

LOW COST OPERATIONAL IMPROVEMENTS AT FREEWAY EXIT AND ENTRY RAMPS

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ABSTRACT

A pilot study was conducted by The Ministry of Transportation, Ontario with the goal of providing drivers with enhanced notification and guidance for freeway must exit lanes and discouraging the use of on and off ramps for queue jumping. The use of enhanced pavement markings, pavement marking arrows and additional signing gives drivers advanced notice in regard to which lane(s) exit the freeway, allowing drivers additional time to change lanes accordingly. The enhanced pavement markings and signing at entrance and exit ramps also discourage drivers from using on ramps and off ramps to by-pass congestion on the freeway. A solid line was painted to the right of the existing dashed line at must exit lanes, and to the left of the existing dashed line at entrance ramps. Pavement marking arrows were painted on the asphalt approximately 450 and 600 metres from the freeway exit, and additional ground mounted lane designation signs were installed.

Before and after studies were conducted at six locations. The studies concluded that the enhanced pavement markings, pavement arrows and additional signing at exit ramps were very successful in reducing queue jumping and last minute lane changing. The studies conducted at the entrance ramps were inconclusive.

INTRODUCTION

At times, freeway drivers are unaware that the lane they are traveling in is a must exit lane. As a result, drivers make last minute and potentially dangerous lane changes to remain on the freeway. To address this problem, the Ministry of Transportation, Ontario designed and installed enhanced pavement lane markings, pavement marking arrows and additional signing at off ramps in order to provide drivers with advanced notice in regard to which lane(s) exit the freeway. The enhanced pavement markings and signing at off ramps, and on ramps, also discourage drivers from using ramps to by-pass congestion on the freeway.

DESIGN

A solid line was painted to the right of the existing dashed line at must exit lanes, and to the left of the existing dashed line at entrance ramps to discourage freeway drivers from entering the on ramp or off ramp for the purpose of queue jumping. Pavement arrows were painted on the asphalt approximately 450 meters and 600 metres from the freeway exit and additional ground mounted lane designation signs were installed adjacent to the pavement arrows to inform drivers that the lane is exiting the freeway. The arrow design can be found in Figure 1 below. The average cost of the enhancement was \$20,000 per location which included all new pavement markings, signing, obliteration of existing pavement markings, and traffic control.

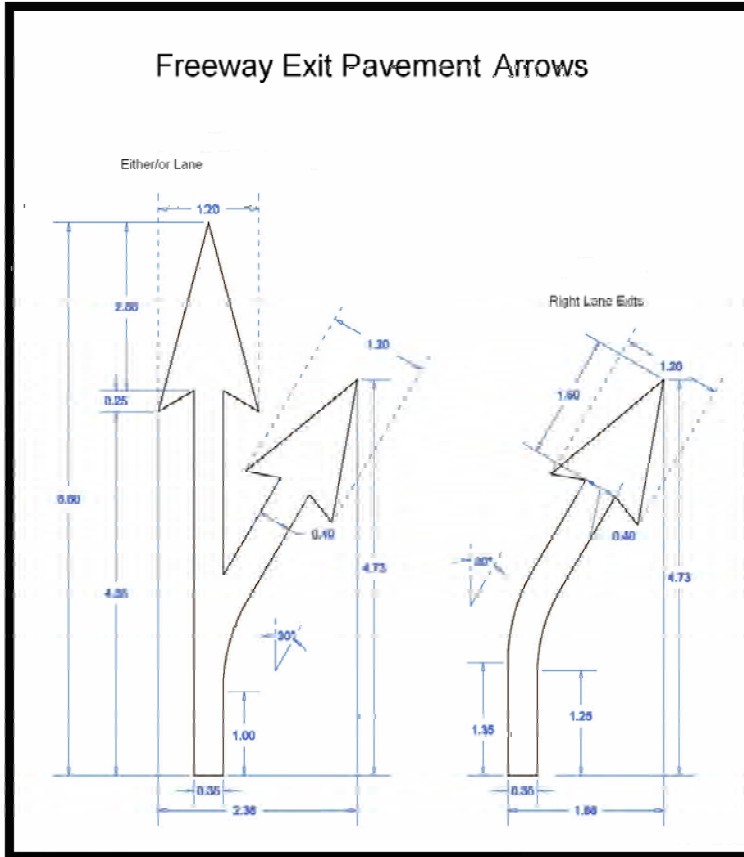


Figure 1: Freeway Exit Pavement Arrows

METHOD

High priority locations were evaluated and ranked based on Annual Average Daily Traffic volume, collision frequency and severity, and public complaints. Each location was divided into several 150 metre long zones for the purpose of evaluation. A before study, recording the number of vehicles changing lanes in each zone, was conducted during peak hours. An after study, using the same zone allocation and time of day, was conducted to determine changes in motorist behaviour. Two after studies were performed; the first was immediately after implementation and the second was one year after implementation. Four exit ramps and two entrance ramps were chosen for the pilot study. Three of the exit ramps are comprised of an either/or lane and a must exit lane and the remaining exit ramp is a single must exit lane.

LOCATION 1: HIGHWAY 401 EASTBOUND EXIT TO KEELE STREET

Location 1 is a combined either/or lane and must exit lane on Highway 401 eastbound at Keele Street. The original and enhanced pavement markings and signing configuration can be found in Figure 2 and Figure 3; the zone allocation can be found in Figure 4. Within each zone, the number of lane changes to the left was recorded.

