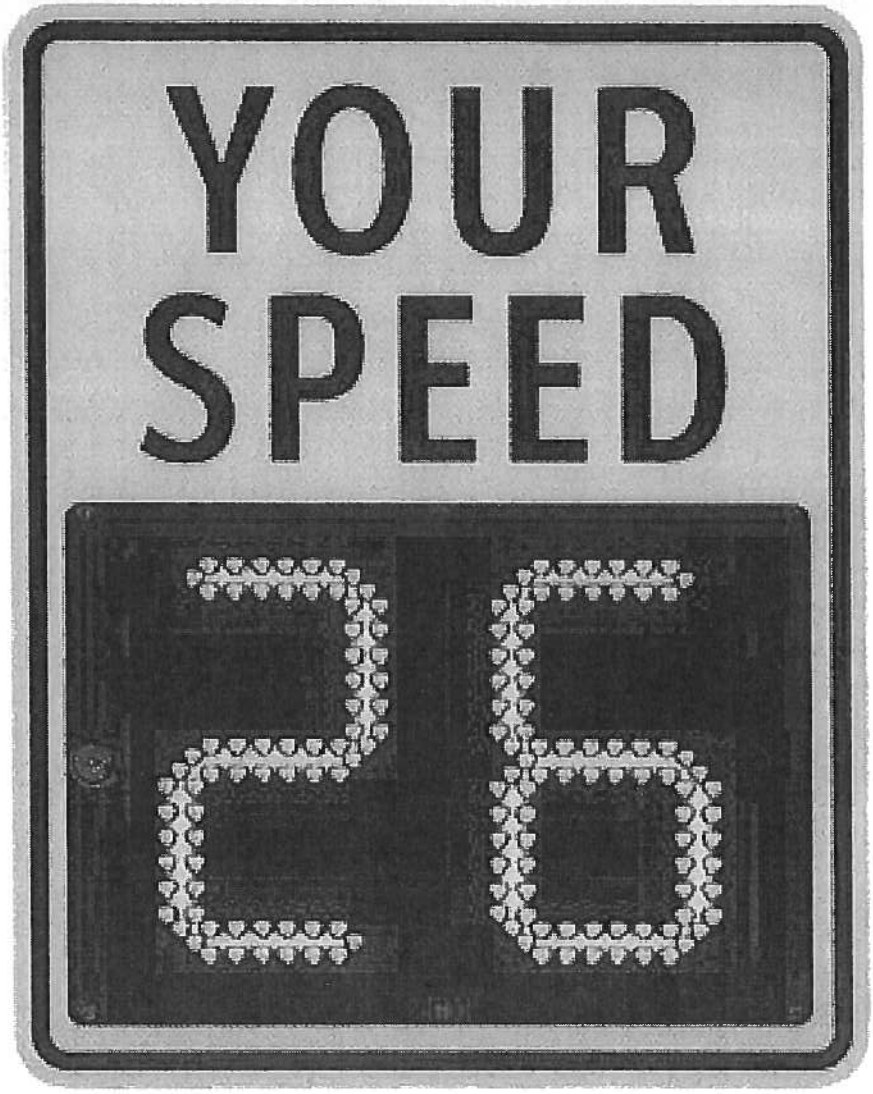
SAFE PACE 100 PILOT PROJECT: WORK ZONE SPEED REDUCTION



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ACKNOWLEGEMENTS

This project was initiated by MHI Northern Region Pavement Crew Member Derrick Miller. Thanks to Derrick Miller and Prince Albert Area Manager Terry Storey for supervising data collection and the foresight to pursue application of this product in Saskatchewan Ministry of Highways & Infrastructure work zones for increased safety.

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With the increasing age of Saskatchewan highway infrastructure, more frequent maintenance is necessary. This increased work, in conjunction with growing traffic volumes, results in more conflicts between the motoring public and Ministry of Highways & Infrastructure (MHI) workers. Observations by MHI staff suggest motorists are frequently travelling above the posted 60 km/hr speed limit when travelling through highway work zones. In an effort to combat this safety concern, the Northern Region purchased two SP-100 Speed Monitoring Radar Units and developed a pilot project to assess the viability of widespread implementation. Similar studies conducted in other jurisdictions were examined to determine best practises and expected results. Results of the pilot study are summarized as follows:

Table 2: Summary of Speed Results (Raw Data)

