TORONTO

STAFF REPORT
ACTION REQUIRED

Traffic Congestion Management and Traffic Signal Coordination

Date:	April 30, 2013
To:	Public Works and Infrastructure Committee
From:	General Manager, Transportation Services Division
Wards:	All Wards
Reference Number:	P:\2013\Clusterb\TRA\TMC\pw13004tmc

SUMMARY

The purpose of this report is to provide an overview on the causes of congestion within the City of Toronto and identify the near term and long term congestion management actions and strategies to improve traffic operations across the entire City, including the 10 most congested intersections. Within the City of Toronto, the impacts related to excessive traffic congestion are significant, as it not only results in economic costs in the billions of dollars each year, it also has a negative impact on the environment and affects the quality of life for the residents of Toronto on a daily basis. Therefore, it is essential that efforts are made to improve the efficiency and effectiveness of the City of Toronto's road and transportation management systems in order to mitigate the impacts of congestion.

Since the effects of aging traffic signal equipment and software as well as poor traffic signal coordination are factors that contribute to the cause of congestion, this report also reviews the signal systems and signal coordination methodologies used within the City of Toronto. As part of the congestion management plan, a program is recommended to improve traffic signal coordination at approximately 1000 intersections on priority routes within the City over the three years.

In addition to improving traffic signal coordination, it is recommended that traffic signal software, hardware and traffic signal systems referred to as the Intelligent Transportation Systems that are currently used within the city of Toronto be upgraded. It is also recommended that traffic cameras and variable message signs be installed on arterial roads and that our current communication system be replace with a more reliable wireless system. As well, strategies are to be developed in the area of road occupation

management, including stepped-up enforcement to minimize the impacts on the flow of traffic due to legal and illegal lane use.

RECOMMENDATIONS

The General Manager of Transportation Services recommends that:

1. City Council endorse the following Intelligent Transportation Systems proposed enhancements (in principle) to mitigate congestion; and direct Transportation Services to prepare the appropriate business cases to be submitted with the 2014 Operating and Capital Budget submissions:

   a) Arterial Road Traffic Cameras
   b) Arterial Road Variable Message Signs
   c) Traffic Operations Centre Upgrade

FINANCIAL IMPACT

The financial implications associated with the implementations scheduled for 2013 are estimated to cost $7.4M and are included in Transportation Services 2013 Operating and Capital Budgets.

The financial implications associated with the proposed implementations is estimated at $10.9M and will be included in the Transportation Services 2014 Operating and Capital Budget submissions complete with the appropriate business cases.

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

DECISION HISTORY

At the meeting of the Public Works and Infrastructure Committee on October 5, 2011, the Committee adopted a motion from Councillor Josh Matlow, Ward 22, that the General Manager, Transportation Services report on the cost and feasibility of implementing a Synchronized Traffic Signal System.

http://www.toronto.ca/legdocs/mmis/2011/pw/bgrd/backgroundfile-41060.pdf

At the meeting of the Public Works and Infrastructure Committee on June 14, 2012, the Committee adopted a motion from Councillor Denzil Minnan-Wong, Ward 34, that the General Manager, Transportation Services examine ten locations that experience the most traffic congestion in the City of Toronto and prepare a report to the PWIC in the Fall of 2012 that prescribes ways in which Transportation Services can improve the flow of traffic at each location.

http://www.toronto.ca/legdocs/mmis/2012/pw/bgrd/backgroundfile-48122.pdf

Since the two motions are interrelated and the action plan overlaps both issues, Transportation Services recommended that both issues be combined into a single report. Both Councillor Matlow and Councillor Minnan-Wong accepted that recommendation.

ISSUE BACKGROUND

According to the Toronto Region Board of Trade's - 2010 Scorecard on Prosperity, as a result of congestion, it costs commuters in the Toronto area over $5 billion annually. The principal economic and social costs of congestion are as follows:

- The cost of reduced economic output and accompanying job loss;
- The cost of travel delays for auto and transit users and unreliable trip times;
- The increase vehicle operating costs associated with higher traffic volumes; and
- The additional environmental costs of vehicle emissions and the higher frequency of collisions.