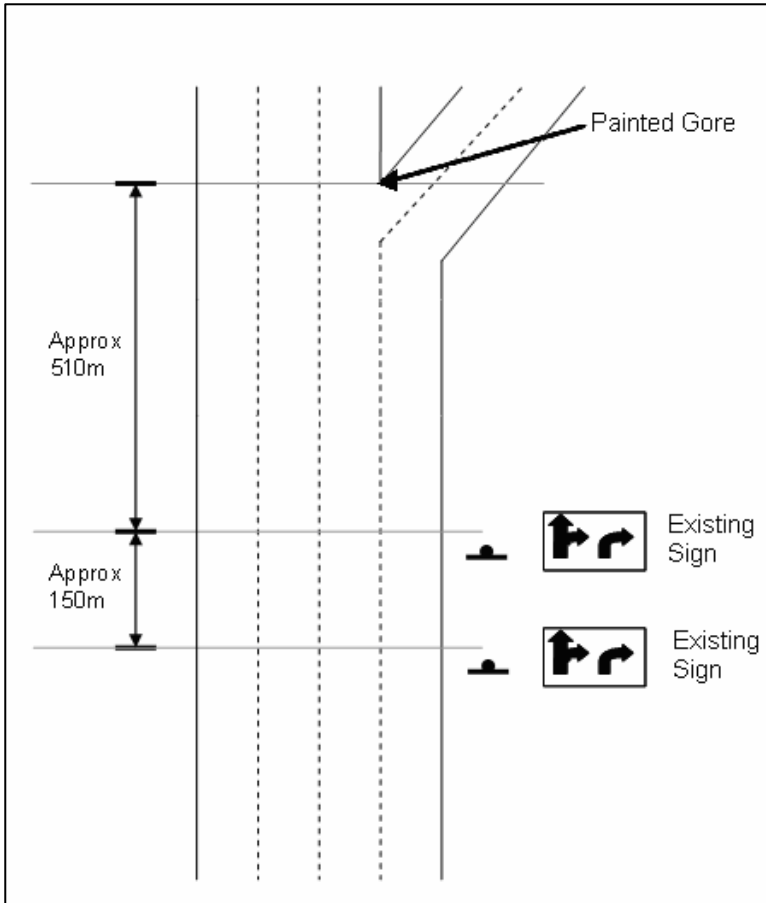


Figure 2: Highway 401 Eastbound Exit to Keele Street – Before

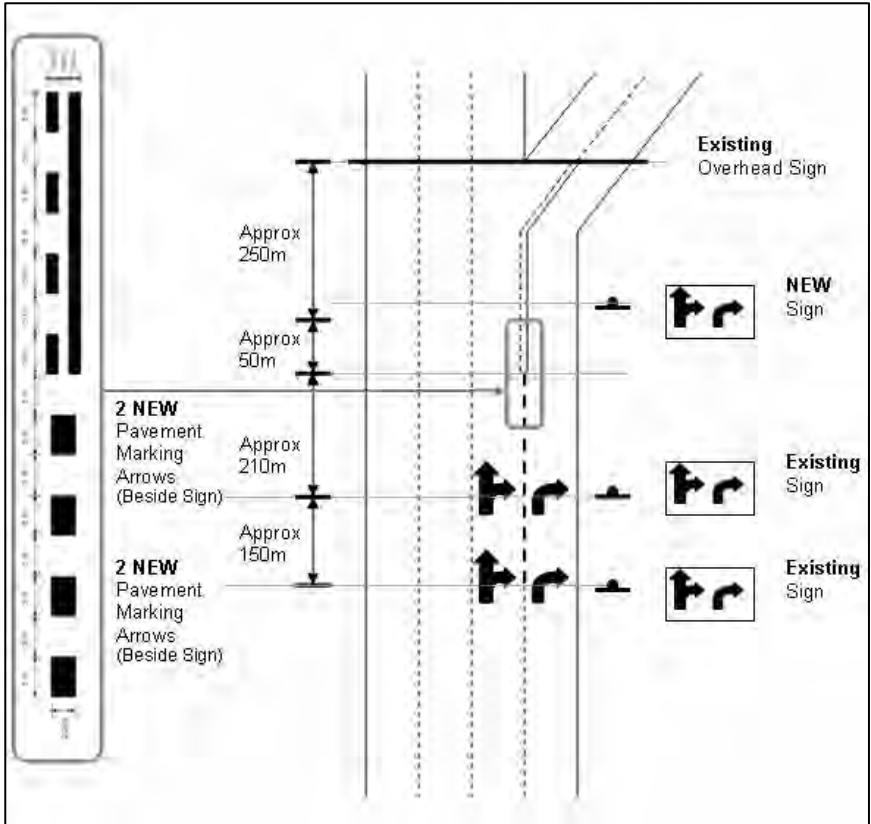


Figure 3: Highway 401 Eastbound Exit to Keele Street - After

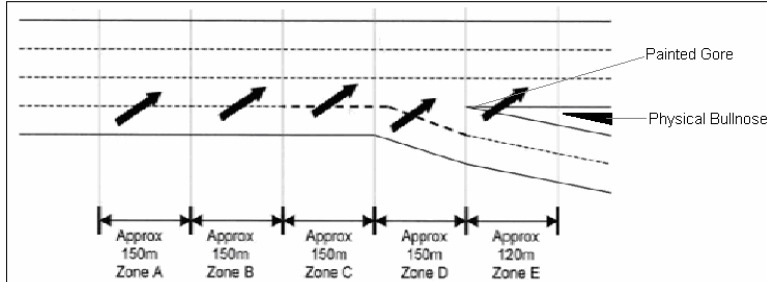


Figure 4: Highway 401 Eastbound Exit to Keele Street – Zones

The treatment was installed in May 2010. The before counts for this location were conducted in March 2010 and the two after counts were conducted in June 2010 and April 2011. The results indicated in Figure 5 show a significant drop in last minute lanes changes in Zone D and Zone E and a considerable increase in early lane changes in Zone B; which is a direct result of the improvement initiative.

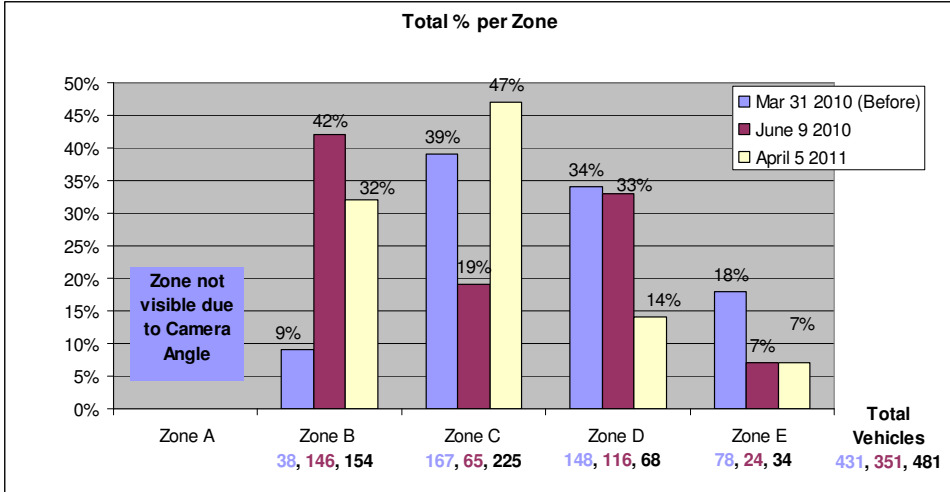


Figure 5: Highway 401 Eastbound Exit to Keele Street - Results

LOCATION 2: HIGHWAY 401 EASTBOUND EXIT TO LESLIE STREET

Location 2 is situated on Highway 401 eastbound at Leslie Street, and is a single lane must exit. The before and after pavement markings and signing configuration can be found in Figure 6 and Figure 7 and the zone allocation can be found in Figure 8.

