



Playground and School Zone Awareness Pilot Project:

Results and Recommendations

December 2014

THE CITY OF CALGARY
ROADS

Executive Summary

In January 2013, a Notice of Motion (NM2013-01) was put forward to investigate alternative traffic measures as a way to increase driver awareness of entering Playground and School Zones. Subject matter experts from Roads examined over 30 different alternative traffic measures which would be suitable for use in Calgary. Based on an investigation from a number of different Canadian cities, stakeholder input and technical studies, eight traffic measures were identified as having the highest potential for improving the awareness of playground and school zones in Calgary. These measures included:

- Traffic cones with reflective spinning anemometer (traffic cones)
- Neighbourhood speed watch program (speed watch)
- Reflective tape on playground/school zone sign poles (reflective tape)
- Double signing at start of playground/school zones (double signs)
- Larger playground/school zone signs (larger signs)
- Multiple playground/school zone signs within a zone (multiple signs)
- Zone ahead signs (zone ahead signs)
- Road marking stencils (road markings)

The theoretical foundation of this pilot program was that drivers can be classified into three groups when considering speed compliance in playground and school zones:

1. Aware and compliant - drivers who follow speed limits and are aware of the zone
2. Unaware but would comply - drivers who would follow speed limits but are unaware of the presence of the zone
3. Aware and non-compliant - drivers who do not comply with the speed limit even when aware of the zone.

The target audience for these measures was drivers who were 'unaware but would comply' with the speed limit but were not able to identify the playground or school zone. By increasing the awareness of the zone through various enhancements this group was most likely to make a change from non-compliance to compliance with the speed limit. All three groups could, however, choose to (further) reduce their speed.

The pilot project was conducted during 2013 and 2014 at 23 treatment sites and 6 comparison sites. Speed data was collected at all sites and six metrics were used to evaluate how each measure improved safety (by reducing speed and increasing compliance) in playground and school zones:

- Average speed reduction
- 85th percentile speed reduction
- Percentage increase in vehicles with a speed equal to or less than 30 km/h
- Percentage decrease in vehicle with a speed between 31 km/h and 35 km/h
- Percentage decrease in vehicles with a speed between 36 km/h and 50 km/h
- Percentage decrease in vehicles with a speed greater than 50 km/h

The four measures which were most effective, based on the six statistical criteria considered, were: speed watch, traffic cones, double signs, and road markings. The speed watch and traffic cones had consistent effects in improving driver awareness in all trial sites. Double signs and road markings were effective in most of the trial sites, but not all sites. Three measures including larger signs, multiple signs, and reflective tape were found to be less effective at reducing speeds and increasing compliance than the four most effective measures. The use of zone ahead signs appeared to result in increased speeds and reduced compliance. A summary of results is presented in Table ES1.

The small changes in speed or compliance indicated that the target audience for these measures (unaware but would comply) was relatively small. This finding suggested that current levels of traffic control are appropriate for most conditions. Despite best efforts to select typical sites, there were some locations where initial compliance was found to be low. Measures were found to have larger effects when initial compliance was low, as compared to sites where compliance was initially high.

A driver intercept survey was conducted to supplement the qualitative statistical results by investigating drivers' opinions regarding the four most effective measures. The survey results indicated that that traffic cones were reported as the most visible measure to attract driver attention (noticed by 96.3% of drivers) followed by the speed watch program and road markings (noticed by 72.6% and 68.5% of drivers, respectively). The least visible measure was double signs; only 34.5% of drivers noted this measure in the investigated zone. Among 212 respondent drivers, 42.9% knew the correct zone timing and 57.1% gave incorrect zone hours; this indicated room for improvement.

A benefit-cost (B/C) analysis was conducted to help determine which measures would be cost effective for enhancement of existing signage in school zones and playground zones. The benefit-cost analysis showed that double signs, traffic cones, and road markings were the three measures with the highest B/C ratios. Although the speed watch was found to be the most effective measures for reducing driver speeds and increasing driver awareness, the infrequent operation resulted in a low B/C ratio of 0.56.

Table ES1 Speed, Compliance, and Benefit Cost Findings

Measure	Rank	Avg. Speed change (km/h)	85% Speed change (km/h)	Compliant Driver Change	Non-compliant Drivers Change by Speed			B/C Ratio
					31-35 km/h	36-50 km/h	>50 km/h	
Speed watch	1	-2.75	-2.50	+19%	-8%	-10%	-1%	0.56
Cones	2	-2.50	-2.50	+15%	-5%	-9%	-1%	10.59
Double signing	3	-1.50	-1.13	+10%	-2%	-7%	-1%	14.91
Do Nothing	-	-1.14	-2.07	+9%	0%	-9%	0%	-
Road markings	4	-1.00	-3.20	+4%	+3%	-5%	-2%	8.68
Multiple signs	5	-0.30	-0.20	+4%	+1%	-5%	0%	0
Bigger signs	6	-0.40	-0.10	+3%	+1%	-3%	-1%	1.09
Reflective tape	7	+0.17	-0.17	+1%	+2%	-2%	-1%	-2.88
Ahead signs	8	+0.83	-0.17	-2%	0%	2%	0%	-8.94

The speed watch program and traffic cones were found to be the most effective measures for reducing speed in playground and school zones. However, these measures rely on volunteer assistance (performing speed watch or placing/removing cones) which presents a sustainability challenge for operation on a city-wide basis. Furthermore, the limited duration of the speed watch results in a low B/C ratio. In contrast, double signs and road markings resulted in smaller speed reductions, but are estimated to have higher B/C ratios since they are always present (with the exception of snow covered pavement). The pilot indicates, however, that the best use of double signage or road markings would be as a site specific enhancement since playground or school zones that already have high compliance are less likely to improve.

Recent education and awareness campaigns about playground and school zones and timing changes appear to have been effective when considering observed driver behaviour changes at sites where no measures were applied; an average speed reduction of 1.14 km/h and an increase in compliance of 9% were observed. Despite improved driver behaviour, there appears to be a lack of awareness about playground and school zone timing and this is an area for improvement.

Table of Contents

Table List

Figure List

1.0 Introduction

Calgary currently has 1,068 playground zones and 182 school zones. The 1,068 playground zones include 212 schools for which playground zone signs have been used. Playground and school zones are designated with 30 km/h speed limits for specified times and days in Calgary, to enhance safety for children. On July 22, 2014 City Council approved harmonization of playground and school zone timing to simplify driver expectations in Calgary:

- Playground zones in effect from 07:30 to 21:00 (9:00 p.m.), all year around.
- School zones in effect from 07:30 to 21:00 (9:00 p.m.), on school days.

In January 2013, a Notice of Motion (NM2013-01) was put forward to investigate alternative traffic measures to increase driver awareness of entering playground and school zones. City subject matter experts examined over 30 different supplemental measures which would be suitable to Calgary. Based on a survey from Canadian cities, stakeholder input and technical studies, eight measures were identified as having the highest potential for improving the awareness of playground and school zones in Calgary (Miller & Iwaskow, TT2013-0362). These measures were:

- Traffic cones with reflective spinning anemometer (traffic cones)
- Neighbourhood speed watch program (speed watch)
- Reflective tape on playground/school zone sign poles (reflective tape)
- Double signing at start of playground/school zones (double signs)
- Larger playground/school zone signs (larger signs)
- Multiple playground/school zone signs within a zone (multiple signs)
- Zone ahead signs (zone ahead signs)
- Road marking stencils (road markings)

The pilot project, which is summarized in this report, was initiated to evaluate effectiveness of the measures listed above in increasing driver awareness of entering a playground or school zone. The goal of the project is to determine if measures could be considered for a city wide application as a new standard, or as a site specific enhancement (e.g. based on high speeds, low compliance, certain geometric conditions, etc.). The pilot included a trial of each measure at three or four sites, with a total of 23 'treatment' sites, and 6 comparison sites where no changes were made. The pilot was conducted from August 2013 to October 2014 including implementation of the following activities: pre-pilot data collection, planning and design of trial measures, installation of trial measures, post-pilot data collection, and driver intercept survey.

