City of Ottawa

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Operational Impacts and Policy Implications of Bus Bays in the City of Ottawa - Executive Summary

GENIVAR

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1. Executive Summary

1.1 Study Purpose

The City of Ottawa and former Region of Ottawa-Carleton have had transit-friendly policies of generally not providing bus bays (except when warranted by specific circumstances) since the late 1990s. These practices were derived from overall objectives for the transportation network.

The purpose of this study is to review bus bay operations in the context of the current City of Ottawa environment. This review is intended to comprise:

- → a review of experiences in Ottawa and elsewhere
- → an evaluation of impacts of implementing or removing bus bays on all users of the transportation infrastructure (buses, bus passengers, other motorists, cyclists, pedestrians)
- → analysis of advantages and disadvantages of bus bays versus curb-side stops
- → recommended changes to the 1998 bus bay guidelines, as required

1.2 Methodology

This assessment comprised both primary data collection and assessment as well as background research from other sources.

1.2.1 Background Research

Literature Review

A literature review was completed to identify other practice, research and policy development related to bus bays including issues of

- → Bus bay and roadway design
- → Implementation policy
- → Safety issues
- → Delays to buses and motorists
- → Yield-To-Bus legislation

Details are provided in various sections of the report dealing with these individual issues.

Review of Industry Practice

A number of Canadian and international jurisdictions were identified for a review of related bus bay policy and implementation guidelines. Additional details are provided in Section 11.

1.2.2 Quantitative Research

The quantitative research element of this assessment comprised collecting and analyzing video data at a variety of stop locations in key corridors in the city.

Two types of stops were observed for the study. **Bus bay stops** were defined as off-line bus stops, where buses pull out of the main travel lanes to stop (the bay may also serve a dual function as an acceleration lane at an intersection).

Curb-side stops are on-line bus stops, located in mixed traffic on a road with no cut-out lane or bus bay area to separate buses from other vehicles.

Location Type

Data were collected from video observations of two types of bus stops: far-side at a signalized intersection and locations distant from a signalized intersection.

Far-side stops are bus stops located immediately after a signalized intersection, while the **distant** locations are located a significant distance downstream from the nearest signalized intersection, and may be located at unsignalized intersections or at mid-block locations.

Delay Components

Each of the different components of delay for transit vehicles and autos were measured from the video observations.

Transit delay

Videos were reviewed to record measurements of the following elements of delay to transit vehicles and passengers:

- → Deceleration time (time required for a bus to slow down and stop)
- → Clearance time (time required for a bus to depart a stop), which includes:
  - o Start-up time (to front of bay)
  - o Re-entry delay (at exit from bay)
  - o Acceleration time (from curb or bay)

Auto delay

Videos were reviewed to record measurements of the following elements of delay to auto drivers and passengers:

- → Deceleration time
  - o time required for a motorist to slow down when a bus decelerates to stop
- → Dwell time (time required for passengers to board and alight)
  - o can be for the full duration or for a portion of the time a bus is stopped (if, for example the motorist changes lanes and passes the bus while it is at the stop)
  - o might include slowing only (with no stop delay) if vehicle changes lanes or arrives as bus is departing
  - o slowing or stop delay as a result of yield-to-bus at bus bay stops

Corridor Analysis

To simulate the impacts of cumulative effects in a corridor served by transit, a spreadsheet simulation model was developed based on the observed results from the video analysis. In this model, observed delays were randomized and accumulated for the number and characteristics of stops on identified routes (Route 12 Westbound and Route 118 Eastbound).

1.3 Research Results

1.3.1 Transit Delay Summary

Transit delay components for the two bus stop types and locations can be summarized as follows. Details are included in Section 5.1.3 on page 23 of the main report.

- → total stop delays (excluding dwell time) varied in range between 7.6 seconds (curb-side) and 14.75 seconds (busbay)
- → clearance (re-entry and acceleration) delays were in a range between 4.8 and 10.5 seconds

Comparisons between bus bay and curb-side stop observations include:

- → due to additional distance and manouevring requirements, deceleration delay at bus bays is approximately one to two seconds longer than at curb-side stops
- → clearance time (re-entry and acceleration) at bus bays is approximately four to five seconds longer than at curb-side stops
- → in total, bus delay is approximately five to six seconds longer per stop at bus bays than curb-side stops
- → there is large variability of re-entry times for bus bay stops
- → re-entry delay increases as traffic volume increases

1.3.2 Auto Delay Summary

The auto delay components for the two bus stop types and two locations can be summarized as follows. Details of the summary can be found in section 5.2.3 on page 29 of the main report.