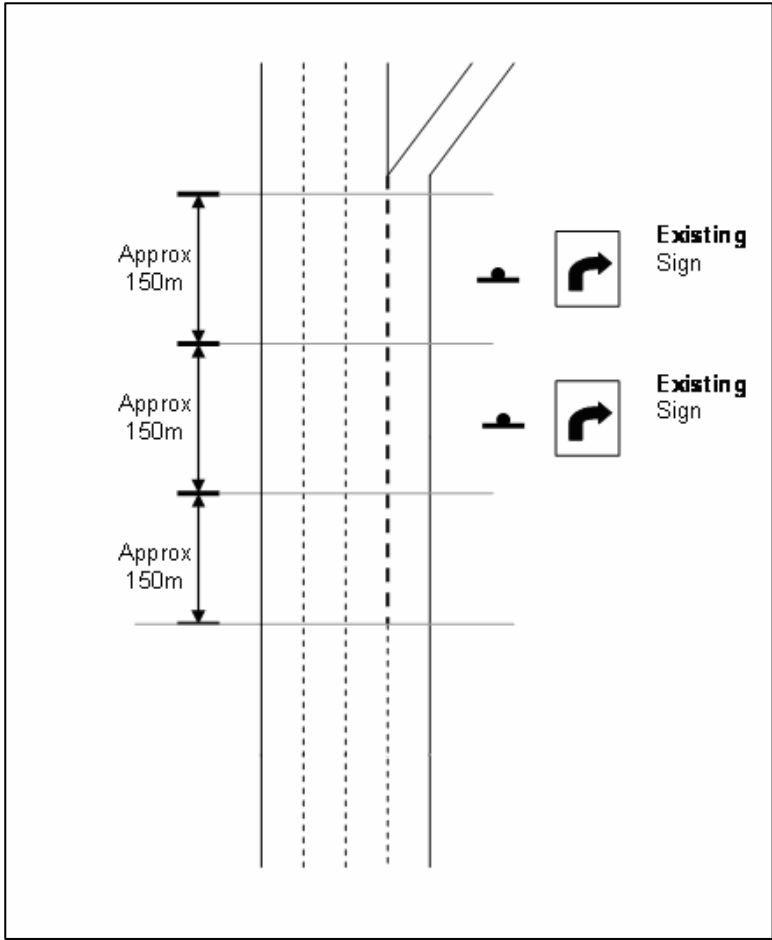


Figure 6: Highway 401 Eastbound Exit to Leslie Street - Before

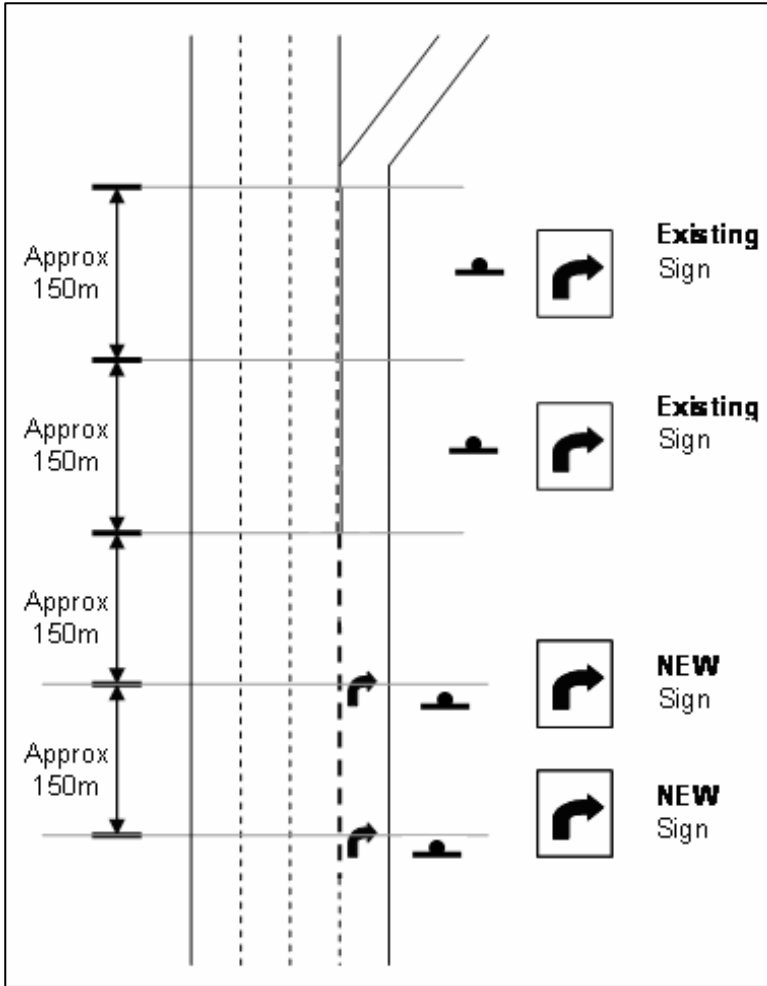


Figure 7: Highway 401 Eastbound Exit to Leslie Street – After

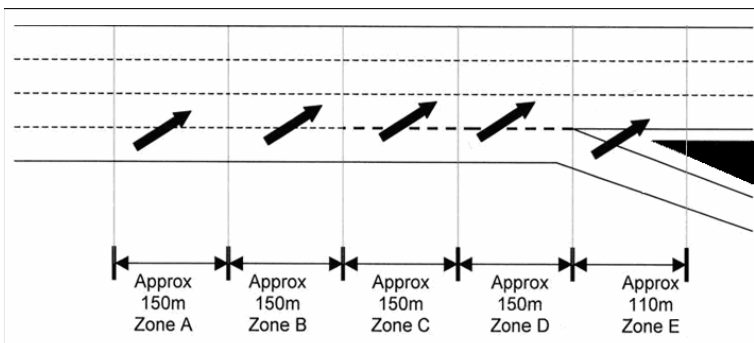


Figure 8: Highway 401 Eastbound Exit to Leslie Street - Zones

The treatment at this location was installed May 2010. The before study for this location was conducted in March 2010 and two after studies were conducted June 2010 and July 2011. The results in Figure 9 indicate that the number of drivers changing lanes in Zones D and E has decreased over time. Zones A, B

and C were not counted in this study due to lack of camera visibility. The counts done in July 2011 show a decrease in the number of lane changes closer to the exit. The results demonstrate a successful operational improvement on the exit ramp.