Comparisons of speed data before and after each treatment and results of driver intercept surveys were used as metrics to determine which measures are the most effective at increasing driver awareness of entering the playground or school zones. Benefit-cost analysis was also conducted to estimate cost effectiveness of each measure.

This report provides a summary of the evaluation of the measures.

2.0 Awareness Pilot Project

2.1 Trial Sites

Treatment sites and 6 comparison sites were selected based on criteria developed during the review of potential measures (Miller & Iwaskow, 2013). The site selection criteria were established to minimize inaccuracies or data biases, and consist of the following:

- Collision rates for the zone should be not be above typical values (collisions in last five years/km length of zone) ;
- Test locations should be on either a residential or collector road;
- Test locations should not be adjacent to all-way stops or signal controlled intersections;
- Test locations should primarily be residential neighbourhoods;
- Test locations for each treatment should include both playground and school zones, except the; treatment of traffic cones which are restricted to school zones;
- The existing speed zone must meet current Transportation Association of Canada (TAC) warrants for the 30 km/hr speed limit.

All selected sites used for the pilot are presented in Table 1 and their locations are shown in Figure 1. Each site had between one and three locations where data was collected, depending on road geometry.

Table 1 Treatment and Comparison Sites

Measure	School Zones	Playground Zones	# of Sites
Treatment Sites			
Traffic cones	Saddleridge Elementary School NE	N/A	3
	Huntington Elementary School NW		
	Mother Mary Greene School NW		
Speed watch	Huntington Elementary School NW	Brenner Dr/Brenner Dr NW	4
	Mother Mary Greene School NW	Silver Mead Rd/72 St NW	
Reflective tape	St. Matthew Elementary & Jr. High SE	Shawglen Rd/Shawglen Pl SW	3
		Bow Cr/66 St NW	
Double signs	Dalhousie Elementary School NW	Pineland Rd/Pineland Pl NE	3
	Ecole St. Cecilia Elementary SE		
Larger signs	Highwood Elementary School NW	Laguna Cl NE	3
	Blessed Damien Elementary SE		
Multiple signs	Our Lady of Peace Elementary and Jr. High SW	Woodbend Rd/Winterbourne Cr SE	3
		Palishall Rd SW	
Zone ahead signs	Mckenzie Towne School	Lake Erie Rd/Lake Erie Pl SE	3
		Winston Dr SW	
Road markings	Riverbend Elementary SE	Tuscany Ridge Cm/Tuscany Ridge Wy NW	3
	Dr. Oakley School SW		
Comparison Sites			
No Change	Delta West Academy NE	Blakiston Dr/Bell St NW	6
	Calgary French & International School SW	Deerview Dr/Deerview Pl SE	
	Light of Christ Elementary & Jr. High NE	Silverdale Dr/68 St NW	

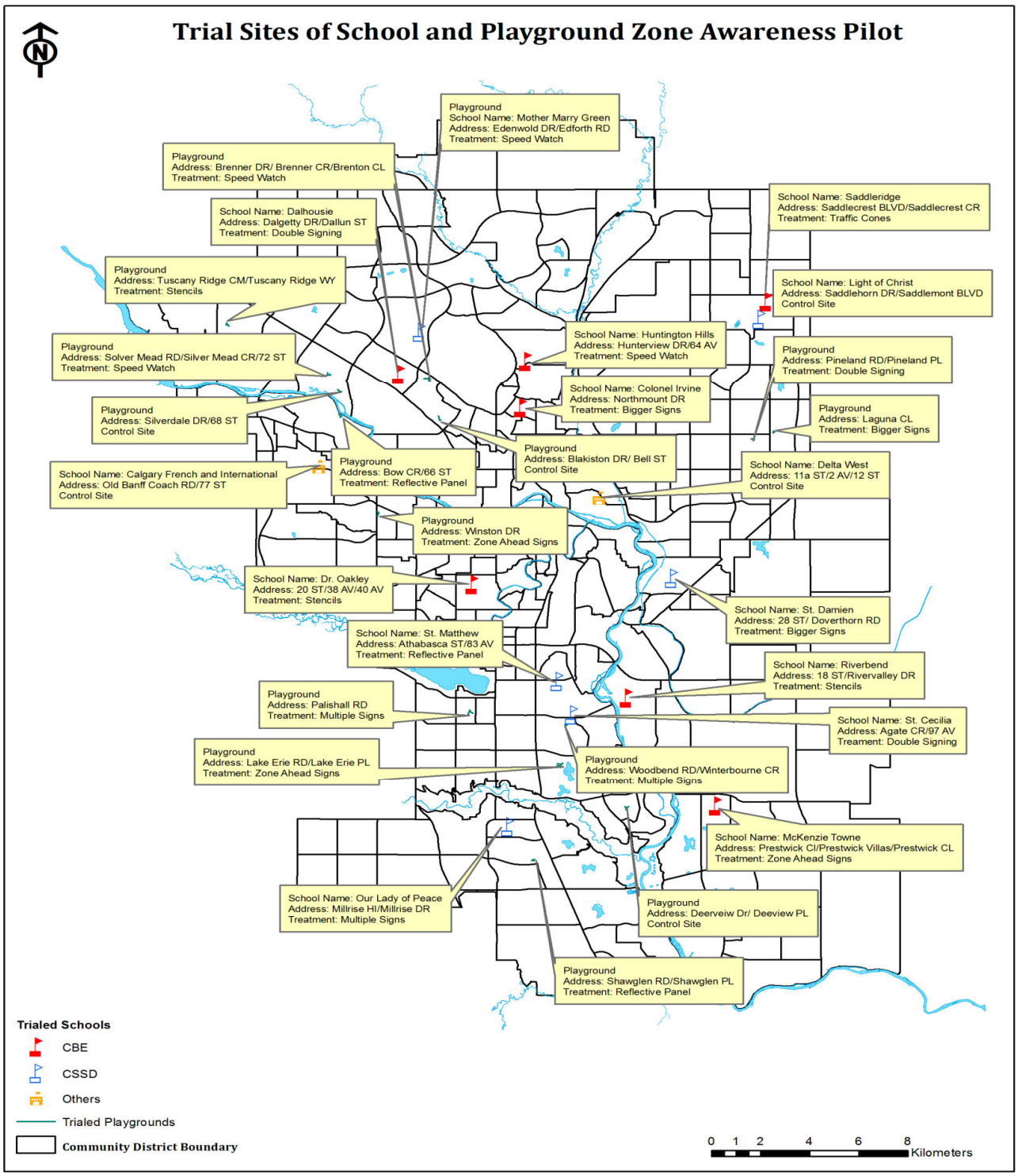

Figure 1 Trial Site Locations

2.2 Trial Timeline

The timeline for the pilot program was dependent on the availability of City crews to install trial measures and collect data, the availability of volunteers to conduct the neighbourhood speed watch program, and schools being in session. The pilot implementation timeline is presented in Table 2.

Table 2 Playground and School Zone Awareness Pilot Project Timeline

Time	Activity
Aug. 2013	Collect before speed data in playground zones
Sep. 2013	Collect before speed data in school zones
Oct. 2013 to Mar. 2014	Plan and implement five treatment measures*
Feb. 2014	Collect after speed data in zones with traffic cones
May 2014	Collect after speed data in zones with five treatment measures*
May to Jun. 2014	Implement neighbourhood speed watch program and data collection
Aug. 2014	Plan and implement road markings
Sep. 2014	Collect speed data in zones with road markings
Oct. 2014	Driver intercept surveys

* The five treatment measures included double signs, larger signs, multiple signs, zone ahead signs, and reflective tape

Most pre-treatment and post-treatment speed data were collected before the harmonized playground and school zone timing was effective, but a small sample of post-treatment data was collected after the zone timing changed. To screen out the potential impact on vehicle speeds made by driver unfamiliarity with the new zone timing, the school zone hours used for analyses were consistently from 7:30 to 17:00 and the playground zone hours used for analysis were from 8:30 to 21:00.

2.3 Playground and School Zone Pilot Project Costs

The material and installation costs associated with the pilot project are summarized in Table 3. Costs for data collection and evaluation are not included.