Traffic congestion is a condition on road networks that occurs as use increases, and is characterized by slower speeds, longer trip times, and increased vehicular queuing. As the city of Toronto continues to grow, the demands on the City's road network also increases resulting in congestion. Whether it is a result of increased population, development, construction, aging traffic signal equipment and software, filming activities or special events, many roadways are operating at or over capacity. As a result, the City of Toronto is experiencing excessive traffic congestion which results in travel times being increased resulting in a loss of productivity, increased pollution and increased driver frustration. Therefore, efforts must be made to maximise the effectiveness and efficiency of the existing road network and transportation systems to improve the flow of traffic within the City of Toronto.

CAUSES OF CONGESTION

In order to address and mitigate the impacts of congestion, it is important to determine the causes of congested experienced everyday by every road user, including motorists, pedestrians and cyclists. It is well reported that motorist experience lengthy commutes to and from work, as well as during non-peak travel times within the City of Toronto. According to a 2012 study conducted by Tom Tom, a GPS provider, the City ranks sixth in average commute times in North America with an average delay per peak period of 33 minutes (Tom Tom North American Congestion Index - 2012).

There are numerous reasons why commute times have increased within the City over the past decade, however, the main factor is the increase in traffic using the City's road network. Traffic volumes have steadily increased as result of growth within and outside

the City of Toronto. For instance, the current 24 hour traffic volumes at the intersections of Bayview Avenue at Sheppard Avenue East and Markham Road and Progress Avenue are 109,684 and 58,186, respectively. These volumes represent an increase of approximately 37 and 46 percent respectively, compared to traffic volumes from 15 years ago. As there continues to be growth in the Greater Toronto Area, particularly in auto travel and in the absence of a new capacity or a shift in mode of travel, it can be anticipated that the roadway system will operate over capacity in the peak periods and into the off-peak periods as well.

Other factors that cause traffic congestion include poor weather conditions, collisions, work zones, special events, bottlenecks and underperforming traffic signal systems, including poor traffic signal coordination.

Traffic Signal Coordination

As mentioned above, aging traffic signal equipment and software, including poor traffic signal coordination can contribute to congestion. It should be noted that the term synchronization is often confused with the term coordination and as a result they are often interchanged. Synchronization refers to traffic control signals that all change at the same time. Coordination refers to the timing of traffic control signals such that a platoon of vehicles on a street travelling at or near the posted speed are able to proceed through multiple signalized intersections without stopping. While the Ward 22 City Councillor's motion refers to synchronization, it was confirmed that this report is to address traffic signal coordination.

The City currently operates four traffic control systems (Attachment 1) to manage the operation of its 2,250 traffic control signals. Each of the four traffic control systems is capable of providing traffic signal coordination to assist in moving vehicles in a safe and efficient manner. A well coordinated signal system, that allows traffic to move through a succession of signalized intersections without stopping, provides the following benefits:

- increases traffic handling capacity of a roadway
- reduces likelihood of rear-end collisions and red-light running
- encourages travel at or below the posted speed limit
- reduces unnecessary stopping and starting which in turn reduces vehicle maintenance, emission, noise and fuel consumption
- improves travel times; and
- reduces driver frustration.

As detailed in Attachment 2, there are challenges in maintaining a coordinated traffic signal system, some of which are listed below:

- Reliable communication between central computers and field computers to ensure that the field equipment clocks are synchronized with the central system clock and to download signal timing changes from the central system to the field.

- Conducting traffic coordination studies on a regular basis, preferably not more than five years apart.
- Aging traffic hardware and software that is susceptible to malfunction which results non-optimal system performance.
- The loss of traffic lanes due to road construction, development, filming, festivals, and special events requires signal timings to be adjusted since road capacity and travel time between intersections will be affected by lane reductions.
- Transit signal priority on streetcar and several bus routes, which can result in green time extension of up to 30 seconds for transit. While this does provide for additional green time for transit, it also impacts our attempts to coordinate traffic signals, as a result, 391 traffic control signals can be impacted during the peak periods.
- Most of Toronto's roadways are "two-way" and have balanced traffic flows. This situation makes signal coordination more challenging in attempting to provide coordination for both directions.