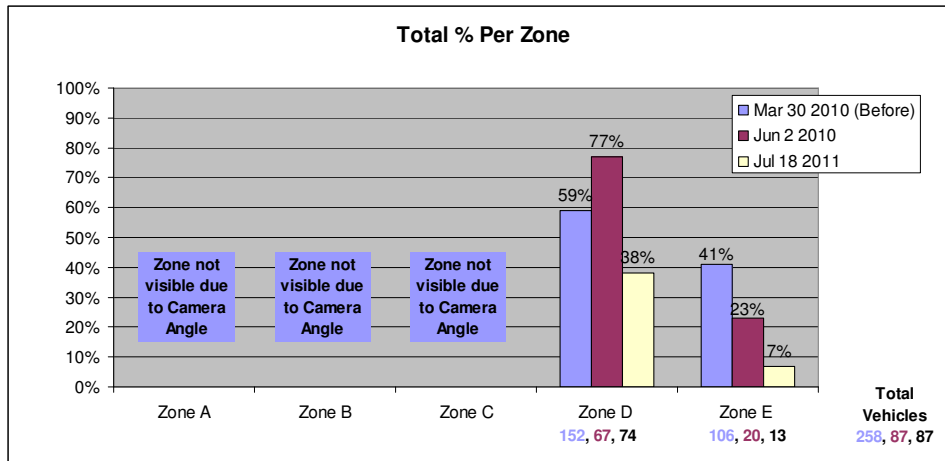


Figure 9: Highway 401 Eastbound Exit to Leslie Street - Results

LOCATION 3: HIGHWAY 401 EASTBOUND EXIT TO ALLEN ROAD

Location 3 is a combined either/or lane and a must exit lane on Highway 401 eastbound at Allen Road. The before and after pavement markings and signing configuration can be found in Figure 10 and Figure 11 and the zone allocation can be found in Figure 12.