Table 3 Pilot Project Costs

Treatments	Material Costs	Labour Costs	Vehicle Costs	Total Costs
Cones[1]	$789	$130	$50	**$969**
Speed watch[2]	$1,143	$580	$80	**$1,803**
Reflective tape[3]	$1,183	$175	$39	**$1,397**
Double signing[4]	$960	$350	$39	**$1,349**
Larger signs[4,5]	$3,435	$350	$39	**$3,824**
Multiple signs[4]	$1,290	$350	$39	**$1,679**
Zone ahead signs[4]	$960	$350	$39	**$1,349**
Road markings[6]	$380	$350	$39	**$769**
Total	**$10,140**	**$2635**	**$364**	**$13,139**

Notes:

[1] 10 traffic cones were purchased from Alberta Traffic Supply, 12 spinning anemometers were purchased from Europe.

[2] 3 sandwich boards were produced; one radar speed gun and one external 12-volt battery were purchased.

[3] 12 reflective tape strips were purchased from Alberta Traffic Supply.

[4] 2.6 additional signs, on average were required per zone for each treatment.

[5] Due to the larger size standard sign production equipment could not be used and signs were made by hand.

[6] 2 stencil sheets with (1.2 m x 2.4 m) were produced for school zone markings, and 2 stencil sheets with the same size were produced for playground zone markings.

3.0 Effectiveness Evaluation Results and Analyses

3.1 Before and After Speed Studies for Each Treatment

Vehicle speeds were measured before and after the placement of each measure to allow comparison of differences in driver behaviour due to the presence of the measure. Comparison sites were also measured to indicate changes in driver behaviour during the same time period without any changes to the site (possibly due to education, enforcement, or seasonal factors). Six metrics were used to evaluate the effectiveness for each treatment:

- Average speed reduction
- 85th percentile speed reduction
- Percentage increase in vehicles with a speed equal to or less than 30 km/h
- Percentage decrease in vehicle with a speed between 31 km/h and 35 km/h
- Percentage decrease in vehicles with a speed between 36 km/h and 50 km/h
- Percentage decrease in vehicles with a speed greater than 50 km/h

The average speed refers to the central tendency of speed probability distribution (50^{th} percentile), while the 85^{th} percentile speed is the speed at which 85% of drivers are below and 15% are above. This speed is commonly used in engineering design processes.

The results of the metrics for each measure and additional details regarding sample sizes are summarized in Appendix A. Summaries of each measure are provided in the sections below.

In general, the small changes in speed or compliance observed indicated that the target audience for these measures (unaware but would comply) was relatively small. This finding suggested that current levels of traffic control near playground and school zones are appropriate for most conditions. Despite best efforts to select typical sites, there were some locations where initial compliance was found to be low. Measures were found to have larger effects when initial compliance was low, as compared to sites where compliance was initially high. A general finding regarding lane widths was that sites with narrower lane widths were found to have better initial compliance than sites with wider lanes. Similarly, local roads had higher levels of compliance initially than collector roadways.

3.1.1 Traffic Cones

This traffic cones with reflective spinning anemometers measure was only applied in school zones due to logistics of cone placement and removal during zone hours by school volunteers. Three school zones were initially identified for this treatment but two schools withdrew their participation due to a lack of volunteers to place and remove cones. In order to get more reliable evaluation results for this measure, two school sites that were previously included for the neighbourhood speed watch pilot treatment were also used for traffic cones. The before and after evaluation results are summarized in Table 4. The results suggest a consistent effectiveness of this measure in all zones. Although cones are considered to

be effective in increasing driver awareness since they are in a direct line of sight of drivers, this treatment has a few challenges for implementation:

- School staff or volunteer availability and willingness to place and remove cones, especially when school zone hours extend to 21:00.
- Cones placed on the centerline of the undivided roadway are easily damaged by vehicles such as gravel trucks or snow plows.
- Cones placed on the roads could be stolen (however none were during the pilot).

Table 4 Before/After Study for Traffic Cones During Zone Hours

Site & Direction	Avg. Speed Change (km/h)	85% Speed Change (km/h)	Compliant Driver Change	Non-compliant Drivers Change by Speed		
				31-35 km/h	36-50 km/h	>50 km/h
Site 1: Saddleridge Elementary School Zone: 2 data collection points results in 4 groups of data						
EB	-3	-1	+14%	-2%	-10%	-2%
WB	-2	-2	+9%	0%	-8%	-1%
NB	-3	0	+20%	-11%	-10%	+1%
SB	-2	-4	+11%	-9%	-3%	+1%
Site 2: Huntington Elementary School Zone: 1 data collection point with 2 groups of data						
EB	-3	-4	+23%	-10%	-12%	-1%
WB	-1	-1	+5%	0%	-4%	-1%
Site 3: Mother Mary Greene School Zones: 1 data collection point with 2 groups of data						
NB	-4	-6	+25%	-7%	-15%	-3%
SB	-2	-2	+12%	0%	-11%	-1%
Overall	**-2.50**	**-2.50**	**+5% to +25%**	**-11% to 0%**	**-15% to -3%**	**-3% to +1%**

3.1.2 Speed Watch

Volunteers were required to undertake this pilot treatment in two school zones and two playground zones. The portable radar guns, sandwich boards signs (Figure 2) and other equipment were provided to volunteers. This pilot treatment lasted two months and the volunteers at the speed watch zones were required to be "watching" one to two times in each two week cycle for at least 2 hours each session. Depending on volunteer willingness and volunteer numbers, the four zones completed between two to six sessions in the two month period. The volunteer schools ended up completing more speed watch sessions than the volunteer communities since schools had more parent volunteers.

The before and after studies indicated that the neighbourhood speed watch measure was effective at increasing driver awareness and lowering speeds at almost all sites except the southbound direction at the Mother Mary Greene school zone. Before and after evaluation results are summarized in Table 5. A possible explanation for this exception could be the downhill terrain of SB Edenwold Drive through the zone. Even though this measure seems successful for increased driver awareness, it required the participation of volunteers and this would limit the sustainability of the measure to locations where it is requested. The level of interest should be clearly understood before capital spending on equipment to support this measure is initiated. Furthermore, there may be a lower level of interest in conducting the speed watch during winter conditions.

Figure 2 Information Showing on Neighbourhood Speed Watch Sandwich Boards

Table 5 Before/After Study for Speed Watch During Zone Hours

Site & Direction	Avg. Speed Change (km/h)	85% Speed Change (km/h)	Compliant Driver Change	Non-compliant Drivers Change by Speed		
				31-35 km/h	36-50 km/h	>50 km/h
Site 2: Huntington Elementary School Zone: 1 data collection point with 2 groups of data						
EB	-3	-4	+19%	-8%	-9%	-2%
WB	-1	-1	+9%	-5%	-4%	0%
Site 3: Mother Mary Greene School Zones: 1 data collection point with 2 groups of data						
NB	-3	-4	+20%	-7%	-11%	-2%
SB	0	0	-3%	5%	-2%	0%
Site 4: Brenner Dr/Brenner Dr Playground: 1 data collection point with 2 groups of data						
EB	-3	-3	+16%	-5%	-11%	0%
WB	-2	0	+23%	-15%	-8%	0%
Site 5: Silver Mead Rd/72 St Playground: 1 data collection point with 2 groups of data						
EB	-6	-4	+37%	-16%	-20%	-1%
WB	-4	-3	+31%	-10%	-18%	-3%
Overall	**-2.75**	**-2.50**	**-3% to +37%**	**-16% to +5%**	**-20% to -2%**	**-3% to 0%**

3.1.3 Reflective Tape

Fluorescent retro-reflective tape attached to sign poles was intended to make existing signs more visible to drivers. However, the results below indicate this treatment had no obvious effect in increasing driver awareness. This treatment may make the signs more visible in dark but may be less effective during daylight hours. Moreover, there is no restriction to park vehicles close to many of playground and school zone signs, and the reflective tape may be obstructed by parked vehicles; this may limit the effectiveness of the measure. Before and after evaluation results are summarized in Table 6.

