

**An Evaluation of the Photo Speed Enforcement Pilot Program in Saskatchewan:
(March 2015 - March 2017)
Final Report**

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Executive Summary

Background

In 2013, the Government of Saskatchewan formed an all-party Special Committee on Traffic Safety that conducted extensive public consultations directed at enhancing road safety in Saskatchewan. Based on public submissions, the Special Committee on Traffic Safety recommended that SGI implement a photo speed enforcement pilot project. In response to this recommendation, a two-year photo speed enforcement (PSE) pilot program was announced by SGI in June 2014 in response to this recommendation.

In December 2014, the Government of Saskatchewan introduced the photo speed enforcement (PSE) pilot program in selected high-speed locations and school zones. After a warning period, tickets issuance commenced in March 2015, with the pilot running for a period of two years ending in March 2017.

The high-speed camera locations included the Highway 1 and 9th Ave. intersection in Moose Jaw, Ring Road in Regina, Circle Drive in Saskatoon, Highway 1 East between Pilot Butte and White City, and Highway 12 near Martensville. School zones were selected from Regina, Saskatoon and Moose Jaw. These locations were clearly and extensively marked to warn drivers that they are approaching photo speed enforced zones. While speed cameras operate 24 hours and 7 days a week, those in school zones vary according to when speed limits are in effect. Saskatoon operates the cameras from 8 a.m. to 5 p.m. weekdays and only when school is in session whereas Regina and Moose Jaw operate the cameras from 8 a.m. to 6 p.m. all year round.

Primary objectives of the PSE pilot program were to deter speeding, and to reduce speed-related collisions and resulting injuries and deaths. The overarching goal of the PSE program was “zero speeding tickets, zero crashes.” A target violation rate of less than 1% of drivers (exceeding a selected location-based speed threshold) was set for all camera locations. The speed threshold over the speed limit that attracts a violation ticket is determined by law enforcement.

Purpose of Evaluation

This evaluation document assesses the short to long term impacts of the pilot program. Online and telephone surveys were conducted to assess the initial and long term levels of public awareness and support for the program. The medium-term effects such as the deterrent effect of the program in reducing travel speed and speed violations at PSE locations were also investigated. The ultimate outcomes examined in this evaluation include the long-term safety impact of the program on speed-related collisions.

Findings

Public Awareness and Opinion of Photo Speed Enforcement (PSE)

Public awareness and opinions were captured through SGI's Traffic Safety Monitor Survey, which is a periodic survey instrument that SGI uses to gauge public opinion on a number of different traffic safety initiatives. The surveys are conducted in the spring and fall each year. Baseline information on the PSE pilot was collected in the spring 2014 survey. The most recent data on the PSE pilot was obtained in spring 2017. The results of the surveys are summarized in this section.

- General awareness of the deployment of PSE in Saskatchewan increased from 70% in spring 2014 (pre-implementation period) to 91.7% in spring 2017;
- Specific knowledge of speed cameras deployed at high-speed locations increased from 26.3% prior to implementation in spring 2014 to 49.2% by spring 2017;
- About 56% surveyed in spring 2017 wanted the program to continue; and,
- 93% of those who wanted the program to continue wanted it expanded.

Speeding and Speed-Related Crashes

The proportion of vehicles violating the speed threshold and average speeds at the camera locations was monitored using data captured by the cameras, as well as through speed data collected before implementation of the pilot program.

Proportion of Vehicles Violating the Speed Threshold at High-Speed Locations

Data on speed threshold violation rates at the high-speed camera locations (Highway 1 and 9th Ave. in Moose Jaw, Ring Road in Regina, Circle Drive in Saskatoon, Highway 1 East between Pilot Butte and White, and Highway 12 near Martensville) since ticketing began in March 2015 were collected for monitoring and evaluation purposes (Table E1). As mentioned earlier, SGI set a target violation rate of less than 1% at all PSE locations. The data indicates that:

- With the exception of the Moose Jaw corridor, the average monthly speed violation rate from March 2015 to March 2017 was below 1%, of the vehicles traveling through the high-speed corridors.
- Although the Moose Jaw corridor witnessed monthly speed violation rates above the target 1% of vehicles travelling through that corridor for most of the pilot's duration, the violation rate decreased from 4.3%, when ticketing commenced in March 2015, to 0.80% (below 1%) at the end of the pilot in March 2017.

**Table E1: Monthly Speed Threshold Violation Rates in High-Speed Locations
(March 2015-March 2017)**

Speed Camera Locations	Mar. '15	Apr. '15	May. '15	Jun. '15	Mar. '16	Apr. '16	May. '16	Jun. '16	Jan. '17	Feb. '17	Mar. '17	Average Mar. '15 - Mar. '17
Highway 1 and 9 th Ave. intersection in Moose Jaw	4.32%	3.61%	2.92%	3.40%	1.28%	0.94%	1.37%	1.62%	0.60%	0.42%	0.80%	2.08%
Ring Road in Regina	0.34%	0.26%	0.21%	0.23%	0.25%	0.28%	0.32%	0.20%	0.12%	0.17%	0.39%	0.25%
Circle Drive in Saskatoon	0.41%	0.19%	0.19%	0.28%	0.63%	0.43%	0.57%	0.15%	0.24%	0.31%	0.38%	0.36%
Highway 1 east between Pilot Butte turnoff and White City	0.80%	0.90%	0.81%	0.93%	0.78%	0.78%	0.80%	1.10%	0.52%	0.51%	0.60%	0.80%
Highway 12 near Martensville	0.64%	0.67%	0.80%	0.74%	0.40%	0.27%	0.53%	0.65%	0.40%	0.59%	0.42%	0.56%

Average Speeds at High-Speed Locations

- Table E2 presents the average travel speeds at the high-speed corridors before and after the implementation of the PSE program. The data indicates that average speeds reduced between 3.4 km/h on the Ring Road in Regina (3.5% reduction) to 17.7 km/h on Highway 12 near Martensville (16.9% reduction).
- In terms of the percentage reduction in average speed, the cameras had the most impact at the Highway 12 location followed by Circle Drive in Saskatoon, Highway 1 East, the Moose Jaw corridor, and the Ring Road in Regina, in that order.

Table E2: Before and After Monthly Average Speeds at High-Speed Locations

High-Speed Locations	Posted Speed Limit (km/h)	Average Speed Before Installation (km/h)	Average Speed After Installation (km/h)	Change in Speed (km/h)	Per Cent Change in Speed (km/h)
Highway 1 and 9th Ave. intersection in Moose Jaw	80	80.9	76.9	-4	-4.90%
Ring Road in Regina	100	98.5	95.1	-3.4	-3.50%
Circle Drive in Saskatoon	90	97.7	86.1	-11.6	-11.90%
Highway 1 East between Pilot Butte and White City	90 (dropped to 80 in Nov 15)	92.1* (87.8)**	87.8* (79.5)**	-4.3* (-8.3)**	-4.7%* (-9.0%**)
Highway 12 near Martensville	90 (dropped from 110 in June 2014)	104.7	87.0	-17.7	-16.90%

*When posted speed was 90 km/h

**At 80 km/h posted speed limit. Average speed was 87.8 km/h just before the drop to 80 km/h

Speed Variance at High-Speed Locations

- Table E3 indicates the 85th percentile speeds (the speed that drivers tend to adopt according to the road environment, which indicates degree of compliance with the posted speed limit, and hence the degree of traffic calming attained) across the high-speed corridors before and after implementation of the pilot.
- The data indicates that the speed at or below which 85% of all vehicles were observed to be travelling at the camera locations trended downwards towards the posted speed limit following the installation of the cameras, which is indicative of more compliance with the posted speed limits.

Table E3: 85th Percentile Speeds on High-Speed Locations: Before PSE vs. After PSE

High-Speed Locations	Posted Speed Limit (km/h)	85 th Percentile Speed Before PSE (km/h)	85 th Percentile Speed After PSE (km/h)	Change in Speed After PSE (km/h)	Per Cent Change in Speed After PSE(km/h)
Highway 1 and 9th Ave. intersection in Moose Jaw	80	90.0	84.4	-5.6	-6.2%
Ring Road in Regina	100	108.4	102.3	-6.1	-5.6%
Circle Drive in Saskatoon	90	109.4	92.6	-16.8	-15.4%
Highway 1 East between Pilot Butte and White City	90 (dropped to 80 in Nov 15)	99.0* (93.4)**	93.4* (84.3)**	-5.6* (-9.1)**	-5.7%* (-9.7%)**
Highway 12 near Martensville	90 (dropped from 110 in June 2014)	113	92.6	-20.4	-18.1%

*When posted speed was 90 km/h

**At 80 km/h posted speed limit. Average speed was 87.8 km/h just before the drop to 80 km/h

Collisions at High-Speed Locations

The impact of the PSE program on collisions was assessed by two different methods –a simple before and after analysis and a more robust statistical intervention analysis. The before and after study used simple before and after collision count to determine how the PSE program changed collision experience compared to a baseline average. The more robust intervention analysis, on the other hand, takes into account locations where no cameras were installed as reference groups along with some socio-economic and environmental factors that might influence the changes in collisions. Both approaches, however, indicated positive safety impacts of the PSE program, i.e. a reduction of the frequency and severity of speed-related collisions (the target collisions) at the camera locations.

Simple Before and After Analysis

The results of the simple before and after analysis of collisions at the high-speed locations are presented in Table E4. A baseline average collision per year for the period 2010 – 2014 (before the implementation of the pilot) was compared to the average number of collisions per year from January 2015 – March 2017 (after implementation). It can be noted from Table E4 that:

- In general, all the high-speed locations registered reductions in collisions that result in either injuries or deaths (casualty collisions). There were 28 fewer casualty collisions resulting in an estimated 40 fewer injuries.
- All speed-related collisions (severe and non-severe) were reduced over the pilot period. The reductions in speed-related casualty collisions indicate a 63% reduction resulting in a 51% reduction in injuries.
- Compared to speed-related casualty collisions, non-speed related casualty collisions registered a modest 3% reduction, which led to 7% fewer injuries.

**Table E4: Changes in Collisions and Injuries at High-Speed Locations:
Jan. 2015 - Mar. 2017 vs. Baseline**

Type of Collisions	Baseline Average Annual Collisions and Injuries Before PSE (2010-2014)			Average Annual Collisions and Injuries After PSE (Jan. 2015 - Mar. 2017)			Change in Total Collisions (Jan. 2015 - Mar. 2017) over Baseline	Change in Casualty Collisions (Jan. 2015 - Mar. 2017) over Baseline	Change in Total Injuries (Jan. 2015 - Mar. 2017) over Baseline
	Total Collisions	Casualty Collisions	Total Injuries	Total Collisions	Casualty Collisions	Total Injuries			
All Types	981	213	289	988	185	249	7	-28	-40
Speed-Related	97	35	43	72	13	21	-25	-22	-22
Non-Speed Related	884	178	246	916	172	228	32	-6	-18

Intervention Analysis

The results of the intervention analyses are presented in Table E5. Similar to the results of the simple before and after approach, this robust approach indicates that the PSE program had a greater impact on speed-related collisions (the target collisions) than non-speed related collisions when both socioeconomic and environmental factors were considered. For example, the statistical model estimated that there was a 53% reduction in total speed-related collisions compared to 6% reduction in the total non-speed-related collisions. The estimated reduction

was found to be statistically non-significant, meaning the impact on collisions not associated with speeding was minimal compared with those in which speeding was a contributing factor.

**Table E5: Changes in Collisions at High-Speed Locations Based on Intervention Analysis:
Jan. 2015 - Dec. 2016 vs. Baseline**

		Baseline Average Annual Collisions Before PSE (2010-2014)			Average Annual Collisions After PSE (Jan. 2015 - Dec. 2016)			Per Cent Change in PDO Collisions	Per Cent Change in Casualty Collisions	Per Cent Change in Total Collisions
		PDO	Casualty	Total	PDO	Casualty	Total			
Impact of PSE on High-Speed, High-Risk Corridors	All Collisions	768	213	981	875	212	863	14% (0.0394)*	-0.44% (0.9608)	-12% (0.0344)
	Speed-Related Collisions	62	35	97	20	16	45	-68% (<0.0001)	-54% (0.0066)	-53% (<0.001)
	Non-Speed Related Collisions	706	178	884	847	171	831	20% (<0.0001)	-4% (0.6547)	-6% (0.519)

*Level of significance. Statistically significant if less than 0.05.

Proportion of Vehicles Violating the Speed Threshold at School Zones

The violation rates for school zone locations are shown in Table E6. The average violation rates in the school zones from March 2015 to March 2017 were between 1.07% and 2.3%. Looking at the trends in violation rates, it can be noted that:

- Saskatoon school zones moved from an average high of 8.7% in May 2015 to 2.37% in March 2017 (no cameras are used during the summer months of July and August in Saskatoon school zones).
- Regina school zones moved from a high violation rate of 6.1% in June 2015 to 0.52% in March 2017.
- Moose Jaw school zones moved from a violation rate of 2.1% in July 2015 to 0.61% in March 2017.