CONGESTION MANAGEMENT ACTION PLAN

In order to better address the impacts of traffic congestion, Transportation Services has developed a Congestion Management Action Plan with the goal of mitigating congestion to improve traffic operations and traffic flow within the City of Toronto. Below are the main components of the plan.

Ten Most Congested Intersections

As directed by the Public Works and Infrastructure and Infrastructure Committee, Transportation Services conducted detailed analyses of the ten most congested intersection and road sections within the City of Toronto with the objective of identifying methods of improving the flow of traffic at each location.

The ten most congested intersections/roadways are listed below and as shown on Attachment 13:

1. Bayview Avenue at Sheppard Avenue East
2. Yonge Street, Highway 401 to Sheppard Avenue
3. York Street, Front Street to F.G. Gardiner Expressway
4. Sheppard Avenue West at Allen Road
5. Leslie Street, Highway 401 to Sheppard Avenue East
6. Lake Shore Boulevard, York Street to Bathurst Street
7. Kennedy Road, Highway 401 to Sheppard Avenue East
8. Markham Road, Highway 401 to Sheppard Avenue East
9. Dufferin Street at Finch Avenue West
10. Black Creek Drive at Lawrence Avenue West

The ten most congested intersections identified are based on traffic volumes, field observations, requests from the public to address congestion as well as staff knowledge of the most congested intersections and road networks within the City. With the exception of two road sections, the downtown area is not included in this review as this area is included in the Downtown Transportation Operation Study (DTOS). The purpose of the DTOS is to develop a list of actions to improve traffic operation in the downtown core, including methods to address congestion. The final DTOS report, complete with near term and long term recommendations will be presented to the November 20, 2013, meeting of the Public Works and Infrastructure Committee.

Each of the 10 most congested intersections was studied to determine which traffic movements are the most congested and the possible reasons for the congestion. Also, each intersection was reviewed to determine what, if any, actions have been taken in the past to improve traffic operations at these intersections. A detailed analysis and list of potential options for each intersection to improve traffic operations are identified in Attachments 3 through 12. Listed below, are the main options that were considered to mitigate the impacts of congestion at these locations:

- Traffic signal timing changes (Near Term)
- Traffic signal coordination reviews (Near Term)
- Implementation of Intelligent Transportation Systems (Mid-Long term)
- Access/egress modifications (Mid-Long Term)
- Expanded use of SCOOT the traffic adaptive signal system (Mid-Long Term)
- Addition of turning lanes (Long Term)

Traffic Signal Coordination Studies

In 2012, Transportation Services completed traffic signal coordination studies on 110 signals on four arterial roadways - Adelaide Street (17 signals), Richmond Street (16 signals), Kennedy Road (25 signals) and Bloor Street (52 signals). The purpose of the studies was to improve traffic flow thereby reducing motorist delay which reduces costs and impacts on the environment. The costs include the additional use of fuel, additional labour costs associated with delay, additional vehicle costs and additional greenhouse gases associated with emissions. As a result of updating the traffic signal coordination along these priority roadways, the following results were achieved:

Cost/Benefit Summary

Description / Route	**Adelaide/Richmond**	**Kennedy Rd**	**Bloor St**
Signalized Intersections	33	25	52
Annual Benefit	$560,000	$4.1 million	$3.4 million
Benefit/Cost Ratio	22	118	55

Measure of Effectiveness Summary

Adelaide Street

Measures of Effectiveness (Yearly)	Adelaide Street		
	Before	**After**	**% Change**
Total Delay (hr)	97,500	83,500	-14%
Stops (#)	15,251,500	13,894,500	-9%
Average Speed (km/hr)	27.0	26.3	-2%
Fuel Consumed (l)	1,186,500	1,104,000	-7%
Greenhouse Gas (kg)	31,415	29,250	-7%

