City of Peterborough

To:	**Members of the General Committee**
From:	**Jasbir Raina, Commissioner of Infrastructure and Planning Services**
Meeting Date:	**July 11, 2022**
Subject:	**Smart Signal Pilot Project Update, Report IPSTR22-012**

Purpose

A report to provide an update on the Smart Signal Pilot Project on Lansdowne Street from Webber Avenue to Monaghan Road.

Recommendation

That Council approve the recommendation outlined in Report IPSTR22-012, dated July 11, 2022 of the Commissioner of Infrastructure and Planning Services as follows:

That the report be received for information.

Budget and Financial Implications

There are no direct financial implications associated with approving this report.

Funding to expand the system to include two additional intersections on Lansdowne Street at Summit Plaza and Lansdowne Street at Clonsilla Avenue can be accommodated within the overall budget approved as part of Report IPSTR20-020.

The 2022 approved capital budget allocated $1,000,000 in capital funding for expansion of the “Smart Signal System” to other high traffic corridors in the City. The estimated cost for the Miovision Smart Signal System is approximately $46,000-$50,000 per intersection, which would allow for up to 20 intersections to be implemented with currently approved funding.

Recommendations for future corridors will be the subject of future reports to Council.

Background

City Council, at is meeting of July 20, 2020, awarded Report IPSTR20-020 - Update on an Autonomous Vehicle Innovation Network Pilot Project and Award of Non-Standard Procurement for Smart Traffic Signal Pilot Project.

Smart traffic signal systems utilize real-time traffic adaptive technologies to optimize traffic flow within the road network. An Adaptive Traffic Signal Control System (Smart Signal System) uses specialized software and field equipment to collect continuous data on traffic volumes, speeds, travel times, and congestion along a roadway corridor which allows the system to make real-time adjustments to signal timing parameters and settings in order to optimize the flow of traffic, reduce emissions, and potentially increase the capacity of major roadway corridors and /or deferring costly road widening projects.

Adaptive Traffic Signal Control Systems require advanced traffic signal detection equipment and a strong communication network to feed the complex traffic adaptive software algorithms. The Smart Traffic Signal Pilot Project leveraged the City’s existing advanced traffic signal camera detection equipment implemented throughout the City of Peterborough.

The Lansdowne Street Smart Traffic Signal Pilot Project was implemented to determine the benefits and/or short comings of adaptive traffic signal control technologies compared with traditional time-of-day traffic signal control.

Pilot Project Corridor

To effectively test and analyze Adaptive Traffic Signal Control, a section of Lansdowne Street, the City’s most congested street, was chosen.

Lansdowne Street, between Webber Avenue and Monaghan Road, is a four-lane high-capacity arterial road with a centre left-turn lane (5 lane cross-section) carrying between 23,000 and 29,500 vehicles per day. The posted speed limit on Lansdowne Street is 50 km/h.

The 1.75 km pilot corridor on Lansdowne Street extends from and includes the intersections between Webber Avenue and at Monaghan Road. There are four non-signalized intersections and six signalized intersections located within the pilot corridor. The pilot corridor also serves numerous commercial developments that access Lansdowne Street via forty-nine (49) private driveways.

The existing traffic signal timing configuration on the selected corridor operates with standard pre-determined Time-of-Day (TOD) plans. TOD plans are user defined plans that establish signal timing settings based on historical traffic volumes. These plans are static and only change when updated by City staff. Updates to TOD plans generally occur when vehicle volume data supports the need for change and require significant staff time to analyze volume patterns, develop new signal timing settings, model the changes in traffic simulation software, test the changes in our traffic signal controllers and then deploy the new settings in the field and monitor performance.

Adaptive Traffic Signal Operations

Adaptive Traffic Signal Control software utilizes multiple detection zones in each lane of traffic which are used to create a simulated model of the vehicles approaching each intersection in real-time. The model is continuously updating to reflect current traffic conditions and is used to generate optimized traffic signal timing plans for each intersection.

The Miovision -Surtrac adaptive traffic signal system builds the model to optimize local traffic flow at individual intersections and communicates with its neighbouring intersections to achieve coordination between adjacent traffic signals.

Adaptive Traffic Signal Control software has two objectives when managing traffic:

1. At busy peak periods, the Adaptive software focuses on maximizing throughput of traffic on Lansdowne Street.

2. When traffic is lighter, the Adaptive software focuses on providing smooth traffic flow and minimizing queuing on side streets.

