ontario Traffic Council (OTC) Bicycle Traffic Signals Guide; and the Transportation Association of Canada (TAC) Guidelines and Standards such as the Canadian Manual for Uniform Traffic Control Devices (MUTCD) (14).

In Ontario, even though traffic signal operations and planning are not generally funded by the provincial government, the province set the traffic signal operations guidelines that municipalities should follow. OTM Book 7 addresses the application of control devices in temporary construction, maintenance, and utility work zones (13). OTM Book 12 provides standards, recommended practices, guidelines, and options for traffic signal operations (10). OTM Book 15 provides practical guidance and application information on the planning, design, and operation of pedestrian roadway crossings in Ontario (12). OTC Bicycle Traffic Signals provides guidance on planning, designing, and operating bicycle signals in Ontario (11). Canadian wide guidelines such as the Canadian Manual of Uniform Traffic Control Devices (MUTCD) are developed by TAC. Similar to the US MUTCD, the Canadian MUTCD provides guidelines and preferred methods in the design, dimensions and application of devices for the control of traffic and the provision of information to drivers and other road users (14). If municipalities decide to deviate from the OTM Guidelines or the MUTCD, they need to provide good reasoning and context for any alternative approach.

Best practices were also drawn from other North American cities and from in-house studies conducted by the City. Different transportation policy categories such as pedestrian-focused, bicycle-focused, transit-focused, emergency vehicle-focused, automobile-focused, and at low-volume locations or periods were reviewed. Often, trade-offs are required between various modes at an intersection because signal timing by its nature is the assignment of right-of-way to competing direction and travel modes. These categories can have competing ideas, such as safe pedestrian crossing times versus maximizing automobile capacity. During the research
stage, stakeholders were informally consulted to address these focus areas and to discuss potential trade-offs. Though public engagement was not part of the policy-making process, comments from the public were accounted for when the report was prepared. This was achieved through reviewing a list of public concerns received by ITSO in the past five years. ITSO is involved in the day-to-day operations of traffic signals and respond to daily public inquiries and concerns. These concerns are documented and summarized in the list that identifies what the public is commonly concerned about with regards to traffic signal operations.

All information collected from the research stage was synthesized into the draft Technical Report. The purpose and guiding principles established in the previous step were considered throughout the process. Since traffic signal operation is a public service, public safety was considered to be of utmost importance when developing the document. Stakeholders were subsequently engaged and involved in the review of the draft.

Stakeholder Engagement
Three weeks before a one-day workshop, the draft Technical Report was submitted to all stakeholders for review. The stakeholders were the units within the City's Transportation Services Division who are involved with the day-to-day traffic signal planning and operations:

- Transportation Districts – District Traffic Operations (DTO), District Traffic Planning (DTP)
- Traffic Management Centre (TMC) – ITSO
- Public Realm (PR) – Pedestrian Projects
- Traffic Infrastructure Management Section (TIMS) – Pedestrian & Cycling Infrastructure

Policies and expectations may vary based on the users, roadway facilities, and mode split. The purpose of the workshop was to gather all stakeholders around the table to discuss their competing interests and develop policies and strategies that take the Complete Streets approach and are context-sensitive. Stakeholders would review the report ahead of time and discuss their concerns and advise whether policies and strategies should be added or omitted during the workshop. To facilitate the discussions, each policy was presented during the workshop and the stakeholders were asked to comment if they agree with the policy or strategy put forth. If none of the stakeholders have issues with the policy, the discussion would progress to the next item. If concerns were raised, an open debate would occur for that item for an allotted time. If no agreement could be reached within the time limit, the item would be deferred for review by the traffic operations managers at the Safety and Mobility Committee (SMC) meeting of Transportation Services. All comments and discussions were documented and subsequently circulated to stakeholders to ensure there was common understanding on which policies and strategies were agreed to and which ones still needed discussion.

An area of competing interest was the walk speed used in Toronto. Public Realm advocates for pedestrian safety and lobbied for lowering the universal pedestrian walking speed to less than the current 1.0 m/s. However, the DTOs were concerned with such an initiative, due to higher overall wait times for pedestrians, higher cycle lengths at major intersections, capacity related issues for local traffic and delays to transit. The compromise was that the standard walk speed would remain at 1.0 m/s but there would be flexibility to reduce to 0.9 m/s or 0.8 m/s based on demographics, in compliance with TAC Guidelines (15).
Committee Review
Any contentious items that the workshop could not agree on collectively due to institutional differences were flagged and raised at the Safety and Mobility Committee (SMC) of Transportation Services. The SMC consists of traffic operations managers from Transportation Services and representatives from TTC, Toronto Parking Authority and Toronto Police Service. SMC reports to the Transportation Services Senior Management Team (SMT) on a quarterly basis. Only the City's traffic operations managers had voting rights on the Technical Report, because they directly manage the day-to-day traffic operation activities.

There were five contentious issues that were escalated to the SMC for direction (Table 1). Two of the five issues could not be resolved at the SMC level, and were further escalated to senior management.

TABLE 1 Summary of contentious issues escalated to the Safety and Mobility Committee of Transportation Services or Senior Management for direction.