Richmond Street

Measures of Effectiveness (Yearly)	Richmond Street		
	Before	**After**	**% Change**
Total Delay (hr)	172,000	121,500	-29%
Stops (#)	13,830,500	11,699,000	-15%
Average Speed (km/hr)	20.0	22.0	10%
Fuel Consumed (l)	1,290,500	1,116,000	-14%
Greenhouse Gas (kg)	34,165	29,550	-14%

Kennedy Road

Measures of Effectiveness (Yearly)	Kennedy Road		
	Before	**After**	**% Change**
Total Delay (hr)	291,000	208,500	-28%
Stops (#)	22,470,500	19,085,000	-15%
Average Speed (km/hr)	29.7	34.3	16%
Fuel Consumed (l)	3,031,500	2,695,000	-11%
Greenhouse Gas (kg)	80,265	71,370	-11%

Bloor Street

Measures of Effectiveness (Yearly)	Bloor Street		
	Before	**After**	**% Change**
Total Delay (hr)	760,000	505,500	-33%
Stops (#)	85,563,000	65,027,500	-24%
Average Speed (km/hr)	28.7	33.3	16%
Fuel Consumed (l)	8,814,500	7,639,000	-13%
Greenhouse Gas (kg)	233,405	202,295	-13%

Based on the benefits achieved in 2012 and need to improve traffic signal coordination, Transportation Services is recommending an action plan to conduct coordination studies on 1,000 traffic control signals on major arterials roadways over a three year period, beginning in 2013.

The coordination studies to be completed in 2013 will be completed by both City staff and Traffic Consultants. Transportation Services plans to conduct studies on 272 signals in 2013 on the following major arterial roadways:

- Lawrence Avenue West, Scarlett Road to Bayview Avenue (43 signals);
- Kingston Road, , Highway 401 – Birchmount Road (39 signals);
- Highway 27, Steeles to Belfield Road (24 signals);
- Weston Road/Keele Street/Parkside Drive, Steeles Avenue to Spring Road (60 signals);
- Lawrence Avenue East, Leslie Street to East Avenue (65 signals); and
- Victoria Park Avenue, Steeles Avenue to Kingston Road (41 signals).

Intelligent Transportation Systems – Current Enhancements and Projects

Traffic Signal Systems

The Main Traffic Signal System (MTSS) is currently being replaced with a more reliable system (TransSuite) that also provides additional functionalities that will result in improved traffic operations. Since 2004, 723 signalized intersections have had their controllers replaced. The remaining 587 controllers that operate on the MTSS system are expected to be replaced by December 31, 2014 at which point the MTSS will be decommissioned.

The traffic adaptive system known as SCOOT which adjusts signal timings based on real time traffic conditions controls 338 traffic control signals has been service for almost 20 years. The SCOOT system is experiencing some challenges in continuing to operate effectively due to the age of the system and its dependency on in-pavement detection as they are damaged regularly due to road work. Transportation Services has retained IBI

Group to review SCOOT and make recommendations on its future. Current options being considered are to upgrade SCOOT, transfer SCOOT signals to TransSuite System or replace SCOOT with another adaptive traffic control system. It is expected that the review, complete with recommendations will be completed by June 2013.

Communication

To address issues of reliability and service associated with the use of existing Digital Channel Services (DCS) lines to communicate between intersections and the central system, Transportation Services conducted a pilot project to evaluate the use of wireless technologies to replace DCS. The pilot was conducted at 30 signalized intersections and was deemed successful in providing safe, reliable and cost effective communication between the TransSuite central system and signalized intersections. Based on the success of the pilot project, Transportation Services has initiated a project, with the assistance of Information and Technology to install wireless communication devices at approximately 1,800 traffic control signals. By having a stable and more reliable communication system, the coordination of traffic signals can be better maintained from a centralized location (Traffic Management Centre) resulting in improved traffic flow. The project implementation is currently scheduled to occur over a 2- 3 year period.