	Minimum Speed	Maximum Speed	Average Speed	15th %ile Speed	85th %ile Speed	Speed Differential
Before	25.0	135.0	62.7	35	85.0	50.0
After	25.0	115.0	47.0	35	65.0	30.0
Change	0.0	-20.0	-15.7	0.0	-20.0	-20.0

Table 7: Summary of Benefit/Cost Analysis

BENEFIT/COST RATIO			
Total Four-Year B/C			
	Benefit	$ 23,439,731.68	
	Cost	$ 150,000.00	
	Benefit/Cost	156.3	
Annualized B/C			
	Benefit	$ 6457,412.74	/year
	Cost	$ 41,323.51	/year
	Benefit/Cost	156.3	/year

Analysis suggests these units produce statistically significant reductions in vehicle speed and it is therefore recommended:

- Additional SP-100 units are purchased for use by MHI work crews to allow for a more diverse sampling;
- Additional education is provided to those using the units as to how to program units for "stealth mode" and "display" mode;
    - As units require programming in order to switch modes, it is recommended units be used on longer term projects in future pilot testing so "stealth" and "display" results can be obtained for the same work location/work type;
- A standardized cover form, similar to that attached in *Appendix D*, is provided to work crews to ensure clear information is provided to the analysis team; and
- Before/After data is collected from a variety of work types to determine where units are most effective and to develop a hierarchy of distribution priority.

1.0 INTRODUCTION

With the increasing age of Saskatchewan highway infrastructure, maintenance becomes increasingly necessary. This increased work, in conjunction with growing traffic volumes, results in more conflicts between the motoring public and Ministry of Highways & Infrastructure (MHI) workers. According to SGI, there is an average of 127 accidents in construction zones in Saskatchewan annually resulting in 4 fatalities and 263 injuries between 2007 and 2011 [1] [2]. Approximately 17% of these accidents could be directed correlated to excessive speed using the SGI TAISIA database [2], but it can be assumed the severity of most accidents would be significantly reduced with lower vehicle speeds. The use of radar speed signs has become increasingly common in recent years throughout the North American highways system. Following a presentation on such devices at a recent UMC meeting, MHI staff discussed the installation of radar speed signs on a pavement marking truck as a pilot project. Two SafePace 100 (SP-100) radar speed signs were purchased from Traffic Logix Co. at a cost of $2169 per unit.

2.0 OBJECTIVES

This project is intended to provide information to MHI to assist in determining the effectiveness of this method of speed control on Saskatchewan highways and, if effective, where best to deploy these units. In order to measure the effectiveness of these units, the project team developed the following metrics for evaluation:

- Reduces speed of vehicles in work zones;
- Encourages speed limit compliance; and
- Increases safety of MHI staff and the motoring public based on discussions with those using the devices.

3.0 LITERATURE REVIEW

There have been several studies conducted on the effectiveness of speed monitoring units since the mid-1980s [3]. Most of this research has been focused on speed reduction in school and work zones [4]. As such, this is not an untested practise and there is sufficient data to suggest this method should be highly effective.

The seminal work on the subject was conducted by South Dakota DOT in 1996. This study placed a trailer-type speed monitoring unit in work zones supplemented with a 45 mph (72.4 km/hr) advisory speed sign [5]. In this study, the speed display was only activated when vehicle speeds exceeded 70 mph (113 km/hr). Only vehicles with headways of greater than 4.0 seconds [5] were used in speed analysis so as to only analyze "free-flowing" vehicles and the study period did not start until after the displays had been in place for 7 days so as to avoid capturing the novelty effects. It was found the mean speed was reduced by 0-1.7 mph (0-2.7 km/hr) and the 85th percentile speed was reduced by 1.2-3.9 mph (1.9-6.3 km/hr) [5]. The ANOVA indicated reductions in mean speed were not significant, but 85th percentile speed reductions were significant. The use of radar speed monitoring trailer was found to reduce the number of passenger vehicles and trucks travelling greater than 70 mph (113 km/hr) by 20-25% and 40% [5], respectively.

It was believed reductions were greater in trucks due to a higher prevalence of radar detectors. These would register the signs as radar detectors similar to those used by police in speed enforcement. This study recommended the use of these radar units in work zones to increase safety based on a test period of 3-5 days. It also suggests that larger reductions in speed could have been achieved if the speed at which the display was triggered was to be lowered.