<table>
<thead>
<tr>
<th>#</th>
<th>Request</th>
<th>Concern</th>
<th>Resolution</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Further lowering pedestrian walking speeds to better accommodate the general population.</td>
<td>The current standard of 1.0m/s was established in 2009 and was approved by SMC's predecessor. Further lowering walking speed leads to higher cycle lengths that would result in higher overall wait times for pedestrians and local traffic such as transit and automobile vehicles.</td>
<td>Resolved at the SMC level. The pedestrian walking speeds should only be lowered on a case-by-case basis as per TAC Guidelines. For example, lower walking speeds are reasonable in areas with high concentrations of seniors or people with mobility disabilities.</td>
</tr>
<tr>
<td>2</td>
<td>Expand the coordination studies design strategy proposed for the downtown core to other areas that have similar characteristics to the downtown core.</td>
<td>Currently, there are no quantitative criteria in place to identify what are areas that encourage walking. This approach would be subjective and too vague practitioners to interpret.</td>
<td>Escalated and resolved at the Senior Management level. Since there are other policies in development that will address how &quot;areas that should encourage walk&quot; is identified, it was temporarily omitted.</td>
</tr>
<tr>
<td>3</td>
<td>Use projected pedestrian volume and delays when conducting warrant analysis for future conditions</td>
<td>Since this is a slight deviation from OTM Book 12, direction from SMC is needed.</td>
<td>Resolved at the SMC level. The decision was to include this step to make the warrant analysis more conservative.</td>
</tr>
<tr>
<td>4</td>
<td>Limit the variation of cycle length of adaptive traffic control systems (ATCS) because it can result in longer cycle lengths that put non-auto traffic at a disadvantage.</td>
<td>Recognizing that there are issues in installing ATCS in dense urban settings, ATSC is being removed in certain sections of the downtown core. ATCS is more applicable in suburban areas and in close proximity to event venues where traffic is highly variable. ATCS's flexibility to vary cycle lengths is needed to allow for effective response to variability in demand.</td>
<td>Resolved at the SMC level. Agreed to restrict of use of ATCS in the downtown except in close proximity to major traffic generators. Agreed to restrict cycle length to max 144 in peak periods, max 128 in off-peak periods and max 160 for special traffic diversion plans.</td>
</tr>
<tr>
<td></td>
<td>Conduct coordination studies for bicycles when 30% of the traffic volume is bicycle.</td>
<td>There needs to be a balance of needs for all users. A 30% threshold is too low to justify for conducting coordination studies for bicycles.</td>
<td>Escalated and resolved at the Senior Management level. The decision was to increase the threshold to 50%.</td>
</tr>
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After SMC review, the revised Technical Report was prepared, incorporating all comments, suggestions, and directions received. The outstanding items were highlighted for senior management to review and provide guidance.

**Senior Management Review**

If institutional differences still could not be resolved at the SMC, it would be escalated to senior management to provide direction. There were two outstanding items (Table 1) that required senior management's attention first before the Technical Report could be finalized. Details can be found in Table 1. Once the Technical Report was finalized, an Executive Summary document and a "Policies and Strategies" document were created and submitted to senior management for final review and approval. Final approval allowed dissemination of the document to the public via the City's website.

The Technical Report and Policies and Strategies documents are living documents. Since traffic signal technology changes at a rapid pace, it is important that ITSO updates the document on a yearly basis to reflect current conditions. In addition to the yearly updates, a comprehensive review is planned after five years to ensure all policies and strategies are still in line with the visions, goals, and objectives of the Official Plan and the Agenda.

**SUMMARY, CONCLUSIONS AND FUTURE WORK**

Though the City's traffic signal operations were guided by SOPs, these SOPs were sometimes inconsistent, incomplete, or out-of-date. The development of the "Traffic Signal Operations Policies and Strategies" document addressed this gap, by providing written policies to guide the City's traffic signal operations. The document was developed by the practitioners of traffic signal operations in consultation with stakeholders. The document addresses the challenge for practitioners when policies are created by policy makers who have limited appreciation for the technical complexity of implementing the strategy to address a specific policy. It also addresses the challenge of policy development where the agency's established policies are not fully understood by the implementing staff, or the implementing staff may not recognize that the policy was established.

The "Traffic Signal Operations Policies and Strategies" document was developed following a policy developmental framework that complies with the visions, goals, and objectives of the Toronto Official Plan and Transportation Services Strategic Agenda. The five-step policy-making process used to develop the document allowed for input from stakeholders and Transportation Services senior management.

Though policy-based traffic control can be better understood by a hierarchy of priorities (16), it often raises sensitivity to public concern on how different road users are prioritized at a signalized intersection and how corridors are prioritized when conducting signal coordination studies. Thus, a context sensitive approach that considers the environment of the traffic signal was used to create the policies and strategies. In the third step of the process, stakeholders, who have their own goals, focuses, and ideas that are typically competing with each other, were engaged. This was the most challenging step of the process because trade-offs are inevitable.
when balancing the needs and concerns of each stakeholder. Signal operation policies and expectations can vary based on the users, roadway facilities, and mode split. Therefore, stakeholders were engaged to ensure that signal operations policies were developed within the correct context. Though this step attempts to address the sensitivities of how different road users are prioritized at a signalized intersection, it cannot eliminate it.

Signal operation policies should be clearly documented and thoroughly communicated within an agency to those who operate and maintain the signal system (3). The document will be used by all City units and external agencies who are involved with day-to-day traffic signal planning and operations. The current policy-making approach encourages input and involvement of those involved with traffic signal operations and planning. The "Traffic Signal Operations Policies and Strategies" document has long-term impact on the City's traffic signal planning operations, ensuring consistency across all agencies throughout the City, avoiding duplication of resources and promoting transparency by providing the public with information on how the City operates its traffic signals.

Following the release of the "Traffic Signal Operations Policies and Strategies" document on the Internet, ITSO will hold four half-day workshops across the City to familiarise staff with the new document and to gather input for any future revisions. ITSO will be updating the City’s current signal operations SOPs to reflect the policies and strategies established in the document. ITSO will also be updating the document on a yearly basis to maintain consistency, completeness and relevance to current transportation conditions. As traffic signal technology changes at a rapid pace, ITSO will undertake a comprehensive review of the document in 2020.
REFERENCES