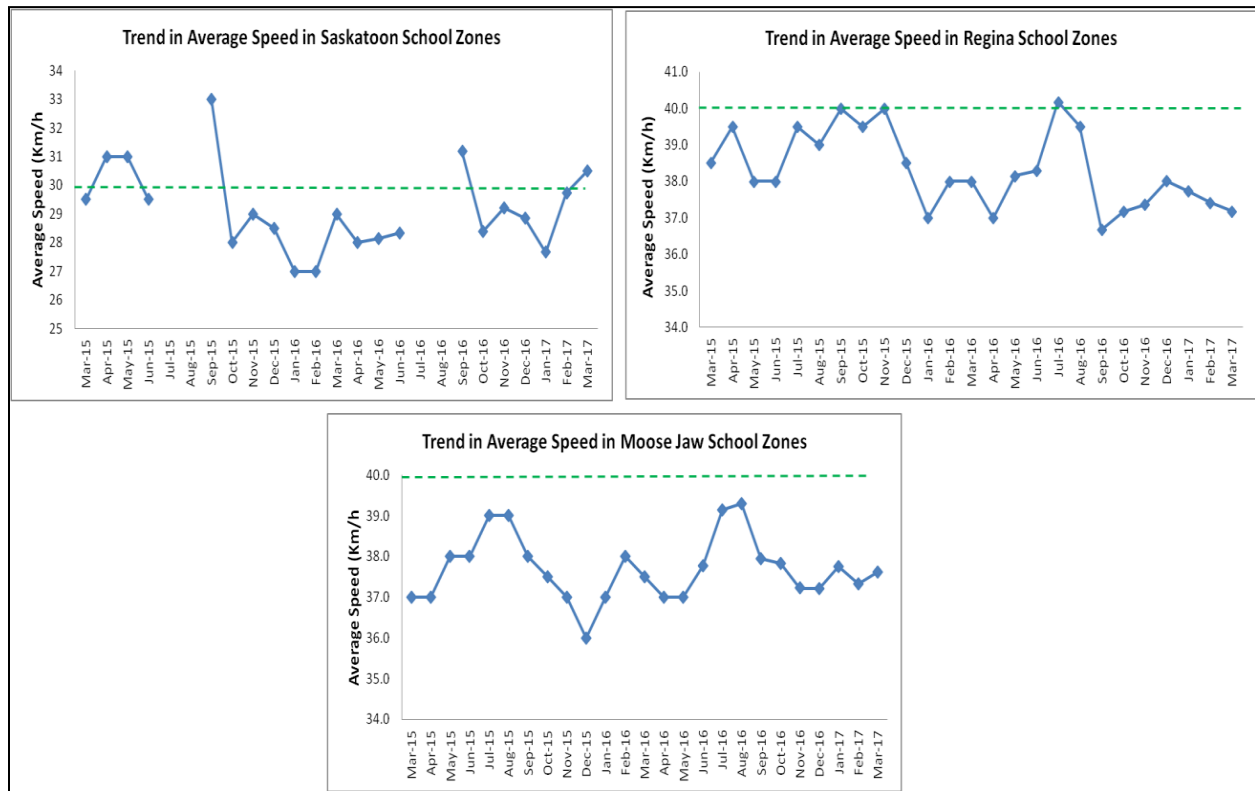
**Table E6: Monthly Speed Threshold Violation Rates in School Zones
(March 2015-March 2017)**

Speed Camera Locations	Mar. '15	Apr. '15	May. '15	Jun. '15	Mar. '16	Apr. '16	May. '16	Jun. '16	Jan. '17	Feb. '17	Mar. '17	Average Mar. '15 - Mar. '17
Moose Jaw school zones	0.64%	0.67%	2.13%	1.88%	0.89%	0.46%	0.27%	0.79%	0.77%	0.62%	0.61%	1.07%
Regina school zones	1.69%	3.98%	2.21%	6.10%	2.05%	1.15%	1.48%	1.07%	0.57%	0.45%	0.52%	1.84%
Saskatoon school zones	1.50%	5.59%	8.70%	6.26%	2.64%	0.42%	0.81%	0.51%	0.28%	2.18%	2.37%	2.30%

Average Speeds at School Zones

- Since there was no baseline speed data for the school zone locations, we compared the average speeds from April 2015 through March 2016 to that from April 2016 through the end of the two-year pilot in March 2017 (Figure E1). The data indicates that average speeds in the Saskatoon zones reduced from 29.3 km/h to 29.0 km/h a year later. Average speed in Regina reduced from 38.8 km/h to 37.9 km/h, while average speed in Moose Jaw remained relatively unchanged from 37.0 km/h to 37.8 km/h a year later.

Figure E1: Trends in Average Speed in School Zones (March 2015 – March 2017)



Speed Variances at School Zones

Similar to the analysis of average speed of travel in the school zones, the 85th percentile speeds were monitored from April 2015 through March 2016 and compared with the same period a year later. The data indicates that the 85th percentile speeds for Saskatoon decreased from 37.4 km/h to 35.1 km/h by the end of the pilot in March 2017, while that for Regina decreased from 45.0 km/h to 42.0 km/h over the same period (Figure E2). There was a slight reduction at Moose Jaw from 43 km/hr in April 2015 to 42.0 km/h by March 2017.

Figure E2: Trends in the 85th Percentile Speed in School Zones (Mar. 2015 – Mar. 2017)



Collisions at School Zones

The main goal of PSE in school zones was to reduce the average speed of travel to decrease the risk of injury to children in these zones. Because there were very few speed-related collisions recorded for school zones, the analysis examined changes in total collisions and injuries in school zones.

Simple Before and After Study

Table E7 presents the results of the simple before and after study for school zones. The table indicates that the cameras in all enforced school zones were associated with an estimated reduction of 42 collisions of all types and seven casualty collisions annually by the end of the program in March 2017. The reduction in casualty collisions led to 38% fewer injuries in the school zones.

**Table E7: Changes in Collisions and Injuries at All Enforced School Zones:
Jan. 2015 - Mar. 2017 vs. Baseline**

Baseline Average Annual Collisions and Injuries Before PSE (2010-2014)			Average Annual Collisions and Injuries After PSE (Jan. 2015 - Mar. 2017)			Change in Total Collisions (Jan. 2015 - Mar. 2017) over Baseline	Change in Casualty Collisions (Jan. 2015 - Mar. 2017) over Baseline	Change in Total Injuries (Jan. 2015 - Mar. 2017) over Baseline
Total Collisions	Casualty Collisions	Total Injuries	Total Collisions	Casualty Collisions	Total Injuries			
99	21	26	57	14	16	-42	-7	-10

Intervention Analysis

The intervention analysis results for school zones are presented in Table E8. The results support the finding from the simple before and after study that there was a reduction in collisions in all enforced school zones following the implementation of the PSE program. The results indicate that there were 44 fewer total collisions annually (44% reduction), and 13 fewer casualty collisions (39% reduction).

**Table E8: Changes in Collisions at All Enforced School Zones Based on Intervention Analysis:
Jan. 2015 - Dec. 2016 vs. Baseline**

Baseline Average Collisions Before PSE (2010-2014)			Average Collisions After PSE (Jan. 2015 - Dec. 2016)			Per Cent Change in PDO Collisions	Per Cent Change in Casualty Collisions	Per Cent Change in Total Collisions
PDO	Casualty	Total	PDO	Casualty	Total			
78	21	99	40	13	55	-48% (<0.0001)*	-39% (0.03)	-44% (<0.0001)

*Level of significance. Statistically significant if less than 0.05.

Financial Implications of PSE Program

SGI's vision for the PSE pilot program was to achieve "zero tickets, zero crashes" in photo-enforced locations, with target violation rates of less than 1% at all locations. SGI totally funds this program and publicly committed that should there be any revenue from the program net of program costs, it would be dedicated to traffic safety initiatives. As of February 28, 2017, the PSE pilot had generated revenues of \$10.43 million with total expenses of approximately \$5.41 million. The expense/revenue breakdown at camera locations is presented in Table E9.

Table E9: Revenues, Expenses and Net Revenues from the PSE Pilot by Location

Cameral Location	Revenue*	Expenses	Net Revenue
Highway Locations	\$1,255,953	\$1,136,810	\$119,143
Saskatoon	\$2,653,081	\$1,579,717	\$1,073,364
Regina	\$4,169,542	\$1,428,469	\$2,741,073
Moose Jaw	\$2,358,359	\$1,273,167	\$1,085,192
Total	\$10,436,935	\$5,418,163	\$5,018,772

*75% of total revenue; the remaining 25% of total revenue is allocated to the General Revenue Fund for the administration of the court and collection processes.

Net revenues at municipal locations go to the respective municipality for dedication to traffic safety initiatives. The City of Saskatoon spent \$460,000 of its net revenue from the PSE pilot on a number of traffic safety projects. These projects include: enforcement, pedestrian crossings, pedestrian safety campaign, and traffic calming measures. The City of Regina spent \$256,000 of its portion of the net revenue on safety projects such as Operation Overdrive, intersection safety and child restraints. Moose Jaw is similarly reinvesting \$450,000 of its PSE revenue for law enforcement to conduct similar operations as Regina and to acquire traffic signal controls.

Cost-Benefit Analysis of PSE Pilot

This section presents an economic analysis of the PSE pilot program on the basis of safety outcomes (i.e., collisions, fatalities and injuries) and net revenues allocated to traffic safety improvements. The measures of effectiveness used in this section are the cost-benefit (B/C) ratio and net present value (NPV).

An analysis of the cost-benefit of the program from SGI's insurance perspective indicates that the PSE program would generate a NPV of \$10.7 million at the end of an assumed projected life of 10 years. This is equivalent to the project returning \$1.64 for each \$1 invested. From a societal perspective, the program would generate a NPV of \$62.4 million, which is equivalent to a B/C ratio of 4.2:1.

Conclusions

There are indications from the findings that:

- The PSE pilot positively impacted speeding behaviour (speed violation rates) at both the high-speed locations and school zones. The less than 1% speed threshold violation target has been achieved at almost all camera locations.
- Average speeds were reduced by between 3.4 km/h on the Ring Road in Regina (3.5% reduction) and 17.7 km/h on Highway 12 near Martensville (16.9% reduction).
- With the exception of Moose Jaw school zone locations, where the 85th percentile speed remained stable, this measure trended downwards towards the posted speed limit at both the Regina and Saskatoon locations following the installation of the cameras.
- The pilot project had a positive impact on the frequency and severity of collisions, especially speed-related collisions at the camera locations. It is associated with reducing casualty collisions by 35 (28 from high-speed locations and seven from school zones) resulting in an estimated 50 fewer injuries (40 from high-speed locations and 10 from school zones).
- The cost-benefit analysis of the PSE pilot from an SGI-insurance costs perspective indicates a net present value (NPV) of \$10.7 million at the end of an assumed projected life of 10 years. This is equivalent to the project returning \$1.64 for each \$1 invested in the PSE program.
- From a societal perspective, the program would generate a NPV of \$62.4 million, which is equivalent to a cost-benefit (B/C) ratio of 4.2:1.
- Most Saskatchewan residents want the PSE program to continue and expand to other areas of the province. Specifically, about 56% of the general public want the program to continue. 93% of those who want the program to continue want it to expand.

1.0 Introduction

Driving at a speed not appropriate for existing conditions or driving at a speed exceeding the posted speed limit increases the likelihood of road collisions and casualties (Aarts & van Schagen, 2006; Bowie & Walz, 1994). Studies have reported that the risk of collision severity increases exponentially with increasing vehicle speed. For example, injury and fatal collisions were found to be proportional to the second and the fourth power of the average vehicle speed, respectively (Elvik, Christensen & Amundsen, 2004; Nilsson, 2004). Similar studies have also indicated that a 5% reduction in average speed results in a 20% reduction in the likelihood of fatal collisions. Research has shown that the relative risk of a speeding collision at the speed of 70 km/h in a speed zone of 60 km/h can be compared to the collision risk while driving with a blood alcohol concentration (BAC) of 0.8g/l (Kloeden, McLean, Moore & Ponte 1997).

Jurisdictions worldwide have recognized speeding as one of the major contributing factors of collisions. A road safety performance survey conducted jointly by the Organisation for Economic Co-operation and Development (OECD), and European Conference of Ministers of Transport (ECMT) in 2005 has shown that speeding was the topmost safety problem in 39% of the 38 responding countries, and 61% of the respondents identified speeding as one of the top three safety problems (OECD, 2006). The survey also reported that speeding contributed to one third of fatal collisions in the participating OECD member countries, and was a potential contributing factor in most collisions.