Table 6 Before/After Study for Reflective Tape During Zone Hours

Site & Direction	Avg. Speed Change (km/h)	85% Speed Change (km/h)	Compliant Driver Change	Non-compliant Drivers Change by Speed		
				31-35 km/h	36-50 km/h	>50 km/h
Site 6: St. Matthew Elementary & Jr. High School Zone: 1 data collection point with 2 groups of data						
EB	0	0	+2%	+5%	-6%	-1%
WB	0	-5	+1%	+6%	-7%	0%
Site 7: Shawglen Rd/Shawglen Pl Playground: 1 data collection point with 2 groups of data						
EB	+2	+2	-5%	+4%	+1%	0%
WB	+1	+4	0%	-10%	+10%	0%
Site8: Bow Cr/66 St Playground: 1 data collection point with 2 groups of data						
EB	-1	-1	+5%	+1%	-4%	-2%
WB	-1	-1	+2%	+5%	-7%	0%
Overall	**+0.17**	**-0.17**	**-5% to +5%**	**-10% to +6%**	**-7% to +10%**	**-2% to 0%**

3.1.4 Double Signing

Double signing involved installation of an additional start of zone sign on the left side of the roadway at the beginning of either the playground or school zone. Logically, double signing should be most effective to increase driver awareness in the two situations: (1) either sign was blocked by trees or parked vehicles; and (2) if there were drivers turning right into the zone and the zone starts near an intersection or a curve, the additional sign on the left side of the roadway will be more visible to drivers, which may increase driver awareness of entering the zone. For zones where the existing signs are clearly visible to drivers this measure may be redundant. A good example in practice to support this rationale is the Pineland Rd./ Pineland Pl. playground double signing (see Figure 3). The before and after evaluation results are summarized in Table 7.

Figure 3 Before and After Double Signs for Pineland Rd PGZ SB

Table 7 Before/After Study for Double Signing During Zone Hours

Site & Direction	Avg. Speed Change (km/h)	85% Speed Change (km/h)	Compliant Driver Change	Non-compliant Drivers Change by Speed		
				31-35 km/h	36-50 km/h	>50 km/h
Site 9: Dalhousie Elementary School Zone: 1 data collection point with 2 groups of data						
EB	0	+1	0%	+3%	-3%	0%
WB	-1	0	+19%	-7%	-11%	-1%
Site 10: Ecole St. Cecilia Elementary School Zone: 2 data collection points with 4 groups of data						
NB	0	-1	-1%	+4%	-3%	0%
SB	-1	0	-2%	+1%	+1%	0%
NB	+2	0	-5%	+4%	+1%	0%
SB	-1	-1	+4%	-4%	+1%	-1%
Site 11: Pineland Rd/Pineland Pl Playground: 1 data collection point with 2 groups of data						
NB	-4	-5	+27%	-2%	-24%	-1%
SB	-7	-3	+40%	-17%	-21%	-2%
Overall	**-1.50**	**-1.13**	**-5% to +40%**	**-17% to +4%**	**-24% to +1%**	**-2% to 0%**

3.1.5 Larger Signs

The size of a standard playground and school zone sign is 75x120 cm, the size of the larger sign is 90x135 cm, 30% larger than the standard sign. Although the overall effectiveness of this measure is lower than neighbourhood speed watch, traffic cones, and double signing, the effect was consistent in two of three trial sites. The before and after evaluation results are summarized in Table 8.

Table 8 Before/After Study for Larger Signs During Zone Hours

Site & Direction	Avg. Speed Change (km/h)	85% Speed Change (km/h)	Compliant Drivers Change	Non-compliant Drivers Change by Speed		
				31-35 km/h	36-50 km/h	>50 km/h
Site 12: Highwood Elementary School Zone: 2 data collection points with 4 groups of data						
NB	-1	-1	+13%	-3%	-8%	-2%
SB	-1	0	+10%	-3%	-7%	0%
EB	-1	-2	+1%	+5%	-5%	-1%
WB	-1	-2	+12%	-6%	-6%	0%
Site 13: Blessed Damien Elementary School Zone: 1 data collection point with 2 groups of data						
NB	-1	-5	+16%	+1%	-14%	-3%
SB	-3	-2	+7%	+1%	-8%	0%
Site 14: Laguna Cl Playground: 2 data collection points with 4 groups of data						
NB	-2	+1	+12%	-12%	0%	0%
SB	+3	+3	-19%	+13%	+6%	0%
NB	+4	+7	-25%	+15%	+10%	0%
SB	-1	0	+2%	-4%	+2%	0%
Overall	**-0.40**	**-0.10**	**-25% to +16%**	**-12% to +15%**	**-14% to +10%**	**-3% to 0%**

3.1.6 Multiple Signs

Based on the results of different trial sites, multiple signs show some overall effectiveness, but with inconsistency among the trial sites. The findings suggest that multiple signs may be more effective on a straight and long zone (e.g. Our Lady of Peace Elementary and Jr. High School Zone SB) than on curves or in shorter zones (e.g. Woodbend Rd/Winterbourne Cr. NB and SB). Similar to the measure of double signing, if the original sign at the start of the zone is visible for drivers, this measure appears to have a limited effect. The before and after evaluation results are summarized in Table 9.

Table 9 Before/After Study for Multiple Signs During Zone Hours

Site & Direction	Avg. Speed Change (km/h)	85% Speed Change (km/h)	Compliant Drivers Change	Non-compliant Drivers Change by Speed		
				31-35 km/h	36-50 km/h	>50 km/h
Site 15: Our Lady of Peace Elementary and Jr. High School Zone: 1 data collection point with 2 groups of data						
EB	0	-1	-3%	+4%	+1%	-2%
WB	+1	+1	-7%	0%	+7%	0%
NB	0	+2	-4%	0%	+3%	+1%
SB	-3	-3	+17%	-8%	-9%	0%
Site 16: Woodbend Rd/Winterbourne Cr Playground: 1 data collection point with 2 groups of data						
NB	+2	+1	-1%	+1%	0%	0%
SB	+2	+3	-7%	-2%	+9%	0%
Site 17: Palishall Rd Playground: 1 data collection points with 2 groups of data						
NB	-4	-2	+26%	+2%	-30%	+2%
SB	-2	-2	+24%	-6%	-18%	0%
EB	-2	-2	-7%	+14%	-7%	0%
WB	+3	+1	+1%	+2%	-3%	0%
Overall	**-0.30**	**-0.20**	**-7% to +26%**	**-8% to +14%**	**-30% to +9%**	**-2% to +2%**

3.1.7 Zone Ahead Signs

The intention of the 'zone ahead' signs was to warn drivers they were approaching a lower speed limit zone. However, at sites where this measure was implemented the average speed increased by 0.83 km/h, and the percentage of vehicles complying with the speed limit decreased by 2%. A possible explanation for this finding is that drivers who were unfamiliar with the 'zone ahead' signs may have misinterpreted the sign as a zone start sign, and begin driving at 30 km/h. This misunderstanding would result in an unusually long zone, which could lead to decreased compliance. When these drivers came into the actual zone, their speeds may have increased above 30 km/hr. The before and after evaluation results are summarized in Table 10.

Table 10 Before/After Study for Zone Ahead Signs During Zone Hours

Site & Direction	Avg. Speed Change (km/h)	85% Speed Change (km/h)	Compliant Driver Change	Non-compliant Drivers Change by Speed		
				31-35 km/h	36-50 km/h	>50 km/h
Site 18: Mckenzie Towne School Zone: 1 data collection point with 2 groups of data						
EB	0	-1	+3%	+2%	-5%	0%
WB	0	0	-2%	0%	+2%	0%
Site 19: Lake Erie Rd/Lake Erie Pl Playground: 1 data collection point with 2 groups of data						
NB	0	0	-6%	+8%	-3%	+1%
SB	+1	+1	-4%	-1%	+4%	+1%
Site 20: Winston Dr Playground: 1 data collection point with 2 groups of data						
NB	+2	0	-9%	+1%	+9%	-1%
SB	+2	-1	+4%	-8%	+7%	-3%
Overall	**+0.83**	**-0.17**	**-9% to +4%**	**-8% to +8%**	**-5% to +9%**	**-3% to +1%**

3.1.8 Road Markings

Road markings were placed in the middle of the travel lane, 10 m downstream from the start of the zone. Appendix B shows the dimensions of playground and school road markings and Table 11 shows the evaluation results. Similar to traffic cones, the road markings are located in the primary view of a driver. However, because they are painted on the surface of the roadway road markings placed on a downhill grade may be less visible than those placed on an uphill road. More importantly, Calgary has a long winter and the roads could be covered by snows or slush during this period, in which case road markings would not be visible to drivers. Furthermore, the results indicated that road markings placed on the road surface near an intersection may be less visible for drivers who turn into the zone.