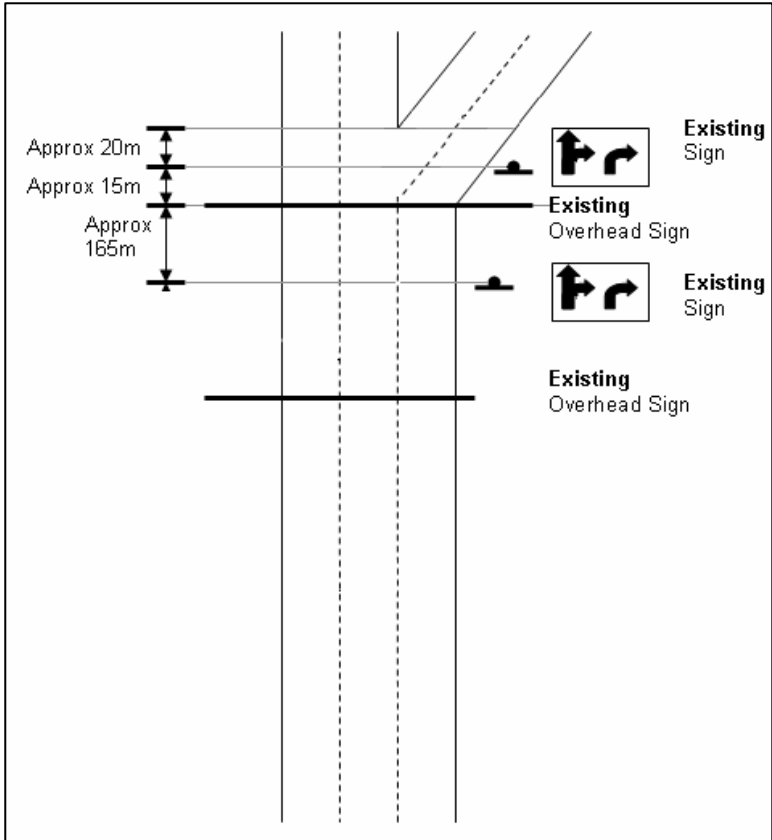


Figure 10: Highway 401 Eastbound Exit to Allen Road - Before

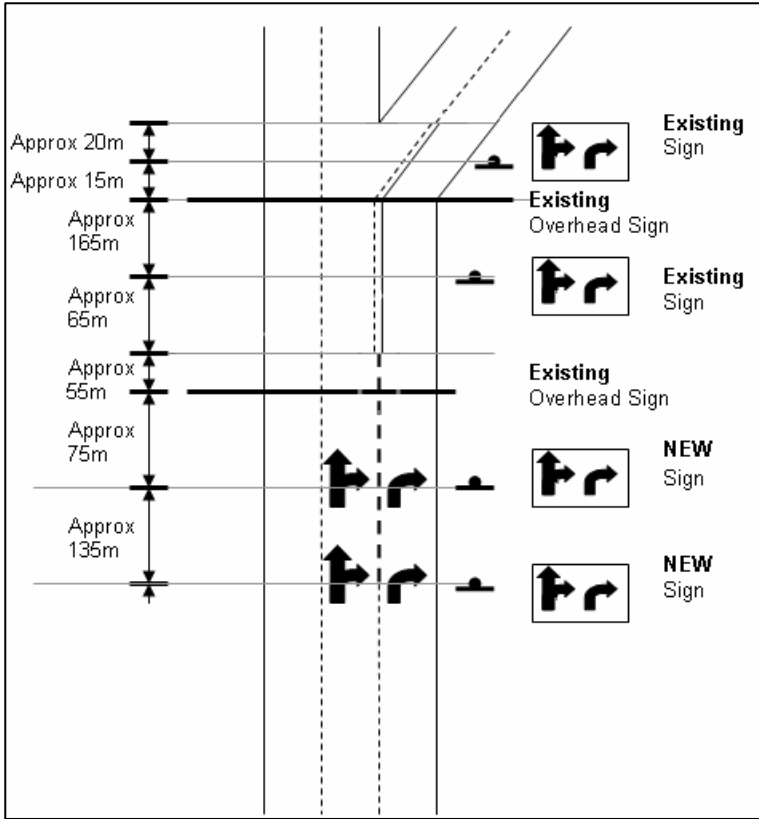


Figure 11: Highway 401 Eastbound Exit to Allen Road - After

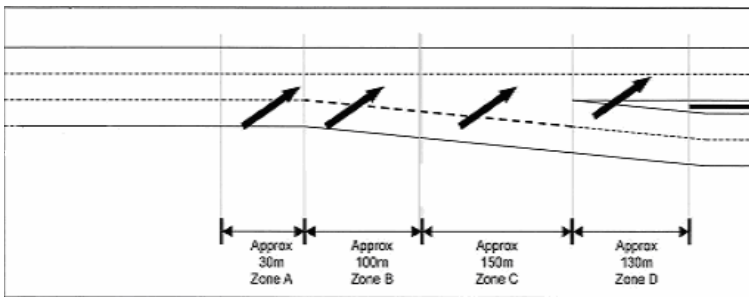


Figure 12: Highway 401 Eastbound Exit to Allen Road – Zones

The treatment was installed May 2010. The before counts for this location were conducted March 2010 and the after counts were conducted in June 2010 and March 2011. The results shown in Figure 13 demonstrate an increase in lane changes in Zone A and Zone B with fewer last minute lane changes in Zone C and Zone D over time. This deployment has achieved positive results as lane changes are being made further away from the exit.

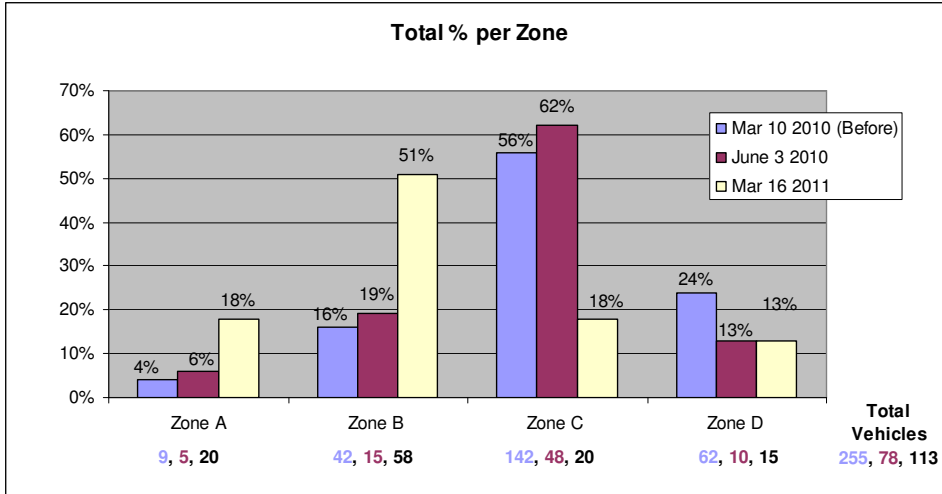


Figure 13: Highway 401 Eastbound Exit to Allen Road - Results

LOCATION 4: HIGHWAY 401 WESTBOUND EXIT TO AVENUE ROAD

Location 4 is located on Highway 401 westbound at Avenue Road and is comprised of an either/or lane and a must exit lane. The before and after pavement markings and signing configuration are displayed in Figure 14 and Figure 15. This is a designated bilingual area per the Provincial French Language Service Act therefore all freeway signing must be bilingual. The zone allocation is presented in Figure 16.