Adaptive Traffic Signal Control software automatically switches between both objectives based on actual traffic demand.

Adaptive Set-up, Testing and Activation

Installation of the adaptive traffic signal control hardware commenced in August 2021 with activation of the software, setting-up detection zones and configuration of the

network. Once configured, the adaptive control system was turned on for “limited control” at individual intersections to test communications and to validate the traffic flow model.

Following the completion of successful testing and validation, adaptive control was deemed stable and full-time control was enabled for longer periods of time to “fine-tune” the network.

Adaptive Traffic Signal Control formally took control of the pilot corridor in November 2021.

Evaluation Method

Performance evaluation commenced November 8, 2021, in the form of “ON-OFF” testing. “ON-OFF” testing was conducted by alternating adaptive control with traditional TOD plan control. This on-off testing alternated control types daily over a two-week period.

Vehicle and traffic signal data was collected during the evaluation period using Miovision’s TrafficLink software to analyze and compare the performance of adaptive control verses traditional TOD control.

The data collected included:

- Travel Time - The average travel time for vehicles between intersections;
- Side Street Vehicle Delay - The average delay experienced by vehicles on the minor street;
- Corridor Stops - When vehicles are forced to stop on main street (Lansdowne Street) due to insufficient green time to meet the vehicle demand; and
- Corridor Level of Service - The performance measure based on vehicle speed, density, congestion, etc. used to categorize traffic flow. Traditional traffic analysis uses 6 level of service categories, from A (free flowing) to F (heavily congested), to describe the quality of traffic flow, with Level E representing the functional capacity of the corridor.

Analysis Findings

1) Travel Time:

Adaptive control and Time-of-Day control maintained similar travel times during non-peak traffic flow periods. Under free flow conditions, it takes a vehicle 126 seconds to travel through the test area at the speed limit assuming no stops. Under the TOD control the average travel time through the corridor during peak times was

approximately 253 seconds in the eastbound direction and 270 seconds in the westbound direction.

Appendix A illustrates the average travel times for vehicles along Lansdowne Street in each direction by time of day, for each type of control. During peak hours, the Adaptive control significantly reduced the travel time by approximately 28 seconds (11%) in the eastbound direction and 80 seconds (30%) in the westbound direction. Peak hours on Lansdowne Street typically occur between the hours of 10:00am to 6:00pm.

2) Side Street Vehicle Delay

While traffic flow along Lansdowne Street improved, there was a corresponding increase in delay to traffic on the side streets.

On average, under Adaptive control, side street vehicle delay increased an average of 63% during peak periods. This was an expected outcome as the adaptive software automatically adjusts and adapts the signal timing to current traffic demand by reallocating green time from the side streets to manage the heavier flow of traffic on Lansdowne Street.

Table 1 summarizes the increase in side street delay for the various intersections in the test corridor.

Table 1 – Side Street Delay at Intersections

Intersection	Average Side Street Delay Increase	Average Side Street Delay Increase (Peak Periods)
Monaghan Road	+26%	+37%
High Street	+90%	+100%
Erskine Avenue	Not enough side street data	Not enough side street data
Goodfellow Road	+75%	+81%
The Parkway	+25%	+36%
Webber Avenue	+59%	+60%

The increase in side street delay was most pronounced at intersections with heavy turning volumes or where there are geometric deficiencies that restrict the types of signal phasing or the ability of side street vehicles to fully utilize the available green time.

3) Corridor Stops

On average the adaptive signal system reduced stops on Lansdowne Street by 37% in the eastbound direction and 53% in the westbound direction. This key performance measure contributed to reducing overall travel time along the corridor.

4) Level of Service

The adaptive signal control system also reduced congestion, delay and travel time which improved the level of service in the westbound direction from a Level of Service C to a Level of Service B. Eastbound traffic flow was also improved; however, it fell short of improving the level of service rating. The overall improved level of service equates to an approximate 6% increase in corridor capacity.

Level of Service B is defined as slightly congested with reasonable free flow and some infringement of maneuverability. At Level of Service C the operation is stable with more fully utilized signal phases and drivers feel more restricted and occasionally may have to wait more than one red signal indication.

Despite the increased delay at sideroad intersections, with the Adaptive Signal Control system the improved corridor travel time on Lansdowne Street resulted in an estimated reduction in overall user travel time in the pilot study area. When the results of the test period were annualized the travel time savings equates to an estimated $977,000 in reduced user costs over a typical year. User cost savings are estimated as the value of reduced delay time for passengers in vehicles, multiplied by the average vehicle occupancy (1.2 for cars and 1.0 for trucks), and are based on the median hourly wage rate for all occupations ($19.64 / hr for passenger vehicles, and $55.24 / hr for trucks).