Table 11 Before/After Study for Road Markings During Zone Hours

Site & Direction	Avg. Speed Change (km/h)	85% Speed Change (km/h)	Compliant Driver Change	Non-compliant Drivers Change by Speed		
				31-35 km/h	36-50 km/h	>50 km/h
Site 21: Riverbend Elementary School Zone: 1 data collection point with 2 groups of data						
EB	0	-3	-4%	+7%	-1%	-2%
WB	-4	-10	+6%	+19%	-17%	-8%
Site 22: Dr. Oakley School Zone: 3 data collection points with 6 groups of data						
EB	0	+1	-1%	-1%	+5%	-3%
WB	0	-2	+7%	-2%	-3%	-2%
EB	-1	-3	+4%	+3%	-5%	-2%
WB	-3	-3	+15%	-6%	-10%	+1%
NB	0	-1	-2%	+2%	+1%	-1%
SB	+1	-3	+5%	+5%	-9%	-1%
Site 23: Tuscany Ridge Cm/Tuscany Ridge Wy Playground: 1 data collection point with 2 groups of data						
NB	+1	0	-1%	-3%	+4%	0%
SB	-2	-8	+13%	+1%	-13%	-1%
Overall	**-1.00**	**-3.20**	**-4% to +15%**	**-6% to +19%**	**-17% to +5%**	**-8% to +1%**

3.1.9 Comparison Sites - No Change

The purposes of using comparison sites in the pilot was to evaluate time trend effects due to external factors such as awareness campaigns, enforcement activities, or seasonal effects on speed. The results presented in Table 12 indicate that speeds in 5 of 6 comparison sites decreased without any physical changes to the sites. From this perspective, it appears that compliance in playground and school zones may have improved during the evaluation period due to education, awareness, and enforcement campaigns related to the harmonization of playground and school zone times. The before and after evaluation results are summarized in Table 12.

Table 12 Before/After Study of Comparison Sites During Zone Hours

Site & Direction	Avg. Speed Change (km/h)	85% Speed Change (km/h)	Compliant Driver Change	Non-compliant Drivers Change by Speed		
				31-35 km/h	36-50 km/h	>50 km/h
Site 24: Delta West Academy School Zone: 2 data collection point2 with 4 groups of data						
NB	-1	-2	+13%	-8%	-5%	0%
SB	-3	-6	+22%	-10%	-11%	-1%
EB	-1	-4	+13%	-5%	-6%	-2%
WB	-2	-4	+14%	-3%	-11%	0%
Site 25: Calgary French & International School Zone: 1 data collection point with 2 groups of data						
NB	+1	0	-4%	+3%	+1%	0%
SB	+1	0	-2%	+1%	+2%	-1%
Site 26: Light of Christ Elementary & Jr. High School Zone: 1 data collection point with 2 groups of data						
EB	-1	0	+7%	-3%	-3%	-1%
WB	-1	0	+5%	-3%	-2%	0%
Site 27: Blakiston Dr/Bell St Playground: 1 data collection point with 2 groups of data						
EB	-3	-1	+15%	-2%	-12%	-1%
WB	-4	-5	+25%	+5%	-31%	+1%
Site 28: Deerview Dr/Deerview Pl Playground: 1 data collection point with 2 groups of data						
NB	+1	+2	+4%	-7%	-1%	+4%
SB	-1	-5	+3%	+15%	-17%	-1%
Site 29: Silverdale Dr/68 St Playground: 1 data collection point with 2 groups of data						
EB	-1	-1	+8%	+4%	-13%	+1%
WB	-1	-3	+9%	+10%	-16%	-3%
Overall	**-1.14**	**-2.07**	**-4% to +25%**	**-10% to +15%**	**-31% to +2%**	**-3% to +4%**

3.2 Speed Evaluation & Ranking Summary

The average values of evaluation speed metrics for each measure are summarized in Table 13. Measures are ranked based on the increase in driver compliance (1 being best to 8 being worst).

Table 13 Overall Evaluation of Treatment Effectiveness

Measure	Rank	Avg. Speed change (km/h)	85% Speed change (km/h)	Compliant Driver Change	Non-compliant Drivers Change by Speed		
					31-35 km/h	36-50 km/h	>50 km/h
Speed watch	1	-2.75	-2.50	19%	-8%	-10%	-1%
Cones	2	-2.50	-2.50	15%	-5%	-9%	-1%
Double signing	3	-1.50	-1.13	10%	-2%	-7%	-1%
Do Nothing	-	-1.14	-2.07	9%	0%	-9%	0%
Road markings	4	-1.00	-3.20	4%	3%	-5%	-2%
Multiple signs	5	-0.30	-0.20	4%	1%	-5%	0%
Bigger signs	6	-0.40	-0.10	3%	1%	-3%	-1%
Reflective tape	7	0.17	-0.17	1%	2%	-2%	-1%
Ahead signs	8	0.83	-0.17	-2%	0%	2%	0%

The speed metrics suggest that the neighbourhood speed watch program, traffic cones, double signing and road markings are the four most effective measures and that the other measures had a negligible effect on driver awareness or had a negative impact (i.e. increased speeds).

With the exception of reflective tape and zone ahead signs, all measures resulted in lower average speeds, with the neighbourhood speed watch program and traffic cones being the most effective. The 85th percentile speeds were also reduced by all measures, and the most effective three measures in light of this criterion include speed watch, traffic cones, and road markings.

According to the increases in compliance, the most effective three measures were the speed watch, traffic cones, and double signing, with increases in compliance of 19%, 15%, and 10%, respectively. Other measures increased compliance as well, with the exception of zone ahead signs which decreased compliance. There were consistent but small reductions in the percentage of drivers exceeding 50 km/h which indicates that many of these drivers likely belong to the group of drivers that are aware but non-compliant.

3.3 Driver Intercept Survey

The driver intercept survey was completed to understand if drivers observed the enhancement measures, if the measures assisted drivers in identifying the zone, and if drivers changed their speed accordingly after identifying the zone. The response to the speed change question is a self reported behaviour and may not accurately represent actual behaviour, but rather intent. The four most effective measures identified from the before and after speed studies were included in the survey.

The media education on the new playground and school zone times had been underway since approved by City Council in July 2013 and police enforcement related to the new zone timing started in September. One open ended question was asked to determine the level of knowledge regarding playground and school zone times of the respondents. The four questions in the survey are listed below:

- Did you see the (cones/speed watch/double signs/road markings)? Yes □ No □
- Did you identify the (Playground/ School) zone? Yes □ No □
- Did you change your speed after identifying the zone? Yes □ No □
- What is the current school/playground zone timing?

The survey was conducted in October 2014 with support from the Calgary Police Service. Motorists driving through three zones with each of the four traffic measures were randomly selected to answer the survey during zone hours. A total of 212 surveys were completed and the results are summarized in Table 14.

Table 14 Driver Intercept Survey Results

	Did you see the measure?		Did you identify the zone?		Did you change your speed?		Current zone time?		# of Survey
	YES	NO	YES	NO	YES	NO	Correct	Incorrect	
Traffic Cones	78 (96.3%)	3 (3.7%)	81 (100%)	0 (0%)	81 (100%)	0 (0%)	43 (53.1%)	38 (46.9%)	81
Speed watch	53 (72.6%)	20 (27.4%)	72 (98.6%)	1 (1.4%)	72 (98.6%)	1 (1.4%)	28 (38.4%)	45 (61.6%)	73
Double signing	20 (34.5%)	38 (65.5%)	58 (100%)	0 (0%)	58 (100%)	0 (0%)	20 (34.5%)	38 (65.5%)	58
Road Markings	102 (68.5%)	47 (31.5%)	148 (99.3%)	1 (0.7%)	148 (99.3%)	1 (0.7%)	69 (46.3%)	80 (53.7%)	149
Total	-	-	-	-	-	-	**91 (42.9%)**	**121 (57.1%)**	**212**

The survey results indicated that that traffic cones were reported as the most visible measure to attract driver attention (noticed by 96.3% of drivers) followed by the speed watch program and road markings (noticed by 72.6% and 68.5% of drivers, respectively). The least visible measure was double signs; only 34.5% of drivers noted this measure in the investigated zone. Almost 100% of drivers said that they realized they were entering a playground or school zone and reduced their speed after identifying the zone.