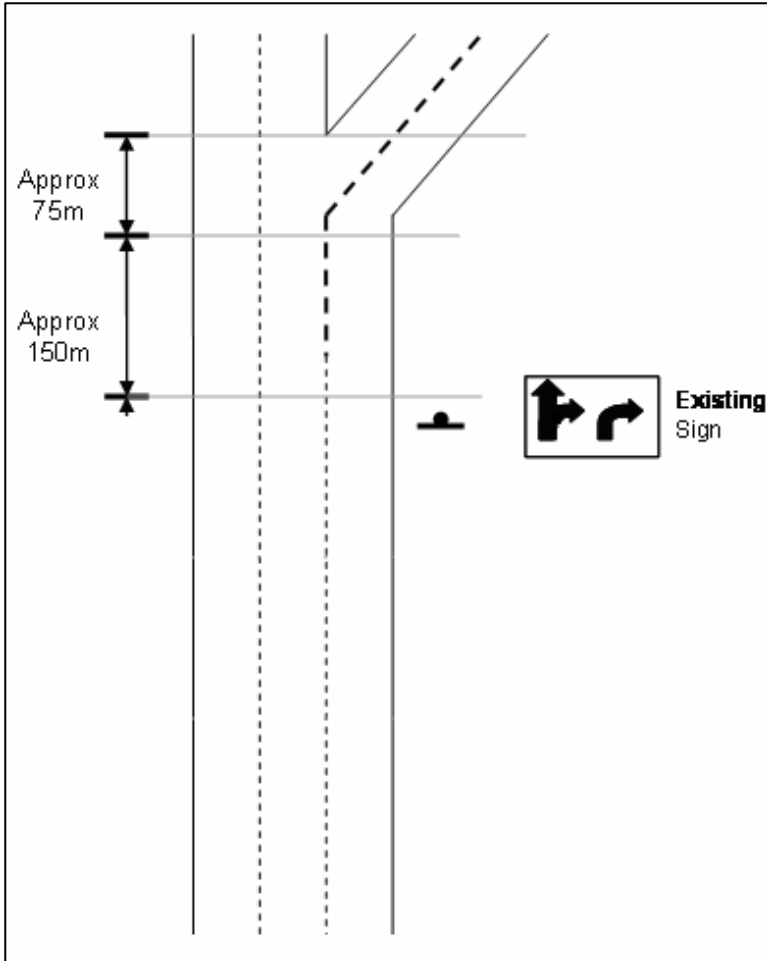


Figure 14: Highway 401 Westbound Exit to Avenue Road – Before

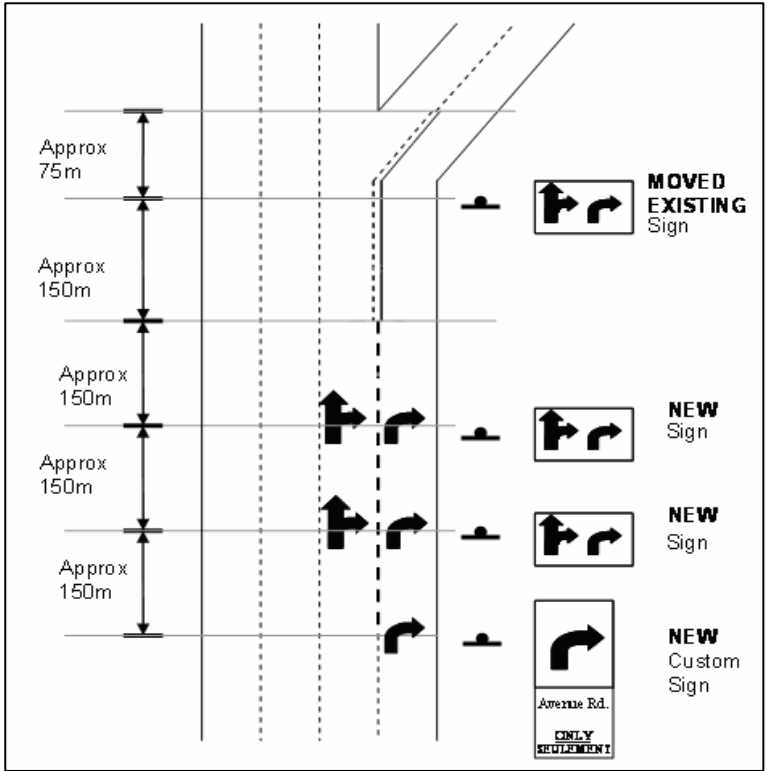


Figure 15: Highway 401 Westbound Exit to Avenue Road - After

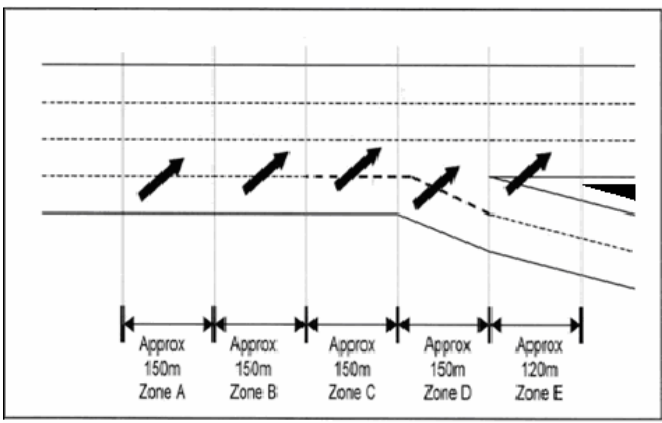


Figure 16: Highway 401 Westbound Exit to Avenue Road - Zones

The treatment was installed in late November 2010. The before study at this site was conducted early November 2010 and the after study was conducted in April 2011; a second after study has not been conducted to date. Zone A was not counted due to lack of camera visibility. The results in Figure 17 indicate an increase in lane changes in the zones closer the exit and a decrease in lane changes in zones further away from the exit. The before and after study suggests that the improvement initiative was not as successful as the other

locations. However, recent observations indicate an increasing percentage of drivers are changing lanes further away from the exit.

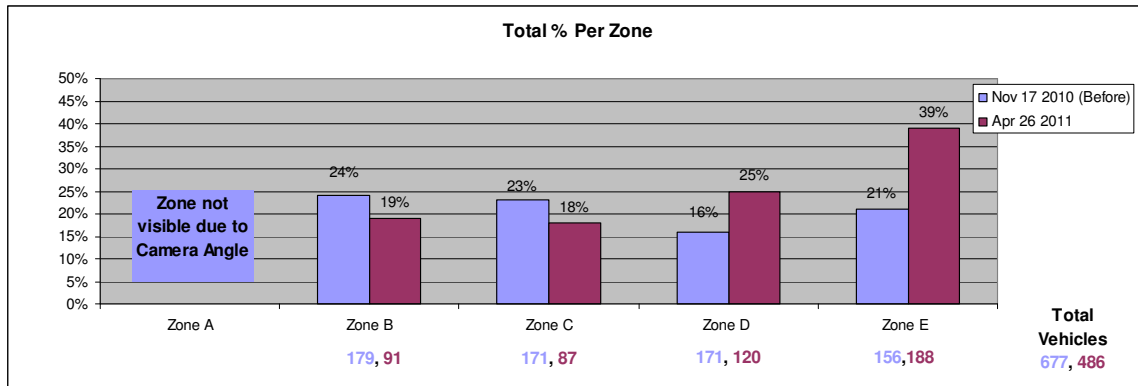


Figure 17: Highway 401 Westbound Exit to Avenue Road - Results

LOCATION 5: HIGHWAY 401 EASTBOUND ENTRANCE AT AVENUE ROAD

Location 5 is Highway 401 eastbound at the Avenue Road entrance ramp. The before and after pavement marking configuration can be found in Figure 18 and Figure 19 and the zone allocation can be found in Figure 20. With each zone, the number of lane changes to the right was recorded. The objective at this location was to discourage freeway drivers from using the on ramp to queue jump.