In another study conducted by Geza Pesti and Patrick T. McCoy, the long-term effectiveness of speed monitoring displays was evaluated as part of the Midwest States Smart Work Zone Deployment Initiative. Three radar units were deployed for a 5-week period along a 2.7 mile (4.35 km) section between two work zones on I-80 near Lincoln, Nebraska. Average daily traffic volumes on the road section were approximately 38 000 vehicles/day [6]. The posted speed limit was 75 mph (120 km/hr), but the speed was reduced in the work zone to 55 mph (89 km/hr) [6]. Traffic speeds were measured once before installation, five times during the 5-week test period, and once after the removal of the radar units. Results at the three locations were as follows [6]:

- Mean Speed Reduction: 3-4 mph (4.8-6.4 km/hr)
- 85th Percentile Speed Reduction: 2-7 mph (3.2-11.3 km/hr)
- Passenger Vehicles:
    - % complying with speed limit: Before 3% - After 14-30%
- Trucks:
    - % complying with speed limit: Before 8% - After 24-40%

Pesti & McCoy found that speeds increased again upon removal of the speed monitoring devices. This method of speed control was therefore only recommended in short-term applications, unless a permanent unit was installed.

A study was conducted by Bowie, Saito & Burns to determine driver opinion of radar speed monitoring units. They found that 59% [7] of those surveyed believed speed monitoring units to be accurate and 75% [7] believed the units are not distracting or challenging to read. In another study 25 state DOTs were surveyed and 17 responded that police enforcement was the most effective means of speed reduction in work zones [7]; however, all admitted this method is not feasible given resource constraints. In the absence of enforcement, most agencies identified speed monitoring units as an effective alternative. This was confirmed through a study conducted by the Texas Transportation

Institute which compared several methods over two years including radar drones, radar-activated flashing flagger paddles, VMS, rumble strips, increased visibility of workers and equipment, and radar speed displays. This study found radar speed display units to be the most effective method of reducing vehicle speeds out of the methods tested [8].

The Maryland State Highway Administration has developed detailed guidelines for deployment of speed radar units. They are summarized as follows [9]:

- Should be used where speeding is known to occur under normal conditions;
- Use in urban areas is discouraged due to the small display size;
- Should not be used on highways with three or more lanes in one direction;
- Should not be used for more than two weeks in one location;
    - If used for more than two weeks, periodic police enforcement should be employed;
- Should be placed upstream of work zone location;
- Mounting height, lateral offset, and orientation of the speed display trailer should conform to guidelines in MUTCD sections 2A.18, 2A.19, and 2A.20;
- More than one unit should be used in work zones longer than 1 mile (1.6 km) and units should not be spaced closer than 1000 ft. (305 m); and
- The display should be visible from ½ mile (800 m).

A study conducted under California and Oregon Advanced Transportation Systems (COATS) entitled "Effective Deployment of Radar Speed Signs" [4] outlines in detail the policies of most state DOTs in regards to these units. A summary of speed results adopted from this report is outlined in *Table 1* below.

Table 1: Summary of Literature Study Review [4]

Study	Road Type	Location	Traffic	Speed Limit	Mean Speed Change	General Effectiveness
Pesti and McCoy	Rural 4-lane Divided	Nebraska	38 000	55 mph (88.5 km/hr)	3-4 mph (4.8-6.4 km/hr)	20-40% increase in compliance with speed limit
Carlson, et al.	Rural 4-lane Divided Short Term (1-12 hours)	Texas	7000	55 mph (88.5 km/hr)	2-3 mph (3.2-4.8 km/hr)	5.5-7% and 9.6-24.4% reduction in passenger vehicle and truck speeds, respectively
Chitturi and Benkohal	Rural 4-lane Divided	Illinois	n/a	n/a	4.4-6.7 mph (7.1-10.8 km/hr)	All speed reductions found to be statistically significant
Fountaine, et al.	Rural two/four-lane short-term	Texas	n/a	n/a	5 mph (8.0 km/hr)	Fewer vehicles found to exceed speed limit
Werties	Rural 4-lane Divided	South Dakota	4560	55 mph (88.5 km/hr)	1.7 mph (2.7 km/hr)	85th Percentile speed reduced from 68.2 mph (109.8 km/hr) to 66.5 mph (107.0 km/hr)
Wang, et al.	Rural 2-lane	Georgia	n/a	45 mph (72.4 km/hr)	7-8 mph (11.3-12.9 km/hr)	Speed variance decreased significantly. Long term speed reductions of 1-3 mph (1.6-4.8 km/hr)
Sorrell, et al.	Rural 2-lane	South Carolina	n/a	45 mph (72.4 km/hr)	5-7 mph (8.0-11.3 km/hr)	85th percentile speed reduced by 2-4 mph (3.2-6.4 km/hr)
Maze	Rural 4-lane Divided	Iowa	n/a	55 mph (88.5 km/hr)	3 mph (4.8 km/hr)	85th percentile speed reduced by 5 mph (8.0 km/hr)