- → Delays to autos forced to stop for the entire time the bus was stopped average about 14 seconds, with a maximum observation of 22.2 seconds.
- → Delays to autos forced to stop for a part of the time the bus was stopped average about eight seconds, with a maximum observation of 11.0 seconds.
- → Delays to autos forced to slow down prior to the bus departure or to manoeuvre around the bus average about two seconds.
- → Delays to autos yielding to the bus or stopped or slowed behind a yielding vehicle average about five seconds
- → In total, delays to autos at curb-side stops amounted to about 8.2 seconds per car (about 6 cars per event) while delays to autos at bus bay stops amounted to about 3.5 seconds per car (about four cars per event)

1.3.3 Corridor Simulation Results

To simulate the impacts of cumulative effects in a corridor served by transit, a simulation model was developed based on the observed results from the video analysis. In this model, observed delays were accumulated for the number and characteristics of stops on identified routes (Route 12 Westbound and Route 118 Eastbound).

In the Route 12 example, simulation of the past removal of nine westbound bays indicates:

- → bus delay decreased by an average of 42.0 seconds per bus trip
- → total transit passenger delay decreased by about 15.0 person-minutes per bus trip
- → total auto person delay increased by almost 6.0 person-minutes per bus trip

These results indicate that total person delay for all road users (transit and auto) was reduced by about 9.0 person-minutes per bus trip, or a total of about 81.0 person-minutes in the peak hour (nine scheduled bus trips per hour).

If the remaining six bays were removed (westbound):

- → travel time savings would increase from 42.0 seconds to approximately 75.0 seconds per trip
- → total transit passenger delays would be reduced by an additional 8.0 person-minutes per trip to almost 23.0 person-minutes per bus trip
- → total auto person delay would increase by an additional 2.0 minutes to about 8.0 person-minutes per bus trip
- → total person delay for all road users (transit and auto) would be reduced by an additional 6.0 person-minutes per bus trip, for a total reduction of 15.0 person-minutes per bus trip or 135.0 person-minutes in the peak hour compared to the 2007 situation of 15 bays along the route

In the Route 118 eastbound example, the simulation examined the potential impact of removing all 25 bays eastbound from Moodie Drive to Billings Bridge Station and converting them to curb-side stops.

In summary, the simulation of the removal of 25 bays on Route 118 eastbound shows:

- → bus delay could decrease by an average of two minutes per trip
- → total transit passenger delay could decrease by approximately 56 person-minutes per bus trip
- → total auto person delay could increase by almost 15 person-minutes per bus trip

These results indicate that total person delay for all road users (transit and auto) would be reduced by about 41 person-minutes per bus trip, or about 410 person-minutes in the peak hour.

Transit passengers are typically subject to greater cumulative delays than auto passengers. Transit passengers are subject to cumulative delays for the entire length of their trip in the corridor while auto drivers are typically able to pass the transit vehicle after only one or two delays.

1.3.4 Travel Time Variability

In addition to the average delay calculations, it is important to consider the potential variation in travel times and their effect on reliability and scheduling variability. In two corridor simulations the total variability in travel time over the course of the route could be two minutes or more per direction on one route and at least six or seven minutes on the other. In the first case, reducing scheduled trip times by two or three minutes can translate into real savings and at a minimum defer the need for running time increases to manage other delay effects such as increasing traffic congestion.

In the second example, eliminating the potential variation of at least five or six minutes means the same service could be operated with one less bus in the peak period, which could reduce peak operating hours by up to 1,500 hours per year, plus the capital cost of purchasing a bus.

Reliability is an important factor in customer satisfaction with the transit system. Reducing the variability of travel times increases the reliability of when buses arrive at stops further along the route.

1.3.5 Yield-to-Bus Legislation

This assessment included review of Yield-to-Bus (YTB) legislation compliance and effectiveness at all observed stop locations, and the following summarizes results of this analysis.