The Canadian Council of Motor Transport Administrators (CCMTA) has identified speeding as the second most significant contributing factor of collisions in its 2015 Road Safety Strategy. Speeding contributed to 25% of traffic fatalities in Canada between 2002 and 2004 (Transport Canada, 2008). Transport Canada (2011) also noted that the rate of speed-related injuries and fatalities was significantly higher in Canada between 2005 and 2007 than between 1996 and 2001.

Unsafe speed continues to be a serious safety concern in Saskatchewan. In 2013, speeding accounted for 20% of the total fatal crashes in Saskatchewan. This remained relatively unchanged in 2015 (21% of all fatal crashes) but decreased to 11.9% in 2016. (SGI, 2014; SGI, 2016; SGI, 2017). Speed-related fatal collisions are more prevalent on high-speed provincial highways or rural roads (63%) than in urban locations (9%).

In 2013, the Government of Saskatchewan formed an all-party Special Committee on Traffic Safety that conducted extensive public consultations directed at enhancing road safety in Saskatchewan. Based on public submissions, the Special Committee on Traffic Safety presented the following as one of its 26 recommendations:

Your committee supports SGI implementing the photo radar pilot project as recommended. Your committee also recommends SGI write warning letters for the first

six months after implementation and then issue tickets for violations after that initial period (The Legislative Assembly of Saskatchewan, 2013).

Consequently, a two-year photo speed enforcement (PSE) pilot program was announced by SGI in June 2014 in response to this recommendation. The overall goal of the pilot program was to determine the feasibility of using PSE cameras as an enforcement tool to impact speeding behavior and safety, in terms of reduced fatalities and injuries from collisions.

2.0 Purpose of Evaluation

The purpose of evaluating Saskatchewan's photo speed enforcement pilot program was to:

- Gain insight on the level of public awareness and support for the program;
- Investigate the program's effect on deterring speeding;
- Estimate the safety impacts on speed-related collisions and related injuries/deaths; and,
- Determine the program's return on investment from both the societal perspective and SGI's perspective.

3.0 General Evaluation Framework

The key tasks completed in this evaluation are:

- Literature review
- Description of the PSE program in Saskatchewan
- Evaluation of the PSE program

The following sections describe the tasks within the evaluation.

3.1 Literature Review

The enforcement of safe speeds is an effective intervention for reducing speeding and speed-related casualties. The widely used traditional method of speed enforcement is manned enforcement where police officers catch speed offenders by using radar technologies installed in police vehicles. However, the traditional method of speed enforcement has long been questioned for its inconsistency and resource intensiveness.

3.1.1 Photo Speed Enforcement

The photo speed enforcement (PSE) system has been used in recent years by many jurisdictions world-wide as an effective alternative to the traditional method of speed enforcement. PSE uses a camera to detect and photograph vehicles exceeding a pre-set speed enforcement threshold with no immediate human interaction or traffic stop. The photograph shows the speeding vehicle's make, model and licence plate, and is stamped with information, such as

date, time, location and speed. The citation along with the photograph is mailed to the owner of the vehicle.

The two most common forms of PSE systems are fixed and mobile speed cameras. Fixed cameras are placed at specific roadside locations and capable of constantly deterring site specific speeding without a human operator. Mobile speed cameras, on the contrary, are usually carried by a police vehicle to detect speeding at different enforcement locations. Some mobile cameras are deployed at roadside and mounted on tripods. Mobile cameras do not provide continuous enforcement at any one location.

The primary goal of PSE is to provide consistent deterrence to speeding, and to improve overall safety of road users by reducing speed-related collisions and casualties. PSE takes the burden of manual enforcement away from limited police resources, and allows enforcement officers to give more time to other safety concerns.

3.1.2 Effects of PSE Programs

Several studies have reviewed the effectiveness of PSE programs deployed in many jurisdictions worldwide. Wilson, Willis, Hendrikz, Le Brocque & Bellamy (2012) conducted a systematic review of 35 studies that evaluated the effects of PSE programs in different jurisdictions around the world. Thirteen studies reported a 1.3km/h to 5.8km/h reduction in mean speed; three studies established that the reductions in average speed range from 0.9km/h to 5km/h. A 14% to 65% reduction in speed relative to controls was reported by a few studies. Twenty-eight of 35 studies showed the effects of PSE programs on reducing collisions either in the vicinity of camera sites (localized effects) or in the system-wide network (generalized effects). The speed cameras were associated with an 8% to 41% reduction in all collisions within the close vicinity of the camera locations. The reductions in all collisions range from 9% to 35% when the generalized effects of the speed cameras were estimated. A few other past studies conducted similar systematic reviews, and the outcome reflected similar positive impacts of PSE programs (Pilkington & Kinra 2005; Thomas, Srinivasan, Decina & Staplin, 2008).

Effects of PSE Programs in Europe

A long-term investigation of the photo radar program in a dangerous section of the German Autobahn between 1970 and 1982 reported that the fixed speed cameras reduced the percentage of vehicles speeding from 95 to 7; fatalities reduced from eight per year to one per year (Lamm & Kloeckner, 1984). A PSE program introduced in Norway in 1988 was associated with a statistically significant 20% reduction in injury collisions (Elvik, 1997).

A few studies in the United Kingdom demonstrated the positive safety effects of PSE programs. An evaluation of fixed speed cameras in the South Wales region of the United Kingdom showed a 51% reduction in injury collisions (Christie, Lyons, Dunstan & Jones, 2003). Hess (2004) conducted an evaluation study with injury collisions from 49 camera sites in Cambridgeshire

between 1990 and 2002. The study indicated that the speed cameras were associated with a 45.7% reduction in injury collisions within the close proximity of camera sites. The PA Consulting Group conducted a nation-wide evaluation of the PSE program in England (Gains, Heydecker, Shrewsbury & Robertson, 2004). The report indicated that the speed cameras were associated with 8% and 4% reductions in average speed in urban and rural areas, respectively. At the camera sites, personal injury collisions dropped by 33%, and the number of victims (seriously injured or killed) reduced by 40%.

Goldenbeld & van Schagen (2005) conducted an evaluation of the mobile PSE program in the Dutch province of Friesland. The authors reported that mobile speed cameras reduced the number of injury collisions and serious casualties by 21%. The study also indicated that there was a significant drop in mean speed after the implementation of the enforcement program. The effect of speed cameras on Barcelona's beltway was assessed by a time series analysis conducted by Perez, Mari-Dell'Olmo, & Borrell (2007). The authors found a 27% reduction in road collisions on the beltway. An assessment of the PSE program in France demonstrated a significant 21% drop in the number of fatalities per 100,000 vehicles (Carnis & Blais, 2013).

Effects of PSE Programs in Australia and New Zealand

The Australian states of New South Wales and Victoria found that the speed cameras were associated with a 22% reduction in serious collisions and a 38% reduction in injury collisions (Coleman & Paniati, 1995). A long-term investigation of Queensland's speed camera program revealed that the speed cameras contributed to a 45% reduction in fatal collisions in areas within 2 km of camera sites (Newstead & Cameron, 2003). The speed camera program produced a substantial benefit cost ratio of 47:1 over the period from its introduction to June 2001.

Keall, Povey & Firth (2001) evaluated the effectiveness of PSEs in New Zealand by using an interrupted time series analysis. The authors reported that the mobile speed cameras accounted for a 0.7 km/h decline in speed as well as a 19% decrease in casualties. An evaluation of 24 speed cameras in Christchurch, New Zealand, showed that there was a 9% reduction in all collisions (Tay, 2000).

Effects of PSE Programs in the USA

In the USA, several jurisdictions used PSE programs for controlling speeding and reducing speed-related collisions and severities. Speed cameras in the city of National City in the South Bay region of the San Diego metropolitan area in California contributed to a 10% decline in traffic speeds and a 51% reduction in collisions (Berkuti & Osbuen, 1998). The City of San Jose in California attributed the effects of mobile PSE with a 15% reduction in the number of vehicles driving at a speed 10 mph over the speed limit (Davis, 2001).

An evaluation of mobile speed cameras deployed in the District of Columbia reported a 14% decline in mean speed and an 82% reduction in the proportion of vehicles exceeding the speed limit by more than 10 mph (Retting & Farmer, 2003).

The city of Charlotte in North Carolina used mobile speed cameras in 14 high-volume urban corridors, and there was an aggregated 12% reduction in total collisions for enforced corridors following the implementation of speed cameras (Cunningham, Hummer & Moon, 2005). For the five heavily enforced camera sites, reductions in injury collisions during day-time and night-time were estimated as 22% and 25%, respectively.

The City of Scottsdale in Arizona used fixed speed cameras on an 8-mile stretch of Arizona State Route 101 to evaluate the effects of highly visible speed cameras on an urban freeway. The presence of speed cameras contributed to a decline in mean speeds from 70 mph to 65 mph, and an 88% decrease in the odds of vehicles travelling 11 mph or more above the 65 mph speed limit (Retting, Kyrychenko & McCartt, 2008). The assessment of the effects of enforcement on collisions indicated a 44% to 55% reduction in total collisions, and a 46% to 56% drop in injury collisions (Shin, Washington & van Schalkwyk 2009).

The state of Maryland first introduced PSE in 2007 in the Montgomery County. The effects of PSE in the county was reflected by a 70% decline in the number of vehicles travelling more than 10 mph above the posted speed limit at locations with both warning signs and speed cameras, and 39% at locations with warning signs but no speed cameras (Retting, Farmer & McCartt, 2008).

Effects of PSE Programs in Canada

In Canada, Ontario was the first jurisdiction to introduce a PSE program on provincial highways in August 1994. The program was cancelled in 1995 due to public outcry, although a four-month preliminary report released by the Ontario Ministry of Transportation indicated that photo radar had reduced speeding on Ontario highways (Toronto City Council, 2003).

In 1996, British Columbia introduced PSE cameras in high-speed areas to deter speeders and to reduce speed-related collisions and casualties. A review of the program indicated that there was a 14% decrease in traffic collision injuries and up to a 26% decrease in collision fatalities (Chen, 2005). The review also revealed an annual net benefit of approximately \$114 million in 2001-dollars to British Columbians. It also found a net annual savings of over \$38 million for the Insurance Corporation of British Columbia. Claims cost savings generated by photo radar were estimated at \$65.6 million per year, more than double the estimated program cost. Initially, the program had wide public support, but later became an election issue with the opposition party promising to cancel it if elected. The photo radar program was officially terminated in 2001 after a change in government.

Manitoba uses photo radar for speed enforcement within the City of Winnipeg. Cameras are used in school zones, playground zones and construction zones, as well as some intersections.

An evaluation by the Traffic Injury Research Foundation in July 2011 indicated that there was a 24% decrease in speed-related injury collisions at camera intersections and a 13% decrease in property damage only collisions at camera intersections (Vanlaar, Robertson & Marcoux, 2011).

In August 2009, Quebec began a pilot project using photo radar and red light cameras to manage speed in 15 high-speed locations. This pilot was expected to run until February 2011, but was extended to enable the National Assembly committee to study an evaluation report submitted in October 2010. The report indicated a decrease in all collisions: a 51% reduction in fixed speed camera locations, and 27% in mobile speed camera locations. Reductions in injury collisions were 58% and 41%, respectively, in fixed and mobile speed camera locations. A law allowing the permanent installation of photo radar technology was endorsed by the provincial legislature in 2012. Plans to expand the program were announced in 2015.

3.2 PSE Program in Saskatchewan

The PSE pilot program officially started on Dec. 8, 2014 in Saskatchewan. Live ticketing began March 8, 2015.

At the start of the pilot, there were eight speed cameras for 28 different camera sites, as outlined below:

- Ring Road - five camera sites (one with dual directions)
- Circle Drive - five camera sites (two with dual directions)
- Highway 1 and 9th Ave. intersection in Moose Jaw - two camera sites
- Highway 1 east between Pilot Butte turnoff and White City¹ - two camera sites
- Highway 12 at Martensville² - two camera sites
- select school zones in Regina - five camera sites
- select school zones in Saskatoon - five camera sites
- select school zones in Moose Jaw - two camera sites

Each of the speed camera sites (i.e., five high-speed locations and three school zones) had one camera rotating among multiple fixed locations on a monthly basis. For example, on Circle Drive in Saskatoon, there were five locations where the camera could be located, but only one camera that rotated among them.

The cameras use a scanning laser to identify a vehicle, track it and calculate the speed of the vehicle. If the vehicle meets the criteria for a speed violation, the system takes a photograph of the offending vehicle. The photo shows all data related to the offence, including time, date, speed, etc. The offending vehicle is shown with a box around the licence plate, with the licence

¹ This camera was relocated after the two-year pilot due to construction/design changes at this location. It was moved to the Highway 1 and 9th Ave. intersection in Moose Jaw in December 2017.

² This camera was relocated after the two-year pilot due to construction/design changes at this location. In July 2017, it was moved to alternate between the Regina Dewdney Ave. and Massey Rd. school zones.

plate number enlarged so it can be easily identified so that it is clear which vehicle the camera is targeting.