Among 212 respondent drivers, 42.9% (91) knew the correct zone timing and 57.1% (121) gave incorrect zone hours; this indicated room for improvement.

In the 121 incorrect answers, only 4 drivers thought the school zone and playground zone had separate zone hours, and the other 117 drivers knew that playground and school zone hours had been harmonized. The investigated start and end times are shown in Figure 4. The survey results show a preliminary success in new zone timing awareness after over 2 months' education and enforcement activities, however, there is still room for improvement with education and enforcement.

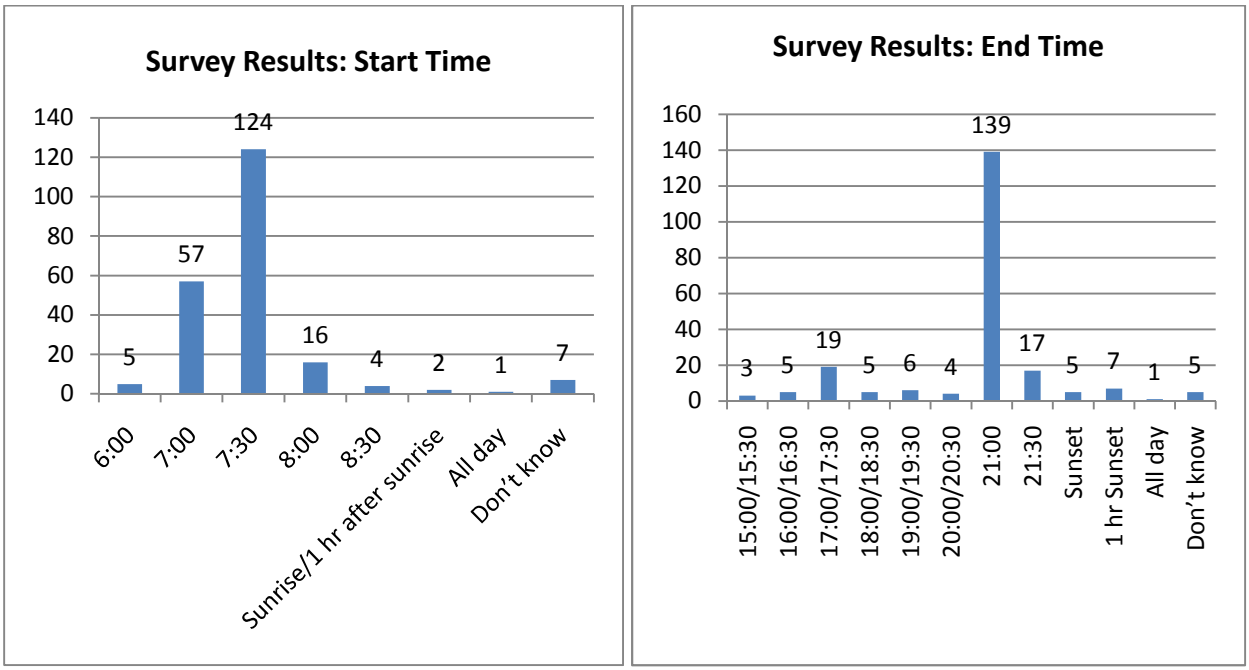

Figure 4 Start/End Times of Driver Intercept Survey

4.0 Benefit-Cost Analysis

Benefit-cost analysis was conducted to evaluate the economic effectiveness of each treatment. The cost of each treatment was based on the capital costs spending on the pilot project. The benefit was calculated as the societal cost of reduced pedestrian fatal and injury collisions based on speed reduction. The following assumptions were made for the analysis:

- The collision cost used here is the Willingness-to-pay Costs + Direct Collision Costs by severity type of collision for the Capital Region in CRISP report (de Leur, 2010):
  - Fatal Collision: $ 5,543,800
  - Injury Collision: $ 134,600
  - PDO Collision: $ 10,900
- The average traffic volume per playground or school zone during zone hours was 1,356 vehicles, based on the traffic volume in all trial sites.
- In Calgary, there were 3,973 collisions in playground and school zones during zone hours from 2008 to 2012 (see Table 15).

Table 15 Collision Data (2008-2012) in Playground and School Zones during Zone Hours

	Fatal Collisions	Injury Collisions	PDO Collisions	Grand total
PGZ	1	135	3059	3195
SZ	0	45	733	778
Total	**1**	**180**	**3792**	**3973**

Therefore, the city-wide collision rates in school/playground zone during zone hours are estimated as:

- Fatal collision: 0.0003/million vehicles entering
- Injury collision: 0.0582/ million vehicles entering
- PDO collision: 1.2258/ million vehicles entering

- Nilsson's power function (Nilsson, 2004) is used to assume the relationship between speed and collision rate, which means: 1% decrease in speed approximately results in:
  - 2% decrease in injury collision rate
  - 3% decrease in severe injury collision rate
  - 4% decrease in fatal collision rate
- The number of effective days to operate each measure per year is assumed:
  - Reflective tape, double signs, larger signs, multiple signs, and zone ahead signs: 365 days/year
  - Traffic cones: 200 days/year (only school days)
  - Speed watch: 12 days/year (one session every two weeks in a total of six months per year)
  - Road markings: 270 days/year (not effective in snow weather)
- A five-year service period was assumed, benefits and costs are expressed in net present value.
- The effectiveness of each treatment is assumed to be consistent on a five-year period base.

The B/C analysis results are summarized in table 16.

Table 16 Benefit-Cost Analysis Results

Treatments	Capital Cost $	Operational Costs $	Change in Average Speed %	Reduced Fatal Collision #	Reduced Injury Collision #	Reduced PDO Collision #	Total Benefit $	B/C ratio
Traffic Cones	969	795	-8%	0.0004	0.0568	0.7979	18677	10.59
Speed watch	1803	200	-8%	0.0000	0.0034	0.0479	1121	0.56
Reflective tape	1397	80	1%	-0.0001	-0.0130	-0.1820	-4261	-2.88
Double signs	1349	80	-5%	0.0005	0.0648	0.9101	21303	14.91
Larger signs	3824	80	-1%	0.0001	0.0130	0.1820	4261	1.09
Multiple signs	1679	80	0%	0.0000	0.0000	0.0000	0	0.00
Zone ahead signs	1349	80	3%	-0.0003	-0.0389	-0.5460	-12782	-8.94
Road markings	769	320	-3%	0.0002	0.0288	0.4039	9455	8.68

The benefit-cost analysis shows that double signing and traffic cones are the two measures with the highest B/C ratios of 14.91 and 10.59, respectively, which are conditionally suggested. Although the speed watch is the most effective measure considering driver speeds it has low benefit due to infrequent operations resulting in a low B/C ratio of 0.56.

5.0 Conclusions

The small changes in speed and compliance observed indicate that current levels of traffic control at playground and school zones are appropriate for most conditions. Furthermore, the measures included in the pilot were found to have larger effects when initial compliance was low, as compared to sites where compliance was initially high (i.e. diminishing returns). For these reasons, there was no measure for which there was a clear benefit to network wide standard application for all playground and school zones. When volunteers are willing to actively manage the use of traffic cones and be visible while doing the speed watch (with support from Calgary Police Service), the largest effects in raising awareness of the playground and school zones were observed.

5.1 Conclusions

Traffic Cones with Spinning Anemometers

In the trial zones with traffic cones, the speed compliance rate increased by 15% and the average speed reduced by 2.50 km/h, on average. This measure ranks second in the effectiveness of increasing driver awareness and its Benefit-Cost (B/C) ratio is 10.59, also ranking second of all treatments based on a five year period estimation. The largest challenge to implementation of this treatment on a city-wide basis is the willingness of school staff/volunteers to place and remove the cones. In this pilot, two of three schools withdrew from the treatment trial, which implies schools may have difficulty finding volunteers to consistently and punctually place and remove cones, especially since the new zone timing started.