The unit chosen for this pilot project was the Safe Pace 100 (SP-100) with 3-Cell battery from Traffic Logix Co. This unit has an 11" (28 cm) [h] x 5.6" (14 cm) [w] display [10]. The unit weighs approximately 23 lbs. (10.4 kg) and can operate between temperatures of -40°C and +85°C [10]. The battery is a 3-Cell Lithium-Ion Phosphate with a battery life of 2-3 weeks between charges [10]. The unit can pick up vehicle speeds from a distance of up to 300 ft. (91.4 m) [10]. The sign can be programmed only to display speeds when vehicles are travelling above a specified threshold and/or to activate a strobe light when vehicles travel above this threshold. Speeds are recorded to the nearest 5 km/hr interval. Analysis software can be purchased for an additional $400. This software would not be necessary after the piloting stage.

The effectiveness of the units was measured based on before/after speed readings. "Before" data was represented by speed readings when the units were in "stealth" mode and "after" by speed readings when the units were in "display" mode. The analysis software does not give the user an indication of when the SP-100 is in "stealth" mode and when it is in "display" mode. In the initial pilot project, the user was relied on to provide this information following completion of data collection. In future data collection, a more robust collection framework should be used.

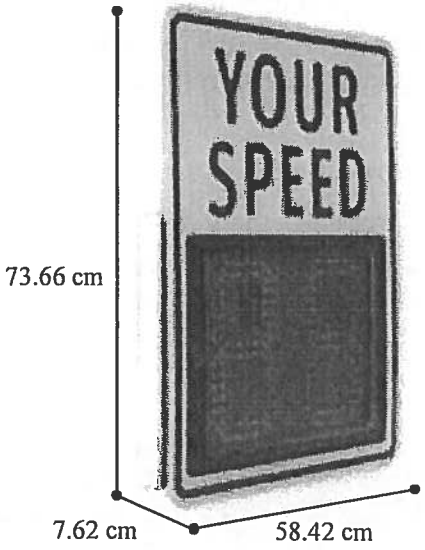

Figure 1: SP-100 Speed Monitoring Radar Unit

The user should be cognisant that using SMRUs is meant to make the motorist conscious of their speed, thereby encouraging those travelling above the speed limit to reduce their speed [9]. These units are not meant as a replacement for speed enforcement. All the studies examined took place in a single work zone, typically a large resurfacing project. There is therefore minimal data on what type of work is most conducive to use of SMRUs. A variety of work types were tested in the pilot project developed by MHI. The initial design was not developed for comparison of speed reduction by work type, but a rough approximation was made in the data analysis stage. This was thought to be important because motorists will treat work zones differently depending on the perceived danger (i.e. equipment in the travel lanes will likely be given more respect than workers along the shoulder).

5.0 Study RESULTS

5.1 Data Validation

Data was first analyzed by exporting tables provided in the SP-100 Management Software package. This program summarizes data on an hourly basis for each week of data collection. Minimum, maximum, average, and 85th percentile speeds are provided for the aggregate data. This data was difficult to work with because of the different sample sizes and the inability to customize data analysis. This data was filtered and weighted based on sub-sample sizes to give more weight to larger, more accurate, data sets. When exported to Microsoft Excel, it was found cells were merged in a manner that made it difficult to perform additional analysis. A simple VBA program was written to remove unnecessary cells and merging. This data was used to test for differences between hourly data and the aforementioned metrics (minimum, maximum, average, and 85th percentile speeds) for the aggregate data sets.