In addition to this, the approximate fuel saved by the implementation of the Adaptive Signal Control System within the pilot corridor is estimated at approximately 106,700 litres per year, for an additional savings of about $213,000 annually based on an average fuel price of $2.00 per L.

The reduction in fuel use by drivers also generates an estimated reduction of 273 tons of CO2 emissions annually within the pilot project study area.

Summary of Pilot Results

The Smart Traffic Signal Pilot Project on Lansdowne Street with implementation of an Adaptive Signal Control System has:

- Improved traffic flow and travel time along Lansdowne Street,
- Reduced vehicle delay on Lansdowne Street,
- Improved level of service and roadway capacity,

- Increased side street delay,
- Decreased vehicle fuel consumption, and
- Reduced Greenhouse Gas (GHG) emissions.

The Adaptive Signal Control System automatically adjusts and adapts to real time traffic demand providing continuous optimization of the corridor without the need for staff input, reducing the need for additional staff resources to develop test and implement new signal timing plans as volumes change in key corridors.

The adaptive system has significantly changed the flow of traffic on Lansdowne Street by platooning approaching vehicles through the corridor in a more coordinated progression. Since the implementation of the adaptive system drivers have altered their driving behavior and have adjusted to the increased delay on the side streets. The increased delay on side streets during peak times resulted in larger queue lengths at some locations which highlighted existing geometric deficiencies at some intersections. The addition of dedicated turn-lanes and advance green movements on the side streets will ultimately reduce side street delay and improve overall corridor performance.

Through this pilot project, analysis has shown that improved traffic signal efficiency has a cost savings to the driving public in the form of time and fuel consumption. Other benefits include increased corridor capacity and the reduction of CO2 emissions.

Next Steps

The implementation of the Adaptive Traffic Signal Pilot Project on a 1.75 km section of Lansdowne Street has highlighted the potential benefits of a wider application of this technology to other major road corridors in the City.

The recently approved Transportation Master Plan, recommended investing in new transportation technologies to improve the efficiency of major roadway corridors across the City and assumed that measures like Smart Signals could increase the capacity on major roadways by approximately 10%. The results of this pilot project have validated this assumption and found that actual capacity increases of 6% were observed on the Lansdowne Street corridor during the pilot period.

Opportunities to further expand the Smart Signal system include:

- Extension of Pilot Corridor on Lansdowne Street
    - Adding the Summit Plaza intersection and the Clonsilla Avenue signal into the system could be completed in 2022/2023 and be coordinated with the re-construction of the Lansdowne Street / Clonsilla Avenue intersection.

  - Extension of the system further west could be incorporated into future phases of the Lansdowne Street West re-construction project.

  - Adding the Park Street, the new Alymer Street, George Street and Lock Street traffic signals in coordination with the planned re-construction of Lansdowne Street could be considered in 2023 / 2024.

- Parkhill Road

  - Between Pinehill Drive and Park Street

  - Between Reid Street and Water Street

- Chemong Road / Reid Street

  - Between McDonnel Street and Sunset Boulevard in conjunction with the Chemong Road reconstruction.

  - Between Shoppers Drug Mart / Walmart intersection and Milroy Drive can be considered for implementation in 2023.

- Clonsilla Avenue / Sherbrooke Street

  - Between the Parkway / Clonsilla Avenue intersection and Monaghan Road / Charlotte Street intersection

  - Between Sherbrooke Street / Wallis Drive and Sherbrooke Street / Monaghan Road intersection

- The Parkway

  - Between Crawford Drive and Clonsilla Avenue

Further study and testing would be required to assess the performance of this type of signal system on major one way street corridors with short side street spacing given the findings of the pilot study which showed increased queuing and side street delays under Adaptive Signal Control. Further analysis will be required to determine the applicability for Adaptive Control on the Reid / Rubidge Street corridors or on George / Water Street in the downtown area.

The 2022 approved capital budget allocated $1,000,000 in capital funding for expansion of the “Smart Signal System” to other high traffic corridors in the City. The estimated cost for the Miovision Smart Signal System is approximately $46,000-$50,000 per intersection, which would allow for up to 20 intersections to be included with currently approved funding. Recommendations for future corridors will be the subject of future reports to Council once staff have undertaken more detailed feasibility reviews of the corridors noted above.