The willingness of Calgary Board of Education and Calgary Catholic School District staff to undertake the placement and removal of cones will need to be investigated. This measure will be suggested only if the investigation shows positive results. Also, the material of the spinning anemometer on the top of cones should be reconsidered because the hard plastic material currently used is easily damaged.

Neighbourhood Speed Watch

In the trial zones with the neighbourhood speed watch program, the speed compliance rate increased by 19% and the average speed reduced by 2.75 km/h. These evaluation results indicate this treatment is the most effective for increasing driver awareness. However, due to the limitation on frequent operation, this measure was found to be much less effective in terms of benefit-cost analysis.

A city-wide implementation of speed watch is not practical or suggested at this time for city wide application. However, a few sets of speed watch equipment may be purchased and distributed to the communities or schools which are willing to do this program. The procedure for signing out speed watch equipment and performing the speed watch properly would need to be developed.

Double Signing and Road Markings

Double signing and road markings are two measures with lower effectiveness in improving driver awareness as compared to the neighbourhood speed watch and traffic cones. Statistics show that the compliance rate increased by 10% and the average speed reduced by 1.50 km/h at double signing treatment sites; and the average speed compliance rate increased by 4% and the average speed reduced by 1.00 km/h at road marking treatment sites. Double signs had the highest estimated B/C ratio of 14.91 and road markings had the third highest B/C ratio of 8.68.

The double signs and road markings could be potentially considered as supplemental measures in playground and school zones based on the above evaluations. However, the pilot experience suggests that the greatest benefit from double signs or road markings would be expected where initial compliance in low, and especially where geometric conditions are favourable. For example, the double signs are suggested where the sign on the right side of roadway may be difficult for drivers to see. Similarly, road markings will be more visible if they are used on sag curves (bottom of hills) or level terrain rather than on crest curves (tops of hills).

Larger Signs, Multiple Signs, and Reflective Tape

Larger signs, multiple signs and reflective tape showed some improvement in driver awareness but to a lower degree than the other measures. Since the related increases in awareness appear to be low and B/C ratios are below 1, the implementation of these measures on a city-wide basis is not suggested.

Zone Ahead Signs

The use of zone ahead signs was the only measure which suggested a negative impact on driver behaviour when entering playground or school zones: a 2% decrease in speed compliance and a 0.83 km/h increase in average speed was observed. Two potential safety risks are: 1) without education, drivers may confuse the zone ahead signs with the zone start signage; 2) a longer playground or school zone is more likely to result in higher speeds through the zone.

6.0 Closure

This report has been prepared by Vicki Wei, M.A..Sc., Traffic Technician and A.E. (Tony) Churchill, M.Sc., P.Eng., Leader of Traffic Safety.

The report was prepared based with contributions from:

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- Greg Iwaskow, P. Eng., Sr. Traffic Leader, Roads, City of Calgary
- Joanna Domarad, P. Eng., Traffic Engineer, Roads, City of Calgary
- Transportation Data Division, Transportation Planning, City of Calgary
- Volunteering schools and communities, including:
    - Huntington Hills Elementary School
    - Mother Mary Greene School
    - Saddleridge Elementary School
    - Silver Springs Community Association
    - Brentwood Community Association

References

de Leur. P., 2010. Collision cost study, Capital Region Intersection Safety Partnership, Edmonton, http://drivetolive.ca/wp-content/uploads/2014/02/Collision_Cost_Study_Final_Report_Feb_2010.pdf

Miller, J. & Iwaskow, G., 2013. Playground/School zones safety: A preliminary review of measures to increase driver awareness of entering playground and school zones, City of Calgary, Calgary, http://www.calgary.ca/Transportation/Roads/Documents/Traffic/Traffic-safety-programs/School-Zones-Report.pdf?noredirect=1

Nilsson, G., 2004. Traffic safety dimensions and the power model to describe the effects of speed on safety. Bulletin 221, Lund Institute of Technology, Lund

Appendix A Before and After Speed and Compliance

Table A1: Speed and Compliance Summary by Measure and Site

Site and Direction	Average Speed km/h		85 Percentile Speed km/h		Compliant Drivers	
	Before	**After**	**Before**	**After**	**Before**	**After**
Traffic Cones						
Site 1: Saddleridge Elementary School Zone: 4 groups of data, with 4324 speed measures						
EB	35	32	42	41	28%	42%
WB	33	31	41	39	37%	46%
NB	29	26	34	34	57%	77%
SB	28	26	37	33	67%	78%
Site 2: Huntington Elementary School Zone: 2 groups of data, with 15597 speed measures						
EB	33	30	40	36	36%	59%
WB	33	32	37	36	35%	42%
Site 3: Mother Mary Greene School Zones: 2 groups of data, with 2467 speed measures						
NB	33	29	41	35	41%	66%
SB	31	29	37	35	50%	62%
Overall Average	**32**	**29**	**39**	**26**	**44%**	**59%**
Speed Watch						
Site 2: Huntington Elementary School Zone: 2 groups of data, with 16297 speed measures						
EB	33	30	40	36	36%	55%
WB	33	32	37	36	35%	44%
Site 3: Mother Mary Greene School Zone: 2 groups of data, with 2504 speed measures						
NB	33	30	41	37	41%	61%
SB	31	31	37	37	50%	47%
Site 4: Brenner Dr/Brenner Dr Playground: 2 groups of data, with 1657 speed measures						
EB	34	31	41	38	32%	48%
WB	34	32	41	41	28%	51%
Site 5: Silver Mead Rd/72 St Playground: 2 groups of data, with 996 speed measures						
EB	34	28	38	33	33%	70%
WB	35	31	40	37	22%	53%
Overall Average	**33**	**31**	**39**	**37**	**54%**	**35%**
Reflective Tape						
Site 6: St. Matthew Elementary & Jr. High School Zone: 2 groups of data, with 1398 speed measures						
EB	31	31	39	39	50%	52%
WB	28	28	38	33	66%	67%
Site 7: Shawglen Rd/Shawglen Pl Playground: 2 groups of data, with 333 speed measures						
EB	26	28	34	36	75%	70%
WB	27	28	33	37	64%	64%
Site 8: Bow Cr/66 St Playground: 2 groups of data, with 1470 speed measures						
EB	35	34	41	40	27%	32%
WB	33	32	40	39	40%	42%
Overall Average	**30**	**30**	**38**	**37**	**54%**	**55%**

Table A2: Speed and Compliance Summary by Measure and Site

Site and Direction	Average Speed km/h		85 Percentile Speed km/h		Compliant Drivers	
	Before	**After**	**Before**	**After**	**Before**	**After**
Traffic Cones						
Site 1: Saddleridge Elementary School Zone: 4 groups of data, with 4324 speed measures						
EB	35	32	42	41	28%	42%
WB	33	31	41	39	37%	46%
NB	29	26	34	34	57%	77%
SB	28	26	37	33	67%	78%
Site 2: Huntington Elementary School Zone: 2 groups of data, with 15597 speed measures						
EB	33	30	40	36	36%	59%
WB	33	32	37	36	35%	42%
Site 3: Mother Mary Greene School Zones: 2 groups of data, with 2467 speed measures						
NB	33	29	41	35	41%	66%
SB	31	29	37	35	50%	62%
Overall Average	**32**	**29**	**39**	**26**	**44%**	**59%**
Speed Watch						
Site 2: Huntington Elementary School Zone: 2 groups of data, with 16297 speed measures						
EB	33	30	40	36	36%	55%
WB	33	32	37	36	35%	44%
Site 3: Mother Mary Greene School Zone: 2 groups of data, with 2504 speed measures						
NB	33	30	41	37	41%	61%
SB	31	31	37	37	50%	47%
Site 4: Brenner Dr/Brenner Dr Playground: 2 groups of data, with 1657 speed measures						
EB	34	31	41	38	32%	48%
WB	34	32	41	41	28%	51%
Site 5: Silver Mead Rd/72 St Playground: 2 groups of data, with 996 speed measures						
EB	34	28	38	33	33%	70%
WB	35	31	40	37	22%	53%
Overall Average	**33**	**31**	**39**	**37**	**54%**	**35%**
Reflective Tape						
Site 6: St. Matthew Elementary & Jr. High School Zone: 2 groups of data, with 1398 speed measures						
EB	31	31	39	39	50%	52%
WB	28	28	38	33	66%	67%
Site 7: Shawglen Rd/Shawglen Pl Playground: 2 groups of data, with 333 speed measures						
EB	26	28	34	36	75%	70%
WB	27	28	33	37	64%	64%
Site 8: Bow Cr/66 St Playground: 2 groups of data, with 1470 speed measures						
EB	35	34	41	40	27%	32%
WB	33	32	40	39	40%	42%
Overall Average	**30**	**30**	**38**	**37**	**54%**	**55%**