The SP-100 software package was examined and a method of exporting the raw data was found. Having access to this raw data allowed for analysis using standard MHI Microsoft Excel spreadsheets for speed studies. Data was filtered to remove speeds of 15 km/hr or lower as these were assumed to be MHI equipment or null readings. Data was categorized as sign #1 or sign #2 and by whether the sign was in stealth mode. This data was used to test for reductions in the average speed and standard deviation in speed following implementation of the SMRUs. This data was also used to give an estimate of if there are differences in results for different work types. Results from the aforementioned aggregated data analysis were used for data validation of raw data analysis.

5.2 Analysis of Results

Study results suggest the SP-100 SMRU produces a statistically significant reduction in vehicle speeds (*see Tables 2&3*). MHI maintenance staff reported feeling a heightened level of safety with the use of SP-100 SMRUs.

Table 2: Summary of Speed Results (Raw Data)

	Minimum Speed	Maximum Speed	Average Speed	15th %ile Speed	85th %ile Speed	Speed Differential
Before	25.0	135.0	62.7	35	85.0	50.0
After	25.0	115.0	47.0	35	65.0	30.0
Change	0.0	-20.0	-15.7	0.0	-20.0	-20.0

Table 3: Summary of Speed Results (Aggregate Data)

	Minimum Speed	Maximum Speed	Average Speed	85th %ile Speed	Total Violations	% Violations
Before	16.0	118.0	61.0	87.0	1730	48%
After	20.0	87.0	44.0	56.0	1867	16%
Change	3.6	-31.5	-16.4	-31.3	0.0	-32.1%

Minitab was used to evaluate the statistical significance of reductions in minimum maximum, average, and 85th percentile speeds and the standard deviation in speed. One-way ANOVA tests were used to analyze raw data for variances and generalized linear models, weighted by sample size, were developed to analyze aggregate data. Standard deviations were compared using a two-variance analysis of before/after raw data. Tukey tests were completed for the aforementioned comparisons. Significant reductions were observed in all metrics except minimum speed (*graphical representations of these reductions can be found in Figures 2&3*).

Figure 2 shows that observed speeds generally decreased when the SP-100 was displaying. It shows a greater number of high outliers in the after data than the before data because of a larger sample size. The box plots of Figure 2 show that the variation in speed results decreased in the after results.

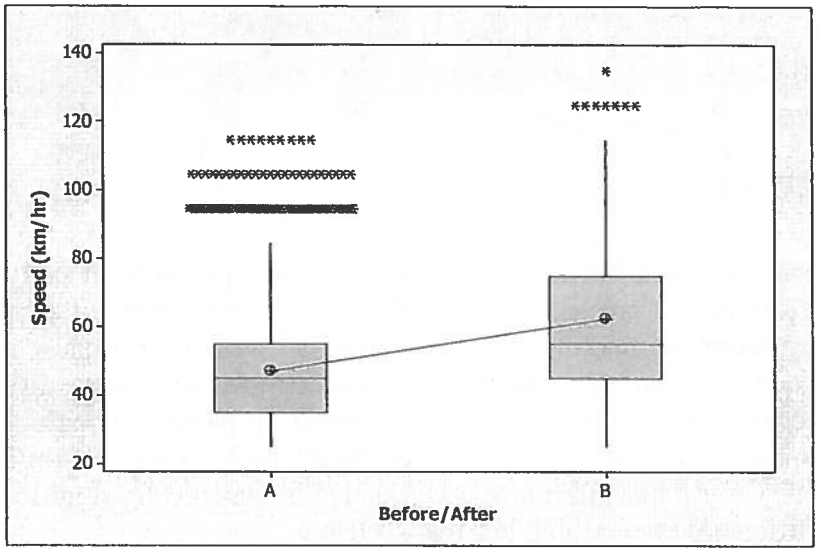

Figure 2: Boxplot of Speeds Before/After: Effect of SP-100 SMRU (Raw Data)

Figure 3 shows the interval plots of aggregate data obtained using the SP-100 software package. The main metrics experienced significant decreases in terms of absolute value and, in the case of average and 85th percentile speeds, in terms of variation.