Summary

The implementation of the Adaptive Traffic Signal Pilot Project on a 1.75 km section of Lansdowne Street has highlighted the potential benefits of a wider application of this technology to other major road corridors in the City. In addition to travel time saving the pilot project demonstrated the ability to use this technology to improve the capacity of major arterial roads while reducing fuel use and the associated Greenhouse Gas Emissions. If deployed on a wider scale, Adaptive signal control would result in further cost savings and a greater reduction in fuel consumption and emissions, contributing to the City reaching its Greenhouse Gas emissions reduction targets.

Submitted by,

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Attachments:
Appendix A – Travel Time Graphs

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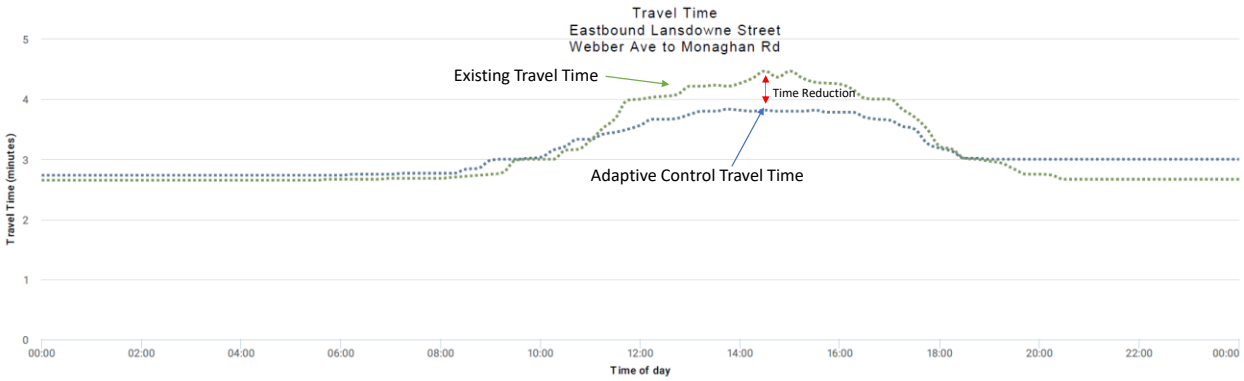
Travel Time - Eastbound Direction

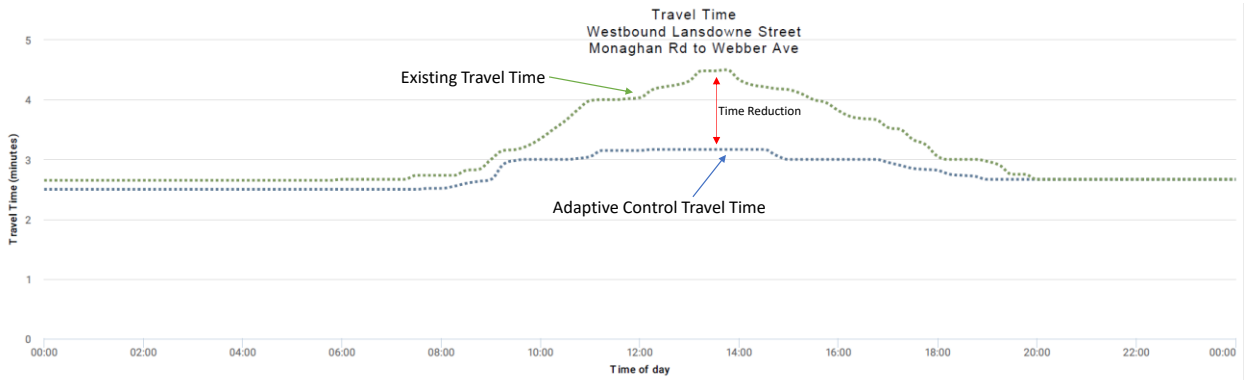
Lansdowne Street from Webber Ave to Monaghan Rd



Results:
Reduction in travel time during the day.
Most **benefit** from 11AM to 6PM.
Travel time **improved** by 28 seconds (11%) at 3PM (15:00).

Travel Time - Westbound Direction

Lansdowne Street from Monaghan Rd to Webber Ave



Results:
Reduction in travel time during the day.
Most **benefit** from 10AM to 6PM.
Travel time **improved** by 1 minute 20 seconds (30%) at 2PM (14:00).