Detection Equipment

In-pavement loop detectors are considered to be "intrusive" detection since they are built into the road surface and are damaged whenever the road is being reconstructed or when the road is disturbed by utilities. As such, Transportation Services is moving away from its dependency on intrusive detection to "non-intrusive" detection such as radar, video, acoustic and LED. "Non-intrusive" implies that the detection is above the road or on the side of the road and is not affected by construction. By the end of 2013, approximately 50 signalized intersections will be equipped with non-intrusive detection. Going forward, contracts for new traffic control signals will specify non-intrusive vehicle detection and all road construction projects will be required to specify non-intrusive detection as a replacement when in-pavement loop detectors are damaged through construction. As well, when in-pavement loop detectors are damaged by utility companies, non-intrusive detection will be installed as the replacement technology. By moving toward non-intrusive technology traffic signal systems and signalized intersections will be less likely to be affected by construction activities resulting in improved traffic operations.

Traffic Operations Centre Upgrade

RESCU is the traffic management system that monitors and manages traffic on the Don Valley Parkway, F.G. Gardiner Expressway and Lake Shore Boulevard. Over the next 12 months, Transportation Services will replace the existing 20 year video monitor system with a LCD video system that will have the flexibility to accommodate additional camera images related to the expansion of camera coverage at major arterial intersections.

Variable Message Signs

Transportation Services currently has six variable message signs (VMS) installed along the Don Valley Parkway, F.G. Gardiner Expressway and Lake Shore Boulevard. By June 2013, six additional VMS will be functional on the east section of the Gardiner Expressway. By December 31, 2013, a further six VMS are expected to be operational on the west section of the Gardiner Expressway and one VMS on the southbound Don Valley Parkway. The new signs will be located in advance of decision points so that motorist can utilize real time traffic information when determine their travel routes.

Construction Management and Enhanced Enforcement

Transportation Services has worked with Toronto Police Services in identifying congested locations for strategic enforcement and education. Recently, Toronto Police Services engaged in several campaigns to improve the traffic flow in the downtown core by focusing on illegal lane occupancy by construction vehicles, illegal stopping, and blocking of intersections during peak periods. Both Transportation Services and Toronto Police Services recognize that it is crucial that Transportation Services work together in finding solutions to better manage traffic within the City of Toronto.

Regional ITS Committee

Earlier this year, Transportation Services spearheaded the establishment of a Regional ITS Committee comprising of members from the Region of York, Region of Durham and the Ministry of Transportation of Ontario. The purpose of the committee is to share and develop ITS strategies that not only can be implemented within our respective municipalities but also traffic management along our boundaries. As the flow of traffic into and out of the City of Toronto is basically balanced, there are opportunities and a need to share information in order to better manage traffic operations along these boundaries.

Intelligent Transportation Systems – Proposed Enhancements and Projects

a) Arterial Road Traffic Cameras

The use of 73 traffic cameras on the Don Valley Parkway (DVP), F.G. Gardiner Expressway (FGGE) and Lake Shore Boulevard (LSB) have been instrumental in reducing the impacts of incidents on these roadways. Through monitoring of traffic via these cameras, staff are able to respond to events almost immediately. Also, by being able to observe the actual incident, staff can ensure that the appropriate actions are taken quickly in response to different incidents. For example, Emergency Services can be dispatched immediately to respond to collisions or other incidents requiring their service. Staff can also place messages on Variable Message Signs based on real time conditions. Another benefit of having the traffic cameras is the ability to monitor the impacts of incidents on adjacent roadways which then allows staff to make informed decisions when adjusting traffic signal timings to mitigate the impacts of incidents. Therefore, based on

the benefits associated with the existing traffic cameras, Transportation Services has retained a consultant to undertake a study of a camera deployment of between 80 and 100 intersections across the City. The study, which will be completed by August 2013 and will report on the following:

- Traffic monitoring needs including requirements for Pan Am Games
- Camera on-street placement options – traffic poles, stand alone poles, hydro poles, City-owned buildings
- Identification of camera locations
- Communication options including the costs associated with each option
- Camera deployment plan based on a two year deployment period
- Costs and benefits analysis and business case

In parallel with the consultant study, Transportation Services has as a pilot two traffic cameras on existing traffic poles in the downtown core as part of the Downtown Traffic Operation Study – one on Richmond Street and one on Adelaide Street. These two cameras will feature full pan, tilt, zoom (PTZ) capability and will be use cellular communication to feed the video back to the Traffic Operations Centre.