Unique to this system (the Vitronic Poliscan system) is the ability to track multiple vehicles at a time. The system uses a scanning laser to track multiple vehicles through the detection zone. Since each vehicle produces a unique set of reflections, the system receives multiple reflections from the scanning laser and is able to determine which reflections come from which vehicle. This allows the system to clearly identify the offending vehicle even when there are multiple vehicles in the scene.

3.2.1 Selection of PSE Locations

High-Speed Locations

The five high-speed locations selected for the pilot study were given critical consideration based on the fact that they:

- are high traffic and high-speed locations;
- pose potential risk to safety of citizens and police if conventional methods were deployed; and,
- have a history of speeding problems.

Based on these criteria, the high-speed locations selected for this pilot were Circle Drive in Saskatoon, Ring Road in Regina, Highway 1 and 9th Ave. intersection in Moose Jaw, Highway 1 East between Pilot Butte and White City, and Highway 12 near Martensville. The posted speed limits at these locations range between 80 km/h to 110 km/h. The posted speed limit was dropped from 90 km/h to 80 km/h at the Highway 1 East location in November 2015. At Highway 12 near Martensville, the posted speed was dropped from 110 km/h to 90 km/h in June 2014.

School Zones

Table 1 presents the school zones where speed cameras were introduced. School zones were selected by the municipalities and their police services not because they are high-collision areas but because of the vulnerability of children in these areas (similar to the vulnerability of highway workers in work zones). Children are not always aware of traffic rules and may dart out into traffic unexpectedly. A reduced speed means more time to react and stop if that were to happen.

Table 1: School Zones with Speed Cameras

School Zones	Camera Sites	Speed Limit
Saskatoon	St. Michael Community School	30 km/h
	École Henry Kelsey School	
	Brownell School	
	Mother Teresa School/Silverspring School	
	École Canadienne-Française	
Regina	Thom Collegiate/O'Neill High School	40 km/h
	Winston Knoll Collegiate/Riffel High School	
	Campbell Collegiate/Massey School	
	Imperial School	
	Judge Bryant School	
Moose Jaw	Palliser Heights School	40 km/h
	William Grayson School	

3.2.2 Speed Enforcement Process

Conduent Incorporated (formerly Xerox Business Services Canada Inc.) was the vendor for Saskatchewan's PSE pilot. A step-by-step overview of what happens when a vehicle violates the pre-set speed enforcement thresholds is as follows:

- camera takes a picture of the offending vehicle
- file is uploaded to Conduent
- Conduent sends the list of licence plate numbers to SGI
- SGI sends Conduent back a file with the registered owner information for the specific licence plate numbers
- Conduent employee (sworn in Saskatchewan as a Commissioner of Oath) validates that the licence plate is legible i.e. not obscured by snow, ice, a trailer hitch, etc.
- file is uploaded to the applicable police service
- applicable police service issues the ticket, meaning they validate the ticket and it is populated with the peace officer's badge number
- file is sent back to Conduent
- Conduent mails out the ticket to the registered owner of the offending vehicle
- customer pays the fine to the Ministry of Justice (Provincial Court of Saskatchewan)

The Conduent employee (Commissioner of Oath, sworn-in in Saskatchewan) does not determine whether a ticket or warning letter will be issued based on the speed travelled. The speed threshold over the speed limit that attracts a violation ticket is determined by law enforcement.

3.2.3 Warning Period

The PSE pilot started with a warning period of three months, beginning Dec. 8, 2014. During this time, drivers exceeding the speed limit were mailed a warning instead of a ticket. Tickets started being issued on March 8, 2015 at all locations.

3.2.4 Hours of Operation

Speed cameras are operated at all high-speed locations 24 hours a day, and 7 days a week all year around. However, the hours of operation vary in school zones. School zones in Saskatoon have their speed cameras in operation from 8 a.m. to 5 p.m., Monday-Friday, only while school is in session. Speed cameras in Saskatoon school zones are not used during the summer months of July and August because speed limits are not in effect in school zones. The camera is moved to Circle Drive for the summer months.

Speed enforcement in Regina school zones is in operation from 8 a.m. to 10 p.m. year-round; whereas in Moose Jaw school zones, hours of operation for speed cameras are from 8 a.m. to 6 p.m. year-round.

3.2.5 PSE Signs

Saskatchewan's PSE locations are marked with highly visible signage. Posted signs clearly indicate that PSE is in use. Drivers should see two different informational signs as they enter a photo-speed-enforced location.

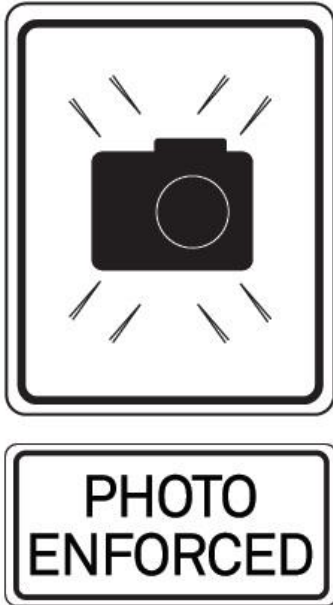
Informational Signs (speed limit photo enforced)

At the high-speed locations, large yellow signs with black lettering inform motorists they are about to enter a photo-speed-enforced zone (signs are approx. 1.2 m x 3 m (4' by 10')). At the school zone locations, smaller yellow signs with black lettering are in use.



Regulatory Signs (photo enforced)

Normal black and white regulatory signs are also used in photo-speed-enforced locations.

**3.2.6 Speeding Fine**

Fines for speeding vary depending on where the vehicle was caught speeding (high-speed locations or school zones) and how fast the vehicle was going as shown in Table 2. Note that speeding fine amounts are the same whether a vehicle is caught speeding by a PSE camera or a police officer.

Table 2: Speeding Fine Schedule

	High-Speed Locations	School Zones
Base fine	\$70	\$140
Fine per km, up to 30 km/h over posted speed limit	\$1	\$2
Fine per km, if between 30-35 km/h over posted speed limit	\$1	\$4
Fine per km, if more than 35 km/h over posted speed limit	\$4; base fine also increases to \$140	\$4
Victims of Crime surcharge	Varies, depending on total fine amount: <ul style="list-style-type: none"> • \$0-\$99 = \$40 • \$100-\$200 = \$50 • \$201-\$350 = \$60 • \$351-\$500 = \$80 • > \$500 = 40% 	Same as High-speed locations

3.3 Evaluation of the PSE Program

The fundamental questions examined in this evaluation are:

- 1) What is the level of public awareness and public support for the program?
- 2) How has the PSE program affected average and 85th percentile speeds in target locations?
Did the program deter drivers from speeding and reduce speed-related violations at the photo-enforced areas?
- 3) What is the change in speed-related collisions since the implementation of the PSE program?
- 4) Is the pilot a good investment both from SGI’s and societal perspectives?

3.3.1 Impact on Public Awareness and Public Support for the Program

SGI designed and conducted a number of online and telephone surveys to measure public awareness and support before and after the implementation of the PSE pilot program in Saskatchewan.

To date, there have been seven surveys conducted from spring 2014 through spring 2017. Each survey had approximately 1,000 respondents. The surveys included questions related to awareness of the pilot program, knowledge of camera locations at both high-speed locations and school zones, and the extent of public support for the program. Other questions included whether the program had improved safety in enforced areas, improved speeding in general and if the program should be continued or expanded.

Public Awareness of the PSE Program

While 70% of spring 2014 survey respondents were aware of the use of PSE in Saskatchewan, this figure went up to 95.5% in the fall 2015 survey and decreased to 91.7% by the fall 2016 (see Figure 1). This question was not asked in 2017.

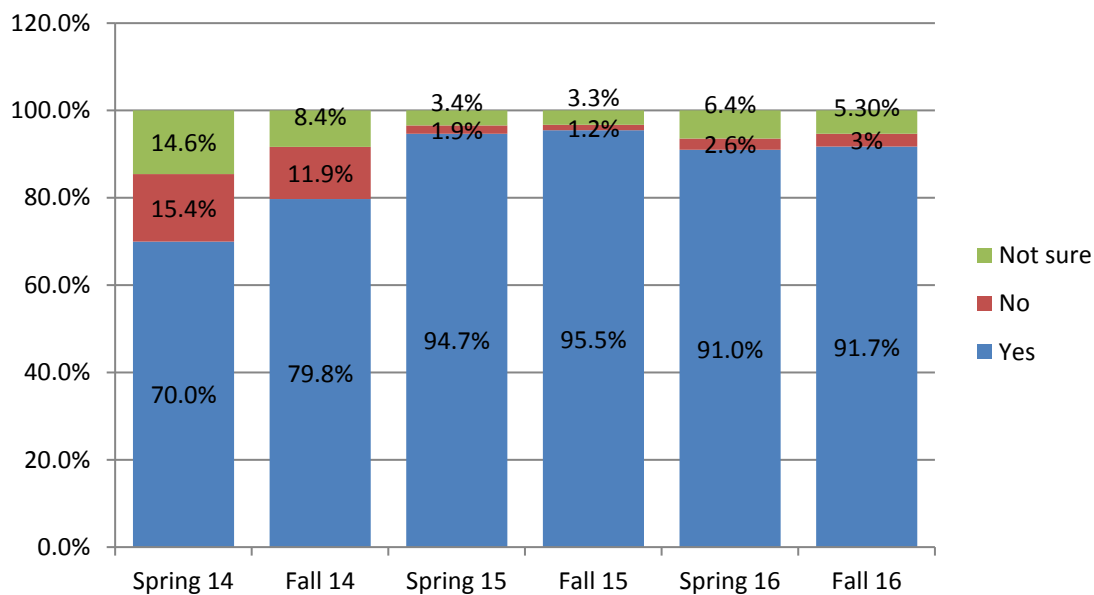


Figure 1: Awareness of PSE Program in Saskatchewan

When the spring 2014 survey respondents were asked if they were aware of high-speed locations, 26.3% respondents answered positively (see Figure 2). This is understandable since the pilot program was still being discussed by provincial safety authorities in spring 2014. However, the awareness of the pilot at high-speed locations increased to 66% in the fall 2014 survey followed by 71.2% awareness in the spring 2015 survey, which was the first survey after the implementation of the pilot program. The awareness has since then dropped to 49.2% in the spring 2017 survey.

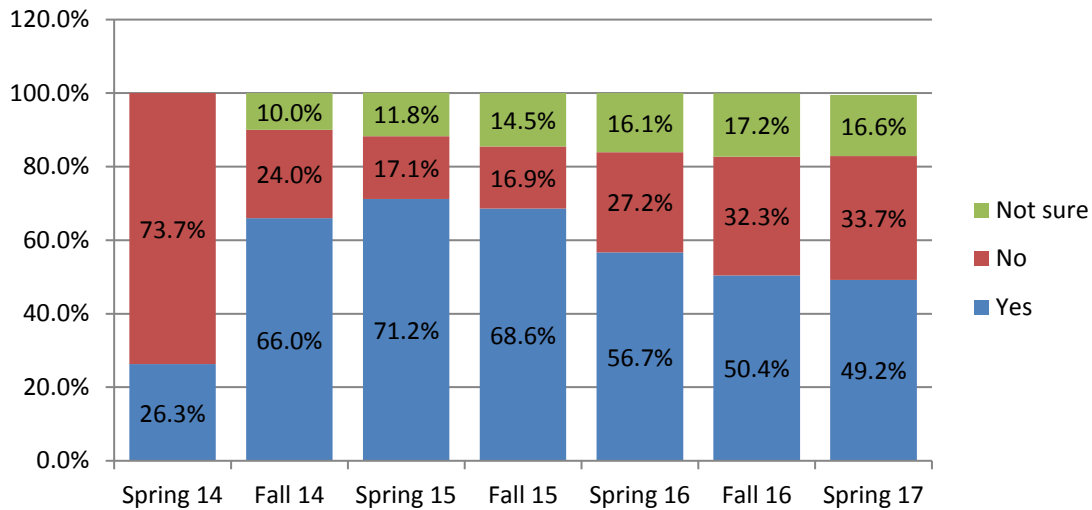


Figure 2: Awareness of PSE Program at High-Speed Locations in Saskatchewan

Public Support for the PSE Program

In the most recent survey in spring 2017, respondents were asked about their opinions on the effectiveness of the pilot program. Table 3 presents respondents’ views on the pilot program. More than half of the respondents agreed that the program improved safety in enforced areas; 27.3% respondents did not agree.

When respondents were asked about the effectiveness of the program on speeding in general, 37.8% agreed that they speed less due to PSE, and 30% of respondents did not think that PSE contributed to reduced speeding.

Respondents were asked if they would support the further continuation of the pilot program in the province. About 56% of the respondents wanted the program to continue and 93% of those who wanted the program to continue wanted it to expand.