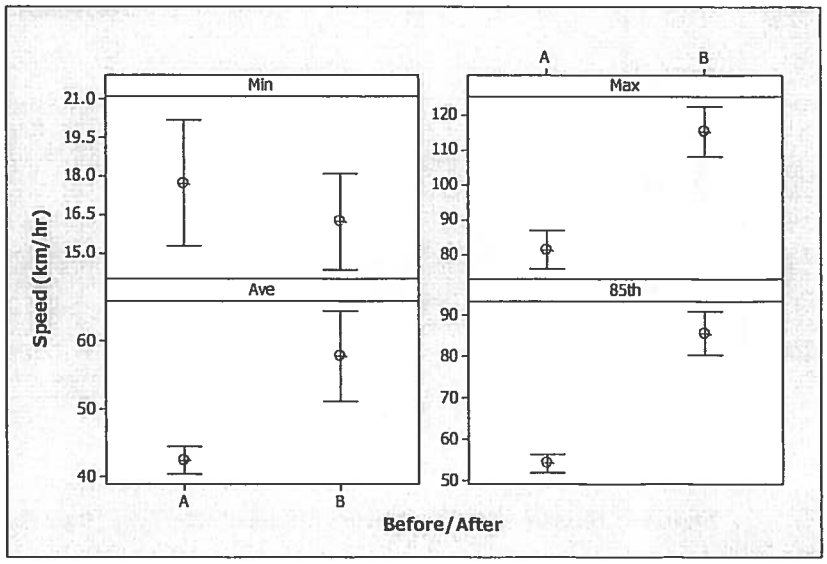

Figure 3: Interval Plot of Min, Max, Ave, and 85th Percentile Speeds: 95% CI for the Mean (Aggregate Data)

Double digit reductions were observed in average and 85th percentile speeds, which are greater than reductions observed in other studies, but within a range of acceptability. This higher reduction could be a result of differences in testing methodology and/or the imprecision of recorded speeds. Another factor to consider is the fact this study did not consider platooning effects due to product constraints.

Results suggest violations decreased by 32.0% after implementation of SP-100 SMRUs (*see Table 4*). This is supported by a decrease in the standard deviation of speeds and increase in vehicles within the pace. These results suggest vehicles are using the speed displayed to them by the SMRUs to regulate their speeds to within an acceptable range of the 60 km/hr speed limit.

Table 4: Summary of Pace Speed & Violation Results (Raw Data)

	Lower Pace Speed	Upper Pace Speed	Total Observations	# In Pace	% In Pace	Total Violations	Percent Violations
Before	33	47	3560	1286	36.1%	1730	49%
After	33	47	11416	5722	50.1%	1891	17%
Change	0	0			14.0%		-32.0%

Differences in results between work types were interpreted from analyzing differences between results from sign #1 and sign #2. Sign #1 was used in a variety of locations and sign #2 was used solely by pavement marking crews. This analysis was rough because no before data was obtained for sign #2 and the initial pilot project was not set up to analyze these differences. It can still be said that the effectiveness of SMRUs appears to be lower for pavement marking applications. The average speeds observed for signs #1 and #2 were 44.25 km/hr and 47.37 km/hr, respectively. Using a one-way ANOVA test this difference was found to be statistically significant. A graphical representation of this difference is presented in *Figure 4* below.