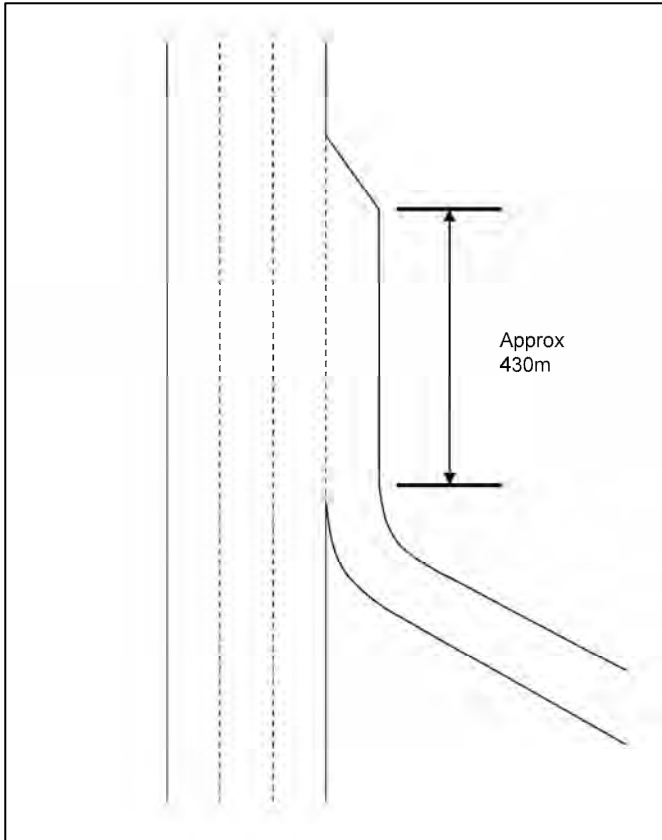


Figure 18: Highway 401 Eastbound Entrance at Avenue Road – Before

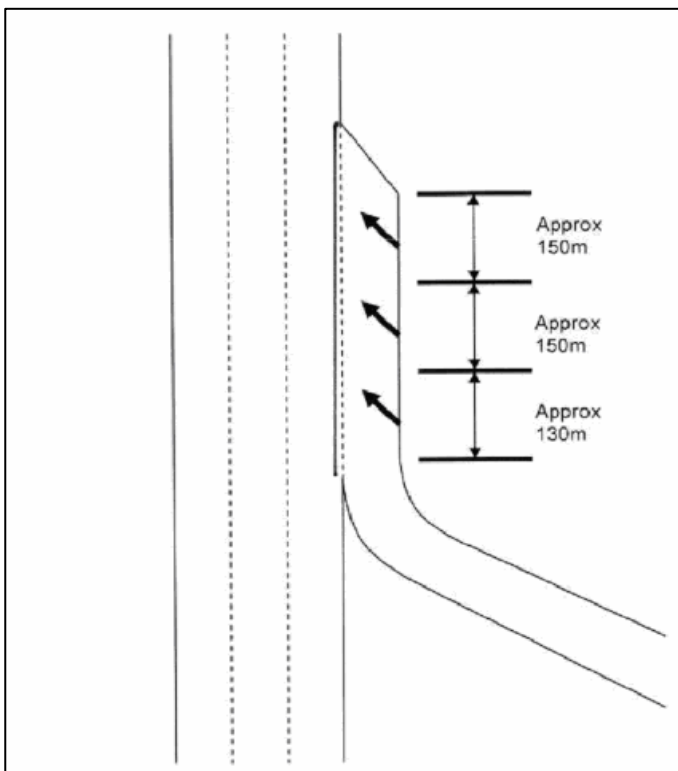


Figure 19: Highway 401 Eastbound Entrance at Avenue Road - After

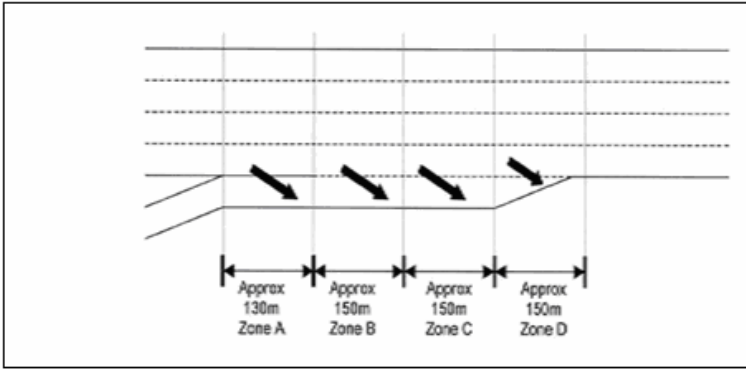


Figure 20: Highway 401 Eastbound Entrance at Avenue Road - Zones

The treatment at this location was installed in May 2010. The before study was conducted in March 2010 and two after studies were conducted in July 2010 and July 2011. The results in Figure 21 demonstrate that the percentage of queue jumping in Zone C has decreased over time and there were very few incidents in Zone D. The total number of vehicles using the on-ramp to bypass the traffic has increased, however the sample size is very small. The results at this site are inconclusive at this time.

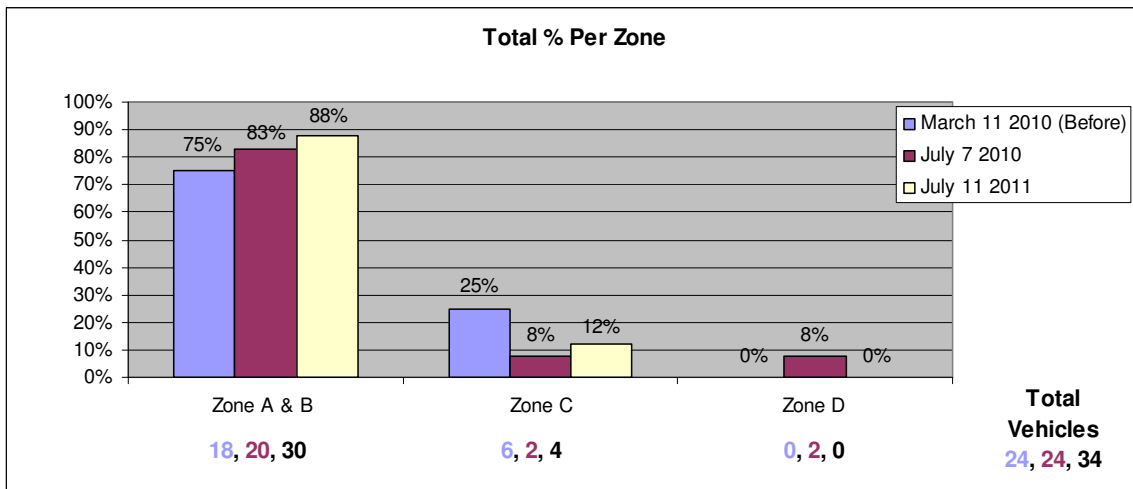


Figure 21: Highway 401 Eastbound Entrance to Avenue Road Results

LOCATION 6: HIGHWAY 401 EASTBOUND ENTRANCE AT DIXON ROAD

Location 6 is located on Highway 401 eastbound at the Dixon Road entrance ramp. The before and after pavement marking configuration can be found in Figure 22 and Figure 23 and the zone allocation can be found in Figure 24.