Table 3: Public Support for the PSE Pilot Program (2017)

	Strongly Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Strongly Disagree
Improved Safety in Enforced Areas	19.8%	33.3%	20.2%	12.8%	14.5%
Speed Less Because of PSE	14.9%	22.9%	32.2%	12.7%	17.3%
Program to be Continued	29.5%	26.5%	17.4%	11.2%	15.4%
Program to be Expanded	26.9%	24.6%	20.9%	10.6%	17.0%

3.3.2 Speed at PSE Locations

High-Speed Locations

Average Speeds

Speeding behaviour at the high-speed corridors was measured by the changes in the average speed before and after PSE implementation. Table 4 presents the average travel speed at the high-speed corridors before and after the cameras were installed.

- The data on the average travel speeds at the high-risk corridors before and after the PSE pilot indicate that average speeds reduced between 3.4 km/h on the Ring Road in Regina (3.5% reduction) to 17.7 km/h on Highway 12 near Martensville (16.9% reduction).
- In terms of the percentage reduction in average speeds, the cameras had the most impact at the Highway 12 location followed by Circle Drive in Saskatoon, Highway 1 East, the Moose Jaw corridor, and the Ring Road in Regina, in that order.
- The average speeds at all high-risk locations were lower than the posted speed limits during the enforcement period. Before camera installation, only the Ring Road had average speeds below the posted speed limit.

Table 4: Before and After Monthly Average Speeds at High-Speed Locations

High-Speed Locations	Posted Speed Limit (km/h)	Average Speed Before Installation (km/h)	Average Speed After Installation (km/h)	Change in Speed (km/h)	Per Cent Change in Speed (km/h)
Highway 1 and 9th Ave. intersection in Moose Jaw	80	80.9	76.9	-4	-4.90%
Ring Road in Regina	100	98.5	95.1	-3.4	-3.50%
Circle Drive in Saskatoon	90	97.7	86.1	-11.6	-11.90%
Highway 1 East between Pilot Butte and White City	90 (dropped to 80 in Nov 15)	92.1* (87.8)**	87.8* (79.5)**	-4.3* (-8.3)**	-4.7%* (-9.0%)**
Highway 12 near Martensville	90 (dropped from 110 in June 2014)	104.7	87.0	-17.7	-16.90%

*When posted speed was 90 km/h

**At 80 km/h posted speed limit. Average speed was 87.8 km/h just before the drop to 80 km/h

Speed Variances

Table 5 indicates the 85th percentile speeds (the speed that drivers tend to adopt according to the road environment, which indicates degree of compliance with the posted speed limit, and hence the degree of traffic calming) across the high-speed corridors before and after implementation of the pilot.

- The data indicates that the speed at or below which 85% of all vehicles were observed travelling under free-flowing conditions past the camera locations trended downwards towards the posted speed limit following the installation of the cameras.
- The reduction in the average 85th percentile speed across the high-speed locations following the implementation of the pilot by between 5.6% and 18.1% in the direction of the posted speeds is a positive outcome.

Table 5: 85th Percentile Speeds on High-speed Locations: Before PSE vs. After PSE

High-Speed Locations	Posted Speed Limit (km/h)	85 th Percentile Speed Before PSE (km/h)	85 th Percentile Speed After PSE (km/h)	Change in Speed After PSE (km/h)	Per Cent Change in Speed After PSE(km/h)
Highway 1 and 9th Ave. intersection in Moose Jaw	80	90.0	84.4	-5.6	-6.2%
Ring Road in Regina	100	108.4	102.3	-6.1	-5.6%
Circle Drive in Saskatoon	90	109.4	92.6	-16.8	-15.4%
Highway 1 East between Pilot Butte and White City	90 (dropped to 80 in Nov 15)	99.0* (93.4)**	93.4* (84.3)**	-5.6* (-9.1)**	-5.7%* (-9.7%)**
Highway 12 near Martensville	90 (dropped from 110 in June 2014)	113	92.6	-20.4	-18.1%

*When posted speed was 90 km/h

**At 80 km/h posted speed limit. Average speed was 87.8 km/h just before the drop to 80 km/h

School Zones

Average Speeds

Speeding behaviour at the school zones was also measured by changes in both the average and 85th percentile speeds before and after PSE implementation. Figure 3 shows the trends in average vehicular speed, and from March 2015 to March 2017 in the PSE school zones. School zones in Saskatoon and Regina showed decreasing trends in the average vehicular speed. Those in Moose Jaw saw a relatively stable trend in the average speed.

Since there were no baseline speed data for the school zone locations, we compared the average speeds from April 2015 through March 2016 to that from April 2016 to March 2017. The data indicates that average speeds in the Saskatoon zones reduced from 29.3 km/h to 29.0 km/h a year later. Average speeds in Regina reduced from 38.8 km/h to 37.9 km/h, while Moose Jaw remained relatively unchanged from 37.7 km/h to 37.8 km/h per hour a year later.

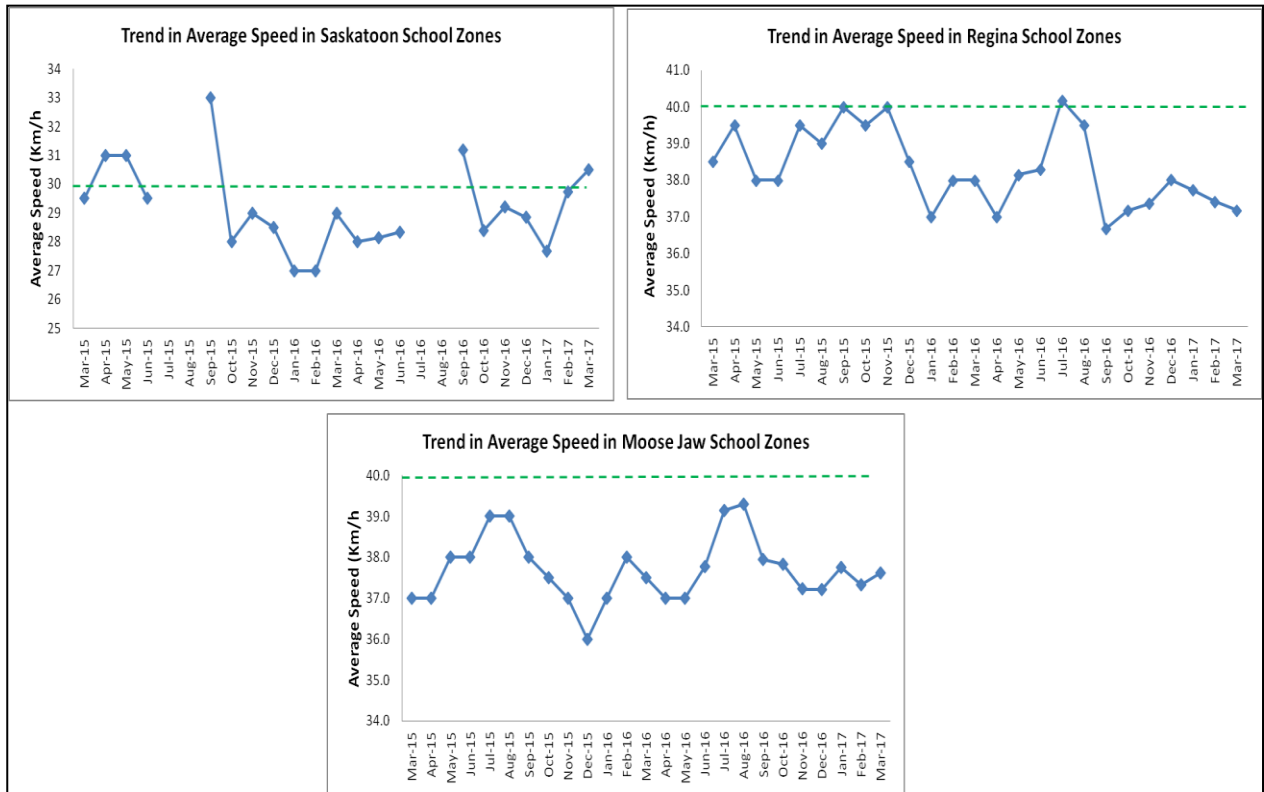


Figure 3: Trends in Average Speed in School Zones (Mar. 2015 – Mar. 2017)

Speed Variances

Figure 4 shows the trends in average 85th percentile speed across the school zones locations in Saskatoon, Regina and Moose Jaw. The 85th percentile speeds were monitored from March 2015 through March 2016 and compared with the same period a year later. The data indicates that Regina and Saskatoon school zones exhibited a downward trend in the average 85th percentile speed while the trends remained stable for Moose Jaw.



Figure 4: Trends in the 85th Percentile Speed in School Zones (Mar. 2015 – Mar. 2017)

3.3.3 Speed Threshold Violation Rates at All PSE Locations

High-Speed Locations

Appendix A presents data on speed threshold violation rates at the high-speed camera locations (Highway 1 and 9th Ave. in Moose Jaw, Ring Road in Regina, Circle Drive in Saskatoon, Highway 1 East between Pilot Butte and White City, and Highway 12 near Martensville) from March 2015 to March 2017. SGI set a target violation rate of less than one percent. The data indicates that:

- With the exception of the Moose Jaw corridor the average monthly speed violation rate during this period was less than 1%, of the vehicles traveling through the high-speed corridors. The average for Moose Jaw was 2.08%.
- Although the Moose Jaw corridor witnessed monthly speed violation rates above the target 1% of vehicles travelling through that corridor for most of the pilot’s duration, the violation rate decreased from 4.3%, when ticketing commenced in March 2015, to 0.80% (below 1%) at the end of the pilot in March 2017.

School Zones

The violation rates for school zone locations are also shown in Appendix A. A lower degree of compliance was realized in the school zones compared to the high-speed locations. The average violation rate in the school zones was between 1.07% and 2.3%. Looking at the trends in violation rates, however, it can be noted that:

- Saskatoon school zones moved from a violation rate of 8.7% in May 2015 to 2.4% in March 2017 (Note: there are no cameras used during the summer months of July and August).
- Regina school zones moved from a violation rate of 6.1% in June 2015 to 0.5% in March 2017.
- Moose Jaw school zones moved from a violation rate of 2.6% in July 2015 to 0.6% in March 2017.

3.3.4 Impact on Collisions at PSE Locations

The effects of the PSE program on collision experience were determined using a simple before and after study as well as a robust intervention analysis. The intervention analysis was used to validate the changes estimated from the simple before and after analysis, while accounting for some socio-economic factors (e.g. consumer price index, the unemployment rate, and gas price) and environmental factors (e.g. average temperature, average snow, and total precipitation).

It is expected that when average speed is reduced, there will be an associated reduction in the frequency and severity of speed-related collisions (the target collisions) at the camera locations. In this report, speed-related collisions are defined as collisions associated with exceeding the posted speed limit or driving too fast for road conditions. Casualty collisions are those that result in death and injuries whereas total collisions include the less severe property damage only (PDO) collisions.

Simple Before and After Study

The simple before and after study analyzed the changes in all speed-related and non-speed related casualty and total collisions at the camera locations. A baseline average collision per year for the period 2010 – 2014 (prior to the implementation of the pilot) was compared to those which occurred between January 2015 and March 2017.

High-Speed Locations

This section presents the safety outcome at the high-speed locations using the before and after analysis, the results of which are presented in Table 6.

- In general, casualty collisions were reduced to a higher degree than total collisions, including PDO collisions, at all high-speed locations. In the case of speed-related collisions, there were reductions in both casualty and total collisions after the installation of the cameras.
- Speed-related casualty collisions were reduced by 22 over the pilot when compared to the baseline average, while total speed-related collisions were reduced by 25.
- Overall, casualty collisions reduced by 28, leading to 40 fewer injuries.
- Although there were reductions in non-speed related casualty collisions and injuries (18 fewer injuries), total non-speed related collisions increased mainly due to factors such as following too closely, distracted driving, and improper lane usage or passing.

Table 6: Changes in Collisions and Injuries at High-Speed Locations: Jan. 2015 - Mar. 2017 vs. Baseline

Type of Collision	Baseline Average Annual Collisions and Injuries Before PSE (2010-2014)			Average Annual Collisions and Injuries After PSE (Jan. 2015-Mar. 2017)			Change in Total Collisions (Jan. 2015 - Mar. 2017) over Baseline	Change in Casualty Collisions (Jan. 2015 - Mar. 2017) over Baseline	Change in Total Injuries (Jan. 2015 - Mar. 2017) over Baseline
	Total Collisions	Casualty Collisions	Total Injuries	Total Collisions	Casualty Collisions	Total Injuries			
All Types	981	213	289	988	185	249	7	-28	-40
Speed-Related	97	35	43	72	13	21	-25	-22	-22
Non-Speed Related	884	178	246	916	172	228	32	-6	-18

School Zones

The overarching goal of putting cameras in school zones was to reduce the average speed of travel to lower the risk of injury to children in these zones. Table 7 presents collisions in school zones before and after the installation of the cameras. Because there were very few speed-related collisions recorded for school zones, the analysis looked at overall collisions and injuries. The results in the table indicate that the cameras in all enforced school zones were associated with preventing seven casualty collisions and 42 collisions of all types annually since the implementation of the speed cameras. The reduction in casualty collisions led to 10 fewer injuries in the school zones as a result.