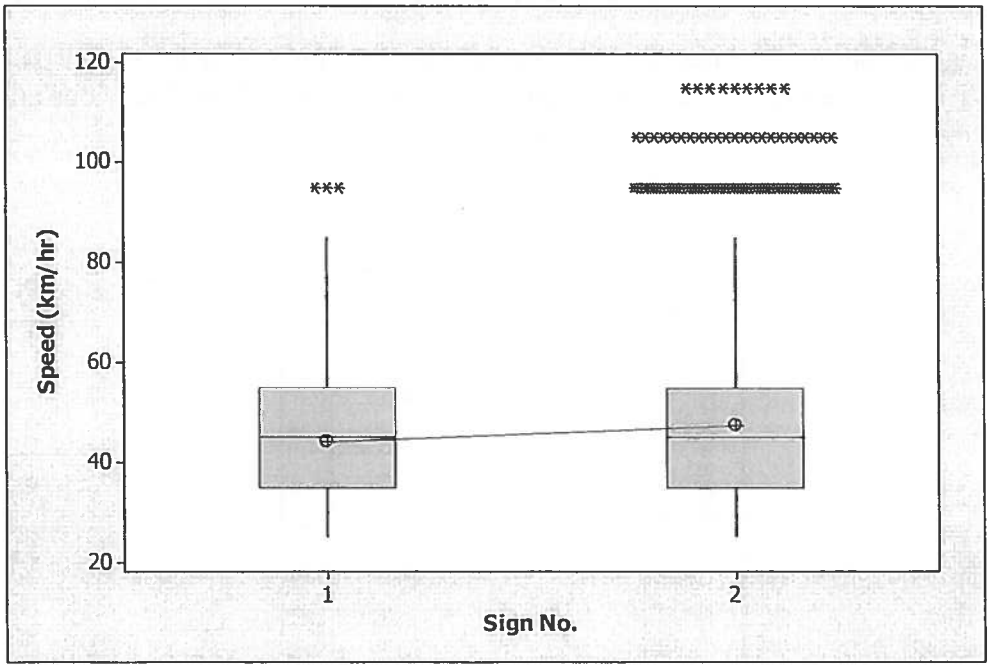

Figure 4: Boxplot of After Speeds: Effects of Site Type (Raw Data)

6.0 COST BENEFIT ANALYSIS

6.1 Cost/Benefit Methodology

In order to determine cost savings, data was obtained from the MHI report "2001 Collision Cost Review" [11]. This outlines the assumed collision cost values to be used in cost/benefit analysis for property damage, injury, and fatal accident types. Values are given in 2001$ and were converted to 2012$ for this analysis using the Bank of Canada Inflation Calculator [12]. The total number of accidents and distribution between severities was based on SGI data [1]. An average 4-year life cycle was assumed for the SMRUs based on information supplied by Traffic Logix. It was assumed 60 units would be purchased (approx. 4 for each operations area) at a cost of $2500/unit [10] with maintenance costs included. The $400 analysis software would not be needed for full scale usage, but analysis capabilities are still embedded within the sign if further data collection is desired in the future.

Accident reductions due to speed reduction were calculated using a Power Model [13] and verified using FHWA assumed values [7]. These reductions were used in calculation of benefit values. Power Model derivations are summarized below.

$$\frac{AccidentsAfter}{AccidentsBefore} = \frac{SpeedAfter}{SpeedBefore}^{n}$$

Table 5: Power Model Derivation of Accident Reductions

Accident Severity	Power [13] (n)	Before/After Speeds (km/hr)	Accident Reduction
PDO	1.0	47/62.7	25%
Injury	2.0	47/62.7	44%
Fatal	3.6	47/62.7	65%

There are essentially two methods of determining collision cost employed by Canadian jurisdictions: the human capital approach and the willingness to pay approach. The human capital approach monetizes the cost of injuries and fatalities to the individual and society as a whole from decreased general health of those injured in motor vehicle accidents. This approach views the individual as an economic revenue stream and assesses lost earnings and cost of rehabilitation. The willingness to pay approach attempts to monetize the value individuals place on life and their willingness to pay for safety improvements. Both methods have their advantages/disadvantages and usage varies by jurisdiction. Values assumed by MHI were developed in a 1995 report entitled "Accident Cost Review" that provides monetary values for the province of Saskatchewan. Due to the large number of resources necessary to conduct this type of study, the standard practise is to inflate these values to current dollars rather than perform new studies. Based on the recommendations of "2001 Collision Cost Review", it was decided to use the willingness to pay approach for benefit/cost analysis of the SP-100. Values for both approaches are summarized below.

Table 6: Summary of Collision Cost Estimates by Severity

Accident Severity	Human Capital		Willingness to Pay	
	2001$	2012$	2001$	2012$
PDO	$5,100	$6,352.91	$6,900.00	$8,537.53
Injury	$150,000	$186,850.15	$64,000.00	$79,188.64
Fatality	$1,500,000	$1,868,501.53	$4,500,000.00	$5,567,951.32

6.2 Analysis of B/C Ratio

Results of the benefit cost analysis suggest acquisition of 60 SP-100 SMRUs by MHI would be an exceptionally cost effective method of reducing accidents in highways work zones. The IRR was calculated to be 4305% over a 4-year life cycle. A summary of the benefit/cost analysis is presented in *Table 7* below and detailed calculations can be found in *Appendix C*.