In addition to the benefits mentioned above, staff monitoring these cameras will be able to share illegal lane use with City By-law staff and Toronto Police Service. This information can be used to assist with enforcement operations intended to maintain road capacity and traffic flow.

b) Arterial Road Variable Message Signs

As with the use of traffic cameras, the six existing variable message signs (VMS) are instrumental in conveying important messages to the public about existing and future road conditions. These messages assist motorists in making decisions about what routes to choose when travelling. Based on the benefits of the existing VMS, Transportation Services will undertake a study of variable message signs at 20-25 intersections across the City. The study, which will be completed in late 2013, will report on the following:

- Traffic monitoring needs including requirements for Pan Am Games
- Identification of VMS locations
- Development of specifications
- Communication options including the costs associated with each option
- VMS deployment plan based on a two year deployment period
- Costs and benefits analysis and business case

c) Traffic Operations Centre Upgrade

The Advanced Traffic Management Software (ATMS) currently being used was developed for RESCU in 1992 and now needs replacement as it is subject regular maintenance and is limited in its functionality to provide advanced traffic management

features. The new software will provide enhanced incident detection and notification that will allow for earlier response to incidents on our expressways and arterial roadways. By responding earlier, the impacts of these incidents on the expressways and adjacent roadways can be mitigated sooner resulting in improved traffic operations. In addition, the ATMS will be utilized to manage the City's variable message signs, including displaying travel time information.

STAFFING IMPLICATIONS

The proposed congestion management plan includes the expansions of our existing Intelligent Transportation System (ITS) as well as an increase in the number of traffic signal coordination studies to be completed as part of our annual program. As such, to ensure that the delivery of the program is completed on schedule and to provide the necessary resources to manage the systems, there is a requirement for additional staff resources. The additional staff will be responsible for the preparation of documents, specifications and contracts associated with the expansion of our ITS. The additional staff will also be responsible for monitoring the additional traffic cameras and implementing the required traffic operation changes when incidents occur. The staff will also conduct the expanded traffic signal coordination studies that will be completed each year.

It is estimated that the cost associate with the required staff is $600K and will be included as part of transportation Services 2014 Operating Budget submission.

COSTS

The financial implication associated with the 2013 implementations noted below will be funded through Transportation Services 2013 Operating and Capital Budgets:

- 10 Most Congested Intersections - $100K - Operating Budget
- 2013 Signal Coordination Studies - $300K - Operating Budget & $700K Capital
- 2013 TransSuite Signal System - $2.5M - Capital Budget
- 2013 Wireless Communication Conversion - $800K - Operating Budget
- Replacement Traffic Operations Centre Video Wall - $1.5M - Capital Budget
- Installation of Variable Message Signs - $1.5M - Capital Budget

The financial implications associated with the proposed implementations noted below will be included in the 2014 Operating and Capital Budget submissions with the appropriate business cases:

- Traffic Signal Coordination Studies - $3.5M - Capital Budget
- Arterial Road Traffic Cameras - $600K - Operating Budget & $2.8M - Capital Budget
- Arterial Road Variable Message Signs - $50K Operating Budget & $2.3M - Capital Budget

- Replacement of Advanced Traffic Management Software - $1.0M -Capital Budget
- Staffing - $600K – Operating Budget

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SIGNATURE

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ATTACHMENTS

Attachment 1: Traffic Signal Systems
Attachment 2: Factors That Influence Congestion
Attachments 3-12: 10 Most Congested Location Sheets
Attachment 13: Map of 10 Most Congested Locations