**Table 7: Changes in Collisions and Injuries at All Enforced School Zones:
Jan. 2015 - Mar.2017 vs. Baseline**

Baseline Average Annual Collisions and Injuries Before PSE (2010-2014)			Average Annual Collisions and Injuries After PSE (Jan. 2015 - Mar. 2017)			Change in Total Collisions (Jan. 2015 - Mar. 2017) over Baseline	Change in Casualty Collisions (Jan. 2015 - Mar. 2017) over Baseline	Change in Total Injuries (Jan. 2015 - Mar. 2017) over Baseline
Total Collisions	Casualty Collisions	Total Injuries	Total Collisions	Casualty Collisions	Total Injuries			
99	21	26	57	14	16	-42	-7	-10

Intervention Analysis

Considering the implementation of the PSE program as an intervention to reducing speed-related collisions at the enforced locations, we used the intervention analysis method to determine the impact of the PSE program. This method takes into consideration factors such as: reference group collisions (locations similar to the high-speed and school zones where no cameras were installed); traffic counts (average annual daily traffic); socio-economic factors (e.g. consumer price index, unemployment rate, gas price) and environmental factors (total precipitation, mean snowfall, and mean temperature). We analyzed the effect of PSE on speed-related collisions, non-speed related collisions and all collisions (speed and non-speed related collisions combined) for the high-speed corridors. An intervention variable indicating when the pilot came into effect was created as follows:

Table 8: Definition of Intervention Variable

Intervention Variable	Code	Period	Description
Intervention	0	if Jan 2010 <= date <= Dec 2014	Before photo speed enforcement (PSE)
	1	if Jan 2015 <= date <= Dec 2016	After photo speed enforcement (PSE)

The response variables were:

Model 1 – Total collisions

Model 2 – Property damage only (PDO) collisions

Model 3 - Casualty collisions
Negative Binomial Regression

This study used the negative binomial regression technique, along with generalized estimating equations (GEE) to measure the impact of the PSE program. GEE technique was used to accommodate correlated observations within the study data (Liang & Zeger, 1986). Negative binomial (NB) regression is a widely used regression technique for modeling traffic collision count data which normally over-dispersed (Lord, Washington & Ivan, 2005). The NB regression improves the Poisson model by introducing a random heterogeneity in the conditional mean of the Poisson model. Suppose a random count of events, Y follows a negative binomial distribution, given a vector of independent variables x_i , the conditional mean model of the NB regression can be expressed as follows:

$$E[y_i | x_i, \varepsilon_i] = \exp(\alpha + x_i' \beta + \varepsilon_i) = h_i \mu_i \quad (1)$$

Where ε_i represents the random heterogeneity, $\mu_i = \exp(\alpha + x_i' \beta)$, and $h_i = \exp(\varepsilon_i)$. The model assumes that h_i follows a one parameter gamma distribution, $G(\varphi, \varphi)$ with mean 1 and variance $1/\varphi = K$. Thus, the functional form of h_i can be written as:

$$f(h_i) = \frac{\varphi^\varphi \exp(-\varphi h_i) h_i^{\varphi-1}}{\Gamma(\varphi)}, h_i \geq 0, \varphi > 0. \quad (2)$$

After integrating h_i out of the joint distribution, the probability density function of the NB distribution becomes:

$$Prob[Y = y_i | x_i] = \frac{\Gamma(\varphi + y_i) r_i^\varphi (1 - r_i)^{y_i}}{\Gamma(1 + y_i) \Gamma(\varphi)}, y_i = 0, 1, \dots, \varphi > 0, r_i = \varphi / (\varphi + y_i) \quad (3)$$

The conditional mean and variance of the NB model after integration are formulated as:

$$E[y_i | x_i] = \mu_i \quad (4)$$

$$Var[y_i | x_i] = y_i [1 + (1/\varphi) y_i] = y_i [1 + K y_i] \quad (5)$$

Where $K = Var[h_i]$

The PROC GENMOD within the SAS Enterprise Guide Version 7.1 was used to develop the NB models. Average annual daily traffic (AADT) was used as an offset in the modeling procedure for all models concerning high-speed high-risk corridors. AADT was not available for the PSE school zones before the introduction of the pilot program.

Intervention Analysis Results

High-Speed Locations

The intervention effects of the PSE program on high-speed locations are presented in Table 9. The table presents a summary of the output in the form of percentage changes in collisions after PSE relative to the baseline average before PSE. The statistical significance (at the 95% confidence level) and the standard error are presented in the parenthesis. Detailed intervention analysis output can be found in Appendix B.

As presented in Table 9, PSE reduced speed-related collisions of all severity types at the high-speed locations. Specifically, the model estimated a 54% reduction in average annual speed-related casualty collisions, a 68% reduction in speed-related PDO collisions, and a 53% reduction in total speed-related collisions (52 fewer total collisions). The reductions in all speed-related collisions were statistically significant at the 95% confidence level.

The model did not find a similar impact either on non-speed related collisions or on all collision types. The model estimated a 6% reduction in total non-speed related collisions (statistically non-significant at the 95% confidence level) and 12% reduction in total collisions of all types after the PSE program.

Table 9: Changes in Collisions at High-Speed Locations based on Intervention Analysis: Jan. 2015 - Dec. 2016 vs. Baseline

		Baseline Average Annual Collisions Before PSE (2010-2014)			Average Annual Collisions After PSE (Jan. 2015 - Dec. 2016)			Percent Change in PDO Collisions	Percent Change in Casualty Collisions	Percent Change in Total Collisions
		PDO	Casualty	Total	PDO	Casualty	Total			
Impact of PSE on High-Speed High-Risk Corridors	All Collisions	768	213	981	875	212	863	14% (0.0394, 0.0711)	-0.44% (0.9608, 0.0885)	-12% (0.0344, 0.0541)
	Speed Related Collisions	62	35	97	20	16	45	-68% (<0.0001, 0.0513)	-54% (0.0066, 0.1318)	-53% (<0.001, 0.0434)
	Non-Speed Related Collisions	706	178	884	847	171	831	20% (<0.0001, 0.0528)	-4% (0.6547, 0.0822)	-6% (0.519, 0.0841)

School Zones

Table 10 presents a summary of the intervention analysis results for collisions at all PSE school zones. Detailed results are attached in Appendix B. Table 8 indicates that the PSE program

reduced all types of collisions in enforced school zones. Since the implementation of the PSE program, there were 44 fewer collisions annually (44% reduction) that include 13 fewer casualty collisions (39% reduction). Reductions in collisions were statistically significant at the 95% confidence level.

Table 10: Changes in Collisions at All Enforced School Zones based on Intervention Analysis: Jan. 2015 - Dec. 2016 vs. Baseline

Baseline Average Collisions Before PSE (2010-2014)			Average Collisions After PSE (Jan. 2015 - Dec. 2016)			Percent Change in PDO Collisions	Percent Change in Casualty Collisions	Percent Change in Total Collisions
PDO	Casualty	Total	PDO	Casualty	Total			
78	21	99	40	13	55	-48% (<0.0001, 0.0145)	-39% (0.03, 0.1387)	-44% (<0.0001, 0.0402)

4.0 Financial Implications of the PSE Program

SGI’s vision for the PSE program was to achieve “zero ticket, zero crashes” in photo-enforced areas. To work towards this goal, the initial target set for the PSE pilot was to achieve a violation rate of less than 1% at all locations. SGI funds the infrastructure costs for this program; the costs associated with court processes and fines collections from tickets issued were borne by the Ministry of Justice. The Government publicly committed that should there be any revenue from the program net of program costs, it would be dedicated to traffic safety initiatives. Twenty-five per cent (25%) of the total revenue is allocated to the General Revenue Fund (to cover the administration costs of the court and collection process³); the remaining 75% is used to pay for operating the program and any amount left over is allocated to funding traffic safety improvements. As at February 28, 2017, the PSE program generated approximately \$10.43 million in revenue with approximate total expenses of \$5.41 million. The expense/revenue breakdown at camera locations is presented in Table 11.

³ The processes are presented in a separate process evaluation report.

Table 11: Revenues, Expenses and Net Revenues from the PSE Pilot by Location (March 2015 – February 2017)

Cameral Location	Revenue*	Expenses	Net Revenue
Highway Locations	\$1,255,953	\$1,136,810	\$119,143
Saskatoon	\$2,653,081	\$1,579,717	\$1,073,364
Regina	\$4,169,542	\$1,428,469	\$2,741,073
Moose Jaw	\$2,358,359	\$1,273,167	\$1,085,192
Total	\$10,436,935	\$5,418,163	\$5,018,772

*75% of total revenue

Net revenues at municipal locations go to the respective municipality for dedication to traffic safety initiatives. The City of Saskatoon spent \$460,000 of its net revenue from the PSE pilot on a number of traffic safety projects. These projects include: enforcement, pedestrian crossings, a pedestrian safety campaign, and traffic calming measures. The City of Regina spent \$256,000 of its portion of the net revenue on safety projects such as Operation Overdrive, intersection safety and child restraints. Moose Jaw is similarly reinvesting \$450,000 of its PSE revenue for law enforcement to conduct similar operations as Regina and to acquire traffic signal controls.

4.1 Cost-Benefit Analysis of the PSE Pilot

This section presents an economic analysis of the PSE pilot program on the basis of safety outcomes (i.e., collisions, fatalities and injuries) and the net revenues allocated to traffic safety improvements. The measures of effectiveness used in this section are the Cost-Benefit ratio (B/C) and net present value (NPV).

The B/C ratio is defined as:

$$\text{B/C Ratio} = \text{Present value of all safety benefits} / \text{Present value of Implementation Costs}$$

The net present value is determined as:

$$\text{NPV of Benefits} = \text{Accumulated annualized benefits} \times \text{Accumulated discount factor}$$

$$\text{NPV of Costs} = \text{Accumulated annualized costs} \times \text{Accumulated discount factor}$$

4.1.1 Benefits

The benefits of the PSE pilot are two fold: i) the safety effect in terms of reductions in collisions converted dollar values, and ii) the return on investments expected from additional traffic safety improvements from net revenue allocated to the municipalities. At a minimum, it is expected that each dollar invested by the municipalities in improving traffic safety would realize a return of one dollar.

In this section, the number of crashes prevented, the average collision costs, and revenues assigned to traffic safety fund are presented.

Number of Crashes Prevented

The analysis of the impact of PSE indicates that PSE, overall, prevented 27 injury collisions and one fatal collision annually in all high-speed locations combined between January 2015 and March 2017. However, there were 35 more property damage only (PDO) collisions registered annually in high-speed locations after the implementation of the cameras. In school zones, PSE contributed to 35 fewer PDO collisions, and 7 fewer injury collisions. In order to get a complete picture of the safety benefits associated with PSE, we calculated the dollar value of the savings using two scenarios:

- Scenario 1: In this scenario, we estimated the benefits based on direct insurance claim costs.
- Scenario 2: In this scenario, we estimated the benefits based on the societal costs⁴ per collision.

Average Collision Costs

In 2013, SGI developed the direct insurance costs of traffic collisions that involved Saskatchewan drivers and vehicles licensed in the province. In particular, costs were developed for many collision configurations including rural versus urban and crash configurations at intersections. Collisions from the Traffic Accident Information System (TAIS) database for 2010-2011 were extracted by severity, and merged with several SGI claims data tables to calculate the corresponding insurance costs for that same period.

The average costs per collision severity are presented in Table 12 for rural/highways and urban areas of Saskatchewan. Since the PSE pilot covers roads that are both rural/highways and urban roads, we used the unit costs for rural/highways from the Table for high-speed locations, and unit costs for urban roads for school zones.

⁴ Societal costs include costs related to start-up, operation and maintenance, advertising, court process, etc.

Table 12: Collision Costs in Saskatchewan: Rural/Highways vs. Urban

Collision Type	Rural/Highways	Urban	All Saskatchewan
Fatal	\$267,763	\$108,563	\$245,476
Injury	\$32,901	\$13,168	\$23,902
PDO	\$9,741	\$8,748	\$9,129
Average Collision	\$14,180	\$10,098	\$11,648

*Based on cost estimates developed using SGI TAIS and claims data and expressed in 2016 dollar values

Benefits from Traffic Safety Improvements

It is assumed that the revenue invested in traffic safety improvements would yield a B/C ratio greater than one. At the minimum, the reinvestment should generate a dollar equivalent of \$5,088,155 (\$2,544,078 annually), which is the net revenue allocated for traffic safety improvements between March 2015 and February 2017.

Calculation of Annual Crash Cost Savings

Using the average collision costs presented in Table 12, the annual crash cost savings of the PSE pilot project were calculated for the two scenarios and presented in Tables 13 and 14.