Table A3: Speed and Compliance Summary by Measure and Site

Site and Direction	Average Speed km/h		85 Percentile Speed km/h		Compliant Drivers	
	Before	**After**	**Before**	**After**	**Before**	**After**
Double Signs						
Site 9: Dalhousie Elementary School Zone: 2 groups of data, with 401 speed measures						
EB	25	25	32	33	81%	81%
WB	26	25	32	32	56%	75%
Site 10: Ecole St. Cecilia Elementary School Zone: 4 groups of data, with 1000 speed measures						
NB	24	24	33	32	77%	76%
SB	23	22	31	31	88%	86%
NB	26	28	37	37	74%	69%
SB	24	23	34	33	78%	82%
Site 11: Pineland Rd/Pineland Pl Playground: 2 groups of data, with 332 speed measures						
NB	34	30	42	37	33%	60%
SB	35	28	41	38	30%	70%
Overall Average	**27**	**26**	**35**	**34**	**65%**	**75%**
Bigger Signs						
Site 12: Highwood Elementary School Zone: 4 groups of data, with 7034 speed measures						
NB	35	34	42	41	18%	31%
SB	35	34	41	41	20%	30%
EB	28	27	35	33	68%	69%
WB	27	26	34	32	70%	82%
Site 13: Blessed Damien Elementary School Zone: 2 groups of data, with 1951 speed measures						
NB	36	33	45	40	22%	38%
SB	33	32	42	40	37%	44%
Site 14: Laguna Cl Playground: 4 groups of data, with 396 speed measures						
NB	27	25	31	32	72%	84%
SB	24	27	30	33	82%	63%
NB	23	27	26	33	92%	67%
SB	26	25	32	32	78%	80%
Overall Average	**29**	**29**	**36**	**36**	**56%**	**59%**
Multiple Signs						
Site 15: Our Lady of Peace Elementary and Jr. High School Zone: 2 groups of data, with 3826 speed measures						
EB	33	33	41	40	40%	37%
WB	31	32	40	41	50%	43%
NB	27	27	37	39	64%	60%
SB	30	27	40	37	49%	66%
Site 16: Woodbend Rd/Winterbourne Cr Playground: 2 groups of data, with 252 speed measures						
NB	23	25	31	32	91%	90%
SB	24	26	32	35	82%	75%
Site 17: Palishall Rd Playground: 2 groups of data, with 223 speed measures						
NB	31	27	40	38	48%	74%
SB	31	29	40	38	39%	63%
EB	27	25	34	32	80%	73%
WB	23	26	32	33	79%	80%
Overall Average	**28**	**28**	**37**	**37**	**62%**	**64%**

Table A4: Speed and Compliance Summary by Measure and Site

Site and Direction	Average Speed km/h		85 Percentile Speed km/h		Compliant Drivers	
	Before	**After**	**Before**	**After**	**Before**	**After**
Zone Ahead Signs						
Site 18: Mckenzie Towne School Zone: 2 groups of data, with 2882 speed measures						
EB	29	29	38	37	54%	57%
WB	30	30	38	38	55%	53%
Site 19: Lake Erie Rd/Lake Erie Pl Playground: 2 groups of data, with 1334 speed measures						
NB	33	33	40	40	39%	33%
SB	30	31	36	37	54%	50%
Site 20: Winston Dr Playground: 2 groups of data, with 185 speed measures						
NB	29	31	40	40	65%	56%
SB	28	30	40	39	55%	59%
Overall Average	**30**	**31**	**39**	**39**	**54%**	**51%**
Road Markings						
Site 21: Riverbend Elementary School Zone: 2 groups of data, with 4675 speed measures						
EB	35	35	44	41	29%	25%
WB	36	32	47	37	41%	47%
Site 22: Dr. Oakley School Zone: 6 groups of data, with 7757 speed measures						
EB	35	35	42	43	27%	26%
WB	33	33	43	41	40%	47%
EB	36	35	45	42	26%	30%
WB	36	33	44	41	23%	38%
NB	32	32	39	38	45%	43%
SB	35	34	42	39	20%	25%
Site 23: Tuscany Ridge Cm/Tuscany Ridge Wy Playground: 2 groups of data, with 188 speed measures						
NB	28	29	36	36	67%	66%
SB	31	29	41	33	54%	67%
Overall Average	**34**	**33**	**42**	**39**	**37%**	**42%**

Table A5: Speed and Compliance Summary by Measure and Site

Site and Direction	Average Speed km/h		85 Percentile Speed km/h		Compliant Drivers	
	Before	**After**	**Before**	**After**	**Before**	**After**
Comparison Sites						
Site 24: Delta West Academy School Zone: 4 groups of data, with 679 speed measures						
NB	28	27	36	34	60%	73%
SB	28	25	38	32	61%	83%
EB	29	28	37	33	60%	73%
WB	27	25	35	31	72%	86%
Site 25: Calgary French & International School Zone: 2 groups of data, with 5575 speed measures						
NB	30	31	39	39	54%	50%
SB	35	36	44	44	26%	24%
Site 26: Light of Christ Elementary & Jr. High School Zone: 2 groups of data, with 5865 speed measures						
EB	34	33	41	41	30%	37%
WB	32	31	40	40	42%	47%
Site 27: Blakiston Dr/Bell St Playground: 2 groups of data, with 370 speed measures						
EB	35	32	41	40	26%	41%
WB	35	31	42	37	28%	53%
Site 28: Deerview Dr/Deerview Pl Playground: 2 groups of data, with 1293 speed measures						
NB	30	31	38	40	51%	55%
SB	33	32	42	37	40%	43%
Site 29: Silverdale Dr/68 St Playground: 2 groups of data, with 932 speed measures						
EB	33	32	40	39	36%	44%
WB	31	30	39	36	45%	54%
Overall	**31**	**30**	**39**	**37**	**45%**	**55%**

Table A6: Compliance Changes by Measure and Initial Compliance

Initial Compliance / Change of Compliance	Comparison Sites	Speed Watch	Traffic Cones	Double Signs	Road Markings	Larger Signs	Multiple Signs	Reflective Tape	Zone Ahead Signs	Grand Total
<=40%	**6**	**6**	**4**	**2**	**6**	**4**	**2**	**2**	**1**	**33**
-25%-0%	1	0	0	0	2	0	1	0	1	**5**
1%-20%	4	3	3	0	4	4	0	2	0	**20**
21%-40%	1	3	1	2	0	0	1	0	0	**8**
41%-70%	**7**	**2**	**4**	**1**	**4**	**2**	**4**	**3**	**5**	**32**
-25%-0%	1	1	0	0	2	0	2	1	3	**10**
1%-20%	5	1	3	1	2	2	1	2	2	**19**
21%-40%	1	0	1	0	0	0	1	0	0	**3**
>=71%	**1**	**0**	**0**	**5**	**0**	**4**	**4**	**1**	**0**	**15**
-25%-0%	0	0	0	4	0	2	3	1	0	**10**
1%-20%	1	0	0	1	0	2	1	0	0	**5**
21%-40%	0	0	0	0	0	0	0	0	0	**0**
Total	**14**	**8**	**8**	**8**	**10**	**10**	**10**	**6**	**6**	**80**
-25%-0%	2	1	0	4	4	2	6	2	4	**25**
1%-20%	10	4	6	2	6	8	2	4	2	**44**
21%-40%	2	3	2	2	0	0	2	0	0	**11**

Appendix B Design of Playground and School Road Marking Stencils