In observations of events where vehicles should have yielded to the bus exiting from the bus bay, cars yielded about 52 percent of the time. In cases where cars failed to yield, the number of cars passing (and delaying) the exiting bus averaged about 1.5 cars per event, and the delay to the exiting bus was approximately 2.0 seconds.

In cases where cars did yield to the bus, the first car yielded approximately 70 percent of the time (36 percent of all observations where the bus was delayed) and the second car yielded approximately 15 percent of the time (8 percent of all observations where the bus was delayed). Average delay to the bus was 5.0 to 6.0 seconds.

Autos delayed as a result of a car yielding averaged about 1.7 cars per event. Average delay was approximately 5.0 seconds per car.

The literature review indicates that compliance with YTB legislation is low in many cities and enforcement is rare.

1.3.6 Safety Research

Safety is of paramount importance for all aspects of the transportation system and an important factor in the decision whether or not to install or remove a bus bay. Safety is consistently identified across transit systems as a primary factor that can justify bus bay installation.

The assessment also relied on research into accident data and situations in Ottawa, conducted in 1994 and 2000, which showed no conclusive evidence of safety implications between the two stop types. Similar conclusions were reached in the research in other cities.

A review of potential collision situations shows that similar potential (with different specific situations) exists for both bus bay and curb-side configurations, and that most collisions would result from driver error and a specific failure to obey the rules of the road.

Collisions involving buses are rare (less than 0.5% of total collisions) and collision rates are approximately five times higher for car passengers than for bus passengers. Transportation systems that prioritize and favour transit will reduce the number of cars on the road and thereby improve overall traffic safety.

In reviewing the sight line consideration included in the current Ottawa bus bay policy, it was concluded by this assessment as well as that of other jurisdictions that substandard sight lines are an issue for autos approaching a stopped bus at curb-side, as well as for a bus trying to exit from a bus bay, and that stops at locations with substandard sightlines should be avoided altogether.

1.3.7 Impacts on Other Users

An assessment of the impact of bus bays on other users of the street right-of way suggests that there are negative impacts of bus bays beyond the quantitative delay measurements. These include:

Physical Space Restrictions

The presence of a bus bay in the road right-of-way typically restricts the amount of space available for other users, including pedestrians and waiting passengers, and the space restriction can create conflicts between the two groups of users.

This space restriction also limits the potential for other amenities for all users of the right-of-way such as streetscaping, shelters, benches, newspaper boxes and such, can add to the quality of the urban space and promote its use by non-motorized modes, consistent with the intent of a number of city policies supporting walking, cycling and transit.

Bus entry angle

Buses must enter a bay on an angle, which makes it harder to position the bus correctly to eliminate the gap between the curb and all of the bus doors and to deploy the wheelchair ramp correctly. Angled entry and exit also mean that conflicts are more likely between pedestrians and overhanging bumpers and mirrors within the limited space available.

The setback of the passenger waiting area from the main curb line of the road at a bus bay may impede visibility between waiting passengers and approaching bus operators.

Roadway Cross-section Implications

The presence of a bus bay also affects the relationship between pedestrians and the travelled portion of the roadway. Pedestrians crossing at bus bay locations may have a longer distance to cross, and this affects the quality of the pedestrian environment and the perception of safety.

The presence of a bus bay also complicates use of shared space in the roadway when cyclists are present, whether or not a bicycle lane is provided.

Accessibility Issues

Many of the negative aspects of bus bays for pedestrians and transit customers are even more pronounced for people with disabilities, including space for adequate manouvering to and on a ramp, limited sidewalk space, bus entry angle, longer roadway crossing distances, visibility and others

Winter Maintenance

A bus bay creates the necessity of clearing an extra lane of snow, while at the same time reducing the amount of space available to store the snow prior to removal. Low traffic volumes in the bus bay lane imply a larger build-up of snow and ice during a storm than regular traffic lanes.

Cost impacts

All of these effects have cost implications either in the short- or longer-term, as well as additional costs related to construction and maintenance of the bay itself.

1.3.8 Other Considerations

Acceleration Lanes

During the consultation for this review a point was raised about the dual nature of some bus bays at far-side intersection locations where both transit and auto functions are served. For right-turning autos, the review was asked to consider that the empty bus bay can serve as an acceleration lane and its removal will affect roadway operations.