Scenario 1:

Table 13: PSE Benefits from SGI's Insurance Cost Perspective

PSE Locations	Collision Type	Annual Reductions in Collisions	Cost per Collision	Annual Savings
High-Speed Locations	Fatal	-1	\$267,763	\$267,763
	Injury	-27	\$32,901	\$888,327
	PDO*	35	\$9,741	-\$340,935
	Total			\$815,155
School Zones	Fatal	0	\$108,563	0
	Injury	-7	\$13,168	\$92,176
	PDO	-35	\$8,748	\$306,180
	Total			\$398,356
ALL PSE Locations	Grand Total			\$1,213,511

Scenario 2:

Table 14: ASE Benefits from Societal Cost Perspective

PSE Locations	Collision Type	Annual Reductions in Collisions	Cost per Collision	Annual Savings
High-Speed Locations	Fatal	-1	\$5,360,000	\$5,360,000
	Injury	-27	\$95,000	\$2,565,000
	PDO*	35	\$9,741	-\$340,935
	Total			\$7,584,065
School Zones	Fatal	0	\$5,360,000	0
	Injury	-7	\$95,000	\$665,000
	PDO	-35	\$9,741	\$340,935
	Total			\$1,005,935
ALL PSE Locations	Grand Total			\$8,590,000

*High-speed locations registered 35 more PDO collisions annually after the PSE pilot in high-speed locations

4.1.2 Pilot Program Costs

The PSE pilot program was associated with four components of costs: 1) start-up/capital costs, 2) operation and maintenance (O&M) costs, 3) advertising costs, and 4) court costs. Tables 15 and 16 present the estimated costs for scenario 1 and scenario 2, respectively. Start-up costs, O&M costs and media costs are estimated based on SGI’s direct expenses reported in the budget. Court costs are estimated based on an assumption that at least 5% of tickets issued would go to court as first appearances, and 3% will be resolved at trial (discussions with law enforcement stakeholders). It is assumed that a docket per case would take 10 minutes, and a trial would be approximately 45 minutes. The resolution of a ticket in court would usually involve standard hours of a provincial judge, a crown prosecutor, a deputy sheriff, and a court clerk. A detailed estimation of court costs is presented in Table C-1 of Appendix C.

Scenario 1:

Table 15: PSE Pilot Program Expenses from SGI’s Insurance Costs Perspective (Nov. 2014 –Mar 2017)

PSE Stage	Start-up/ Capital Costs	Operation and Maintenance (O&M) Costs	Advertising Costs
2014	\$158,683	\$140,538	\$301,370
2015	\$199,856	\$2,175,068	\$160,724
2016	-	\$2,337,706	-
2017 (Jan. – Mar.)	-	\$623,022	-
Total	\$358,539	\$5,276,334	\$462,094

Scenario 2:

Table 16: PSE Pilot Program Expenses from Societal Costs Perspective

PSE Stage	Start-up/ Capital Costs	Operation and Maintenance (O&M) Costs	Advertising Costs	Court Costs (Mar. 2015 – Mar. 2017)*
2014	\$158,683	\$140,538	\$301,370	
2015	\$199,856	\$2,175,068	\$160,724	
2016	-	\$2,337,706	-	
2017 (Jan. – Mar.)	-	\$623,022	-	
Total	\$358,539	\$5,276,334	\$462,094	\$705,697

*See Appendix C for court costs

To set up the cash flow for the Benefit-Cost analysis, it was assumed that the start-up/capital costs would be recovered over a period of 10 years (the assumed program life). We used the Capital Cost recovery approach to annualize the capital costs and media costs over the useful life of the project:

Annualized start-up cost = Capital Cost Recovery Factor (CRF) X start up/capital cost.

Annualized media cost = Capital Cost Recovery Factor (CRF) X media cost.

The CRF is determined using the following equation:

$$CRF = (1+i)^n i / (1+i)^n - 1 \tag{1}$$

Where n = useful life of the project, and i is the interest rate. The following assumptions were made in computing the CRF:

- Useful life of the program is 10 years;
- Interest rate is 6%; and
- Salvage life of equipment is 0.

Using these assumptions, the CRF was calculated as 0.135867958. Thus,

$$\text{Annualized start-up cost} = 0.135867958 \times \$358,539 = \$48,714$$

$$\text{Annualized media cost} = 0.135867958 \times \$462,094 = \$62,784$$

The annualized start-up/capital cost and advertising cost could be recovered annually until the end of the assumed program life, which is 10 years. Annual operation and maintenance costs and court costs were estimated as \$2,185,855 and \$352,849 respectively until the end of the projected program life.

4.1.3 PSE Cash Flow and Cost-Benefit (B/C) Calculations

Tables 17 and 18 indicate the cash flow over a 10-year time period (assumed) for estimating net present value (NPV) and Benefit-Cost (B/C) ratio from SGI’s insurance costs perspective (Scenario 1) and societal costs perspective (Scenario 2), respectively. The NPV of costs, savings, and net benefits were calculated using a discount rate of 6% (the Saskatchewan Government rate in 2016).

Table 17 indicates that should the PSE pilot continue to generate net annual benefits as presented, it will return a net present value of \$10.7 million (net benefit), and a benefit-cost ratio of 1.64:1. This is from SGI’s perspective.

Table 17: Cash Flow for Estimating NPV and B/C Ratio From SGI's Insurance Costs Perspective

Year	Start-up/Capital Costs (\$'000)	Operation and Maintenance Costs (\$'000)	Advertising Costs (\$'000)	Total Costs (\$'000)	Benefits (PSE Safety Outcomes) (\$'000)	Return on Investment on Safety Improvements (\$'000)	Total Annual Benefits (\$'000)	Net Benefits (\$'000)
1	-49	-2186	-63	-2297	1214	2544	3758	1460
2	-49	-2186	-63	-2297	1214	2544	3758	1460
3	-49	-2186	-63	-2297	1214	2544	3758	1460
4	-49	-2186	-63	-2297	1214	2544	3758	1460
5	-49	-2186	-63	-2297	1214	2544	3758	1460
6	-49	-2186	-63	-2297	1214	2544	3758	1460
7	-49	-2186	-63	-2297	1214	2544	3758	1460
8	-49	-2186	-63	-2297	1214	2544	3758	1460
9	-49	-2186	-63	-2297	1214	2544	3758	1460

10	-49	-2186	-63	-2297	1214	2544	3758	1460	
NPV								10,747	
B/C Ratio				1.64					

The cash flow analysis in Table 18 shows that when costs are included from a societal perspective, the PSE program will generate a net present value of \$62.4 million (net benefit) and return \$4.20 dollars to society for each dollar invested by SGI (B/C ratio).

Table 18: Cash Flow for Estimating NPV and B/C Ratio from Societal Costs Perspective

Year	Start-up/Capital Costs (\$'000)	Operation and Maintenance Costs (\$'000)	Media Costs (\$'000)	Court Costs (\$'000)	Total Costs (\$'000)	Benefits Savings (PSE Safety Outcomes) (\$'000)	Return on Investment on Safety Improvements (\$'000)	Total Annual Benefits (\$'000)	Net Benefits (\$'000)
1	-49	-2186	-63	-353	-2649	8590	2544	11134	8484
2	-49	-2186	-63	-353	-2649	8590	2544	11134	8484
3	-49	-2186	-63	-353	-2649	8590	2544	11134	8484
4	-49	-2186	-63	-353	-2649	8590	2544	11134	8484
5	-49	-2186	-63	-353	-2649	8590	2544	11134	8484
6	-49	-2186	-63	-353	-2649	8590	2544	11134	8484
7	-49	-2186	-63	-353	-2649	8590	2544	11134	8484
8	-49	-2186	-63	-353	-2649	8590	2544	11134	8484
9	-49	-2186	-63	-353	-2649	8590	2544	11134	8484
10	-49	-2186	-63	-353	-2649	8590	2544	11134	8484
NPV								62,442	
B/C Ratio				4.2					

4.1.4 Summary of Benefit-Cost Analysis

Overall, the PSE program would generate net present values from \$10.7 million to \$62.4 million at the end of its assumed project life if all costs and benefits remain the same as presented in Tables 13 through 18. This is equivalent to the project returning between \$1.64 and \$4.20 for each \$1 invested in the PSE program. Thus, the PSE project can be described as effective in improving safety with a positive return on investment.

6.0 Conclusion

This evaluation of the PSE pilot project found the following:

- The PSE pilot positively impacted speeding behaviour (speed violation rates) at both the high-speed locations and school zones.
- The 1% violation target has been achieved at almost all camera locations.
- Average speeds have been reduced between 3.4 km/h on the Ring Road in Regina (3.5% reduction) to 17.7 km/h on Highway 12 near Martensville (16.9% reduction). With the exception of Moose Jaw school zone locations, where the 85th percentile speed remained stable, the speed at or below which 85% of all vehicles were observed travelling under free-flowing conditions past the camera locations trended downwards towards the posted speed limit following the installation of the cameras.
- The pilot project has had a positive impact on the frequency and severity of collisions, especially the targeted speed-related collisions, at the camera locations. It is associated with reducing 35 casualty collisions (28 from high-speed locations and seven from school zones) resulting in an estimated 50 fewer injuries (40 from high-speed locations and 10 from school zones).
- The benefit–cost analysis of the PSE pilot from SGI’s insurance costs perspective indicates a net present value of \$10.7 million at the end of an assumed projected life of 10 years. This is equivalent to the project returning \$1.64 for each \$1 invested in the PSE program. From a societal perspective, the program would generate a net present value of \$62.4 million, which is equivalent to a B/C ratio of 4.2:1.
- Most Saskatchewan residents want the photo speed enforcement program to be continued and expanded to other areas of the province. Specifically, about 56% of the general public want the program to continue, while 93% of those who want the program to continue want it to expand.

The evaluation results indicate that the program is an effective enforcement tool for managing and calming traffic speeds and reducing speed-related collisions and injuries.

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Appendix A

Monthly Speed Threshold Violation Rates in High-Speed Locations (Mar. 2015 – Mar. 2017)

Speed Camera Locations	Mar. '15	Apr. '15	May. '15	Jun. '15	Jul. '15	Aug. '15	Sep. '15	Oct. '15	Nov. '15	Dec. '15	Jan. '16	Feb. '16	Mar. '16	Apr. '16	May. '16	Jun. '16	Jul. '16	Aug. '16	Sep. '16	Oct. '16	Nov. '16	Dec. '16	Jan. '17	Feb. '17	Mar. '17	Average Mar. '15 - Mar. '17
Highway 1 and 9 th Ave. intersection in Moose Jaw	4.32%	3.61%	2.92%	3.40%	6.15%	3.92%	1.90%	1.91%	2.30%	2.43%	1.35%	0.84%	1.28%	0.94%	1.37%	1.62%	1.17%	1.61%	1.15%	2.20%	1.53%	2.24%	0.60%	0.42%	0.80%	2.08%
Ring Road in Regina	0.34%	0.26%	0.21%	0.23%	0.65%	0.73%	0.40%	0.08%	0.07%	0.07%	0.14%	0.14%	0.25%	0.28%	0.32%	0.20%	0.18%	0.48%	0.28%	0.11%	0.10%	0.05%	0.12%	0.17%	0.39%	0.25%
Circle Drive in Saskatoon	0.41%	0.19%	0.19%	0.28%	0.43%	0.99%	0.28%	0.15%	0.22%	0.16%	0.22%	0.90%	0.63%	0.43%	0.57%	0.15%	0.39%	0.56%	0.13%	0.24%	0.29%	0.22%	0.24%	0.31%	0.38%	0.36%
Highway 1 east between Pilot Butte turnoff and White City	0.80%	0.90%	0.81%	0.93%	1.32%	1.38%	0.68%	0.53%	0.60%	0.68%	0.58%	0.58%	0.78%	0.78%	0.80%	1.10%	1.93%	1.32%	0.36%	0.43%	0.46%	0.73%	0.52%	0.51%	0.60%	0.80%
Highway 12 near Martensville	0.64%	0.67%	0.80%	0.74%	1.05%	0.80%	0.54%	0.47%	0.55%	0.61%	0.41%	0.55%	0.40%	0.27%	0.53%	0.65%	0.52%	0.41%	0.52%	0.62%	0.43%	0.43%	0.40%	0.59%	0.42%	0.56%

Monthly Speed Threshold Violation Rates in School Zones (Mar. 2015 - Mar. 2017)