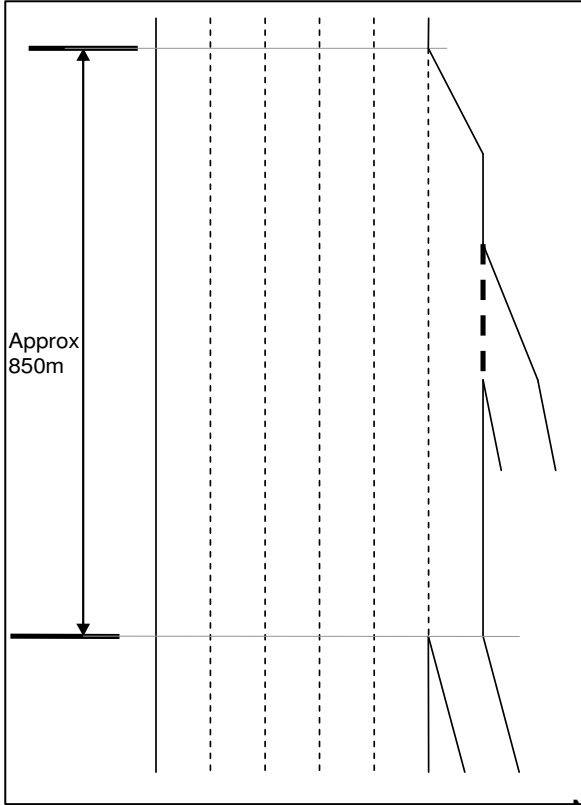


Figure 22: Highway 401 Eastbound Entrance at Dixon Road - Before

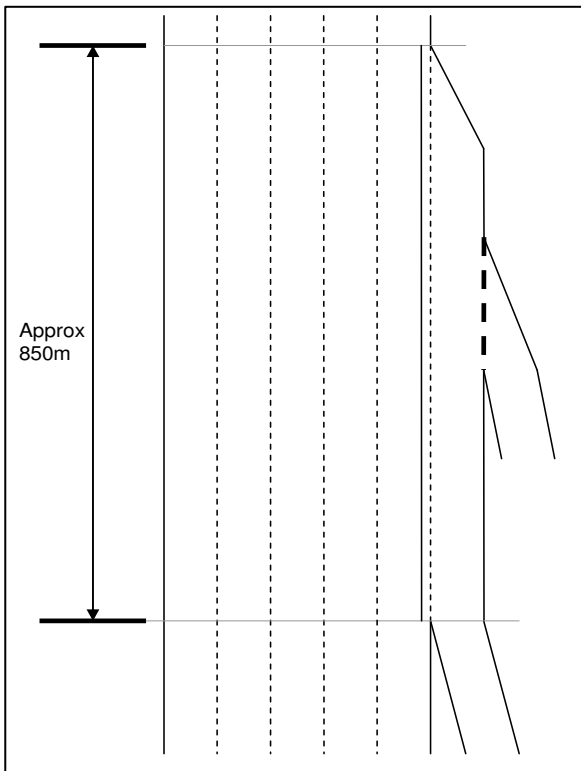


Figure 23: Highway 401 Eastbound Entrance at Dixon Road - After

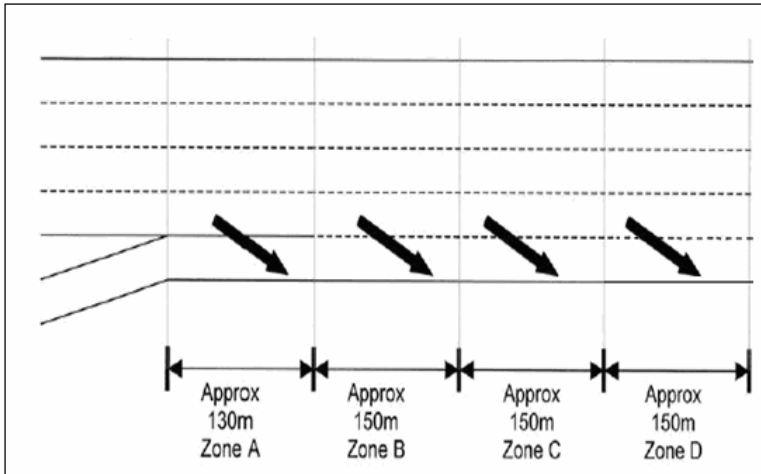


Figure 24: Highway 401 Eastbound Entrance at Dixon Road - Zones

The treatment was installed late August 2010. The before study for this location was conducted early August 2010 and two after studies were conducted November 2010 and March 2011. Figure 25 indicates a decrease in the percentage of queue jumping in Zone A and in Zone B over time. As a percentage, the queue jumping in Zone C has increased, and remained relatively the same in Zone D. The number of vehicles using the ramp to bypass congestion on the freeway has increased. The sample size is much larger than in the previous location. The enhancements at Highway 401 and Dixon Road therefore have not yielded operational improvements.

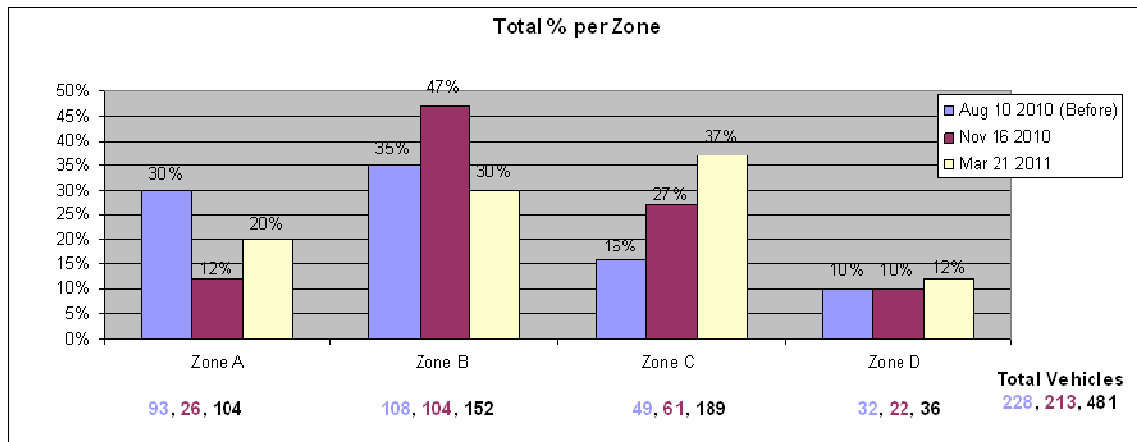


Figure 25: Highway 401 Eastbound Entrance to Dixon Road - Results

CONCLUSION

The before and after studies at three of the four freeway exit pilot locations concluded that the enhanced pavement markings, pavement arrows and additional signing at freeway exits were successful in reducing queue jumping and last minute lane changing. The fourth location requires additional data collection to confirm results.

The additional pavement markings at freeway entrance ramps yielded either inconclusive results or an increase in undesirable driver behaviour. More data collection is required to confirm results.

Based on the results of the pilot study, the Ministry of Transportation, Ontario, continues to implement enhanced pavement markings, pavement arrows and additional signing at high priority freeway exits. The enhancements will be implemented at other high priority on ramp locations to determine the benefit of installing enhanced pavement markings at freeway on ramps. Before and after studies will always be conducted at every freeway exit and entrance where enhanced pavement markings and/or signing is installed. Currently, it has been demonstrated that enhanced pavement markings, pavement arrows, and additional signing at freeway off ramps is a low cost technique to improve driver behaviour.