This assessment relied on a 2007 study of acceleration lane use in Ottawa. Extensive observations of short acceleration lanes (comparable to the length of a far-side bus bay) revealed that in practice these lanes are rarely utilised. The observed lanes were considerably shorter than the design standards recommended by the Transportation Association of Canada (TAC), and there is anecdotal evidence to suggest that acceleration lanes that are closer in length to TAC standards are typically used for their intended function.

In practice, very few acceleration lanes of any length have been provided on major roads that have been constructed or widened in the last decade. In recent years the City has also been moving away from high speed right turn channels to the “smart channel” design which promotes safety and convenience for all users (including motorists and pedestrians) and that does not typically require acceleration lanes.

The conclusion of this review in the context of bus bay operations is that that the need for acceleration lanes at any specific intersection should be examined, and if warranted, the acceleration lane should be provided and constructed to the appropriate standards. The decision to share this function with transit vehicles for a bus bay can then also be decided on a case-by-case basis.

Two-Lane Roads

For the most part, consideration of transit operations on two-lane roads with only one travel lane in each direction will be limited to local and collector streets, where traffic volumes are lighter, speeds are slower, transit frequencies are lower, and the absence of bus bays will not present any operational or delay issues.

Throughout the city however, there are instances where buses operate on two-lane roads where traffic volumes are higher and an apparent conflict between autos and buses might exist. A variety of different roadway and streetscape environments have different design objectives and deserve specific consideration for the provision of curb-side versus bus bay stops in the roadway context. Each must be considered individually to ensure that all elements of the roadway are contributing to the desired objective.

1.4 Consultation

As part of this report preparation, a wide variety of City of Ottawa stakeholders were consulted at two meetings – one early in the study and one to review the Draft Report.

Written and verbal comments were received and considered from various branches and units within Planning and Growth Management Department, Public Works Department, Transit Services Department, Ottawa Police Services and Infrastructure Services Department.

Transit Priority staff also met with the Pedestrian and Transit Advisory Committee, the Roads and Cycling Advisory Committee, and the Accessibility Advisory Committee to solicit input.

1.5 Findings and Conclusions

1.5.1 Findings

The following conclusions summarize the results of the analysis in this study:

→ reducing bus bays provides net positive benefits of person-delay when considering all users of the road under common traffic and ridership conditions

→ the impact of curb-side stops on motorists is minimal, though perception can be different

→ cumulative effects of bus bays can have a significant impact on transit operations in terms of running time, reliability, scheduling impacts and ultimately, operating cost

→ the cumulative impacts on transit riders are greater than on auto drivers and passengers

→ there is no evidence of safety issues differentiating bus bays from curb-side stops

→ a variety of City transportation, environmental and urban design objectives support favouring transit and removal of bus bays

→ bus bays have external impacts unrelated to delay comparisons (maintenance and construction costs, urban environment)

→ Ottawa is consistent with state-of-the-art practices and research in other Canadian and international cities in terms of policies, delays, safety, and YTB experience (though delays to both transit vehicles and autos are somewhat lower than other examples)

1.5.2 Conclusions

These findings lead to the conclusion that the current bus bay policy is appropriate for the Ottawa context, with the following considerations:

→ with respect to the safety criteria – posted speed 70 km/h or greater:
  - there is a lack of safety data clearly supporting either bus bay or curb-side case
  - speed element still recognized as important factor

→ with respect to the safety criteria – inadequate horizontal or vertical geometry:
  - there are contradictory positions on sight line issues
  - bus stops with substandard geometry should be avoided

→ with respect to the total person delay criteria:
  - actual delays are shorter than perceived delays for both buses and autos
  - there are important delays for buses and transit passengers on a corridor basis

→ with respect to the impacts on other users
  - including bus bays as part of the street programming, and therefore, the street right-of-way cross-section, reduces the amount of ROW for people
  - bus bays do not contribute to, and may reduce, pedestrian safety, utility, attractiveness, comfort and ultimately the usefulness of the public street as a place for people; improving the design of street rights-of-way to address these factors is more difficult when bus bays are present

- many of the negative aspects of bus bays for pedestrians and transit customers are even more pronounced for people with disabilities

→ other

- while YTB legislation is better for transit operations than not having it, the legislation has not proven to be a solution for eliminating re-entry delay