Speed Camera Locations	Mar. '15	Apr. '15	May. '15	Jun. '15	Jul. '15	Aug. '15	Sep. '15	Oct. '15	Nov. '15	Dec. '15	Jan. '16	Feb. '16	Mar. '16	Apr. '16	May. '16	Jun. '16	Jul. '16	Aug. '16	Sep. '16	Oct. '16	Nov. '16	Dec. '16	Jan. '17	Feb. '17	Mar. '17	Average Mar. '15 - Mar. '17
Moose Jaw school zones	0.64%	0.67%	2.13%	1.88%	2.58%	2.36%	1.40%	1.31%	0.59%	0.42%	0.73%	1.21%	0.89%	0.46%	0.27%	0.79%	1.73%	2.14%	1.21%	0.78%	0.36%	0.21%	0.77%	0.62%	0.61%	1.07%
Regina school zones	1.69%	3.98%	2.21%	6.10%	3.23%	2.23%	2.32%	2.48%	2.75%	2.23%	1.16%	1.20%	2.05%	1.15%	1.48%	1.07%	2.23%	1.11%	0.32%	0.95%	1.10%	1.39%	0.57%	0.45%	0.52%	1.84%
Saskatoon school zones ¹	1.50%	5.59%	8.70%	6.26%	-	-	1.42%	1.67%	2.43%	1.10%	1.09%	0.54%	2.64%	0.42%	0.81%	0.51%	-	-	4.62%	1.56%	1.67%	0.94%	0.28%	2.18%	2.37%	2.30%

Appendix B

Intervention Analysis Output for High-Speed Locations

Speed-related Collisions

PDO Collisions

Analysis Of GEE Parameter Estimates						
Parameter	Estimate	Standard Error	95% Confidence Limits		Z	Pr > Z
Intercept	-14.246	2.5167	-19.1786	-9.3135	-5.66	<.0001
Intervention	-1.1545	0.1626	-1.4732	-0.8358	-7.1	<.0001
PDOSP_ref	0.0079	0.0034	0.0012	0.0147	2.31	0.0211
CPI	0.0435	0.0201	0.0042	0.0829	2.17	0.0302
Gas_Pr	-0.0403	0.0079	-0.0558	-0.0248	-5.1	<.0001
Tot_Prec	-0.0015	0.0007	-0.0029	-0.0002	-2.18	0.0292

Casualty Collisions

Analysis Of GEE Parameter Estimates						
Parameter	Estimate	Standard Error	95% Confidence Limits		Z	Pr > Z
Intercept	-13.5118	1.8353	-17.109	-9.9146	-7.36	<.0001
Intervention	-0.783	0.2884	-1.3483	-0.2177	-2.71	0.0066
CASSP_ref	0.0153	0.0032	0.009	0.0217	4.74	<.0001
CPI	0.0221	0.0064	0.0095	0.0347	3.44	0.0006
Gas_Pr	-0.0256	0.0111	-0.0474	-0.0038	-2.3	0.0214
Mean_Temp	-0.0607	0.0038	-0.0681	-0.0533	-16.02	<.0001
UR	-0.2932	0.0514	-0.3939	-0.1926	-5.71	<.0001

Total Collisions

Analysis Of GEE Parameter Estimates						
Parameter	Estimate	Standard Error	95% Confidence Limits		Z	Pr > Z
Intercept	-11.4592	1.1181	-13.6505	-9.2678	-10.25	<.0001
Intervention1	-0.7638	0.0932	-0.9464	-0.5812	-8.2	<.0001
TotSP_ref	0.0014	0.0005	0.0005	0.0023	3.06	0.0022
CPI	0.0091	0.0036	0.002	0.0162	2.5	0.0124
Gas_Pr	-0.0232	0.008	-0.0388	-0.0076	-2.92	0.0035
Tot_Prec	-0.0008	0.0003	-0.0014	-0.0001	-2.36	0.0185
Mean_Temp	-0.0561	0.0143	-0.0842	-0.028	-3.92	<.0001

Non-Speed Related Collisions

PDO Collisions

Analysis Of GEE Parameter Estimates						
Parameter	Estimate	Standard Error	95% Confidence Limits		Z	Pr > Z
Intercept	-9.8968	0.514	-10.9043	-8.8893	-19.25	<.0001
Intervention1	0.1832	0.044	0.097	0.2694	4.16	<.0001
PDONSP_ref	0.0001	0.0001	0	0.0002	1.75	0.0804
UR	-0.117	0.0684	-0.2511	0.017	-1.71	0.087
CPI	-0.0058	0.0023	-0.0103	-0.0013	-2.54	0.0111

Casualty Collisions

Analysis Of GEE Parameter Estimates						
Parameter	Estimate	Standard Error	95% Confidence Limits		Z	Pr > Z
Intercept	-14.0864	0.409	-14.8881	-13.2848	-34.44	<.0001
Intervention1	-0.0382	0.0854	-0.2056	0.1292	-0.45	0.6547
CASNSP_ref	0.003	0.0003	0.0024	0.0035	10.37	<.0001
CPI	0.0103	0.0022	0.006	0.0147	4.66	<.0001
Mean_Snow	-0.0004	0.0002	-0.0008	0	-1.96	0.0494
UR	-0.0451	0.0204	-0.0851	-0.0051	-2.21	0.027

Total Collisions

Analysis Of GEE Parameter Estimates						
Parameter	Estimate	Standard Error	95% Confidence Limits		Z	Pr > Z
Intercept	-10.8389	0.1524	-11.1376	-10.5401	-71.11	<.0001
Intervention1	-0.0575	0.0891	-0.2321	0.1172	-0.64	0.519
TotNSP_ref	0.0001	0.0001	0	0.0002	2.3	0.0217
Tot_Prec	-0.0002	0.0001	-0.0003	-0.0001	-3.6	0.0003

All Collisions

PDO Collisions

Analysis Of GEE Parameter Estimates						
Parameter	Estimate	Standard Error	95% Confidence Limits		Z	Pr > Z
Intercept	-10.9035	0.4068	-11.7009	-10.1061	-26.8	<.0001
Intervention1	0.1287	0.0625	0.0063	0.2512	2.06	0.0394
PDO_ref	0	0.0001	-0.0001	0.0001	0.42	0.6761
Mean_Temp	0.0112	0.0016	0.008	0.0144	6.85	<.0001
Mean_Snow	0.0023	0.0002	0.0019	0.0028	9.8	<.0001
UR	-0.0618	0.0685	-0.1961	0.0724	-0.9	0.3667
Tot_Prec	-0.0002	0.0001	-0.0004	-0.0001	-2.96	0.0031

Casualty Collisions

Analysis Of GEE Parameter Estimates						
Parameter	Estimate	Standard Error	95% Confidence Limits		Z	Pr > Z
Intercept	-13.7127	0.5332	-14.7577	-12.6677	-25.72	<.0001
Intervention1	-0.0044	0.0889	-0.1786	0.1698	-0.05	0.9608
CAS_ref	0.0025	0.0005	0.0016	0.0034	5.39	<.0001
UR	-0.0751	0.0243	-0.1228	-0.0274	-3.09	0.002
CPI	0.0092	0.0034	0.0025	0.0159	2.71	0.0067
Mean_Temp	-0.0041	0.0009	-0.0058	-0.0024	-4.74	<.0001

Total Collisions

Analysis Of GEE Parameter Estimates						
Parameter	Estimate	Standard Error	95% Confidence Limits		Z	Pr > Z
Intercept	-11.3051	0.5597	-12.4022	-10.2081	-20.2	<.0001
Intervention1	-0.1303	0.0616	-0.2509	-0.0096	-2.12	0.0344
Tot_ref	0.0001	0	0	0.0001	2.92	0.0035
Mean_Temp	0.0152	0.0016	0.012	0.0184	9.26	<.0001
Mean_Snow	0.0024	0.0002	0.002	0.0028	11.83	<.0001
Gas_Pr	-0.0045	0.0014	-0.0073	-0.0017	-3.19	0.0014
CPI	0.0067	0.0043	-0.0018	0.0152	1.55	0.1208
Tot_Prec	-0.0002	0.0001	-0.0004	-0.0001	-3.11	0.0019

Intervention Analysis Output for School Zones**All Collisions***PDO Collisions*

Analysis Of GEE Parameter Estimates						
Parameter	Estimate	Standard Error	95% Confidence Limits		Z	Pr > Z
Intercept	2.1802	0.3963	1.4035	2.9569	5.5	<.0001
Intervention1	-0.6589	0.0281	-0.7139	-0.6039	-23.46	<.0001
PDO_ref	-0.0017	0.003	-0.0076	0.0042	-0.56	0.5733
CPI	0.0134	0.0021	0.0092	0.0176	6.25	<.0001
Gas_Pr	-0.0089	0.0009	-0.0107	-0.0072	-9.92	<.0001
Mean_Temp	-0.0196	0.0045	-0.0284	-0.0108	-4.36	<.0001
Mean_Snow	0.002	0.0006	0.0009	0.0032	3.59	0.0003

Casualty Collisions

Analysis Of GEE Parameter Estimates						
Parameter	Estimate	Standard Error	95% Confidence Limits		Z	Pr > Z
Intercept	-0.7522	0.2728	-1.2868	-0.2176	-2.76	0.0058
Intervention1	-0.4927	0.227	-0.9375	-0.0478	-2.17	0.03
CAS_ref	-0.0523	0.0447	-0.1399	0.0353	-1.17	0.2416
CPI	0.0143	0.0015	0.0114	0.0173	9.62	<.0001
Mean_Temp	0.0283	0.003	0.0223	0.0343	9.3	<.0001
Mean_Snow	0.0056	0.0005	0.0045	0.0066	10.14	<.0001
UR	0.058	0.0288	0.0016	0.1144	2.02	0.0437

Total Collisions

Analysis Of GEE Parameter Estimates						
Parameter	Estimate	Standard Error	95% Confidence Limits		Z	Pr > Z
Intercept	2.0683	0.4245	1.2362	2.9004	4.87	<.0001
Intervention1	-0.5881	0.0724	-0.7301	-0.4461	-8.12	<.0001
Tot_ref	0.0235	0.0113	0.0014	0.0456	2.08	0.0372
CPI	0.0076	0.0031	0.0015	0.0137	2.43	0.0152
Tot_Prec	-0.0008	0.0003	-0.0013	-0.0003	-3.21	0.0013
UR	0.0602	0.0135	0.0338	0.0866	4.48	<.0001
Gas_Pr	-0.0015	0.0033	-0.0081	0.005	-0.45	0.6501

Appendix C

Estimation of Court Costs Associated with the PSE Pilot

It is assumed that at least 5% of tickets issued would go to court dockets, and 3% will be resolved by a trial. It is also assumed that a case in a docket would take 10 minutes, and a trial would be approximately 45 minutes. The resolution of a ticket in court would usually involve standard hours of a provincial judge, a crown prosecutor, a deputy sheriff, and a court clerk.

Hourly Salary

Table C-1 shows the approximate hourly salaries of a provincial judge, a crown prosecutor, a deputy sheriff, and a court clerk. The table also provides the links that were used to collect the hourly salary information.

Table C-1: Average Hourly Salary of a Provincial Judge, a Crown Prosecutor, a Deputy Sheriff, and a Court Clerk in Saskatchewan

Items	Average Hourly Salary	Source of Information
Provincial Judge	\$137	http://www.justice.gov.sk.ca/provcourtcomm/replys2011/06%20gov%27t%20reply%20-%20Tab%20B%20-%20Marshall%20Report.pdf
Crown Prosecutor	\$61	http://lawstudents.ca/forums/topic/29239-crown-salary-ranges-2012/
Deputy Sheriff	\$38	https://ca.indeed.com/salaries/Deputy-Sheriff-Salaries-at-Government-of-Saskatchewan,-Regina-SK https://www.livingin-canada.com/salaries-for-police-officers-canada.html
Court Clerk	\$25	http://www1.salary.com/CA/Ontario/Court-Clerk-salary.html https://www.glassdoor.ca/Salaries/canada-court-clerk-salary-SRCH_IL.0,6_IN3_KO7,18.htm https://alis.alberta.ca/occinfo/occupations/judicial-clerk/71002570/

Estimation of Court Costs

Table C-2 presents court costs that would incur for resolving all tickets issued that ended up being in a provincial court. Between March 2015 and March 2017, the PSE pilot issued a total of 115,878 speeding tickets; of which 8,111 tickets would end up going to court (approximately 5,794 tickets would go to court dockets and 2,318 tickets would go to trials). Court costs are estimated based on the hourly salary presented in Table C-1, and assumed hours (i.e., 10 minutes for a docket, and 45 minutes for a trial) that would require for resolving all 8,111 cases in court. The Table indicates that during the period of pilot, assumedly, \$705,697 converted

dollar value of court hours was lost in resolving the cases. To set up a cash flow, the annualized court costs was estimated as \$352,849 for each of assumed 10 years of program life.

Table C-2: Court Costs Associated with the PSE Pilot**

	Total Speeding Tickets Issued (Mar. 2015 - Mar. 2017)	Docket (5% of Tickets Issued)	Trial (3% of Tickets Issued)	Total
	115,878	5,794	2,318	
Court Hours		966	1738	
Court Costs		\$252,035	\$453,662	\$705,697
Annualize Court Costs				\$352,849

**These costs do not include other administrative costs borne by the Ministry of Justice’s Fine Collections and other departments. These, though significant, were not available at the time of preparing this report. The fine collection processes are outlined in a separate Process Evaluation report.