Table 7: Summary of Benefit/Cost Analysis

BENEFIT/COST RATIO			
Total Four-Year B/C			
	Benefit	$ 23,439,731.68	
	Cost	$ 150,000.00	
	Benefit/Cost	156.3	
Annualized B/C			
	Benefit	$ 6457,412.74	/year
	Cost	$ 41,323.51	/year
	Benefit/Cost	156.3	/year

7.0 RECOMMENDATIONS

This initial pilot project was deemed successful based on a broad range of metrics. MHI maintenance staff have requested additional SP-100 SMRUs are purchased. There were several challenges in data collection and further analysis is necessary before full implementation should be approved. It is therefore recommended:

- Additional SP-100 units are purchased for use by MHI work crews in other Northern Region operations areas to allow for a more diverse sampling;
- Additional education is provided to those using the units as to how to program units for "stealth mode" and "display" mode;
    - As units require programming in order to switch modes, it is recommended units be used on longer term projects in future pilot testing so "stealth" and "display" results can be obtained for the same work location/work type;
- A standardized cover form, similar to that attached in *Appendix D*, is provided to work crews to ensure clear information is provided to the analysis team; and
- Before/After data is collected from a variety of work types to determine where units are most effective and to develop a hierarchy of distribution priority.

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APPENDIX A: Minitab Analysis

Results for: Worksheet 2

General Linear Model: Min versus B/A

```
Factor  Type   Levels  Values
B/A     fixed       2  A, B


Analysis of Variance for Min, using Adjusted SS for Tests

Source  DF  Seq SS  Adj SS  Adj MS     F      P
B/A      1   6.610   6.610   6.610  3.55  0.072
Error   24  44.662  44.662   1.861
Total   25  51.271

S = 1.36415   R-Sq = 12.89%   R-Sq(adj) = 9.26%


Unusual Observations for Min

Obs      Min      Fit  SE Fit  Residual  St Resid
 20  33.7937  19.6705  1.3641   14.1232      4.40 R

R denotes an observation with a large standardized residual.


Grouping Information Using Tukey Method and 95.0% Confidence

B/A   N  Mean  Grouping
A    17  19.7  A
B     9  16.0  A

Means that do not share a letter are significantly different.
```

General Linear Model: Max versus B/A

```
Factor  Type   Levels  Values
B/A     fixed       2  A, B


Analysis of Variance for Max, using Adjusted SS for Tests

Source  DF  Seq SS  Adj SS  Adj MS      F      P
B/A      1  497.78  497.78  497.78  84.35  0.000
Error   24  141.62  141.62    5.90
Total   25  639.40

S = 2.42920   R-Sq = 77.85%   R-Sq(adj) = 76.93%

Unusual Observations for Max

Obs      Max      Fit  SE Fit  Residual  St Resid
  6  132.117  117.906   2.429    14.211      2.48 R

R denotes an observation with a large standardized residual.


Grouping Information Using Tukey Method and 95.0% Confidence

B/A   N   Mean  Grouping
B     9  117.9  A
A    17   86.4     B

Means that do not share a letter are significantly different.
```

General Linear Model: Ave versus B/A

```
Factor  Type   Levels  Values
B/A     fixed       2  A, B


Analysis of Variance for Ave, using Adjusted SS for Tests

Source  DF  Seq SS  Adj SS  Adj MS      F      P
B/A      1  135.58  135.58  135.58  58.02  0.000
Error   24   56.09   56.09    2.34
Total   25  191.67


S = 1.52870   R-Sq = 70.74%   R-Sq(adj) = 69.52%


Unusual Observations for Ave

Obs      Ave      Fit  SE Fit  Residual  St Resid
  4  69.2134  60.4018  1.5287    8.8117      2.32 R
  9  41.7917  60.4018  1.5287  -18.6101     -2.88 R

R denotes an observation with a large standardized residual.


Grouping Information Using Tukey Method and 95.0% Confidence

B/A   N  Mean  Grouping
B     9  60.4  A
A    17  43.9    B

Means that do not share a letter are significantly different.
```

General Linear Model: 85th versus B/A

```
Factor  Type   Levels  Values
B/A     fixed       2  A, B

Analysis of Variance for 85th, using Adjusted SS for Tests

Source  DF  Seq SS  Adj SS  Adj MS       F      P
B/A      1  494.38  494.38  494.38  201.31  0.000
Error   24   58.94   58.94    2.46
Total   25  553.32


S = 1.56711   R-Sq = 89.35%   R-Sq(adj) = 88.90%

Unusual Observations for 85th

Obs     85th      Fit  SE Fit  Residual  St Resid
  2  75.0000  86.9785  1.5671  -11.9785     -2.57 R
  6  95.0000  86.9785  1.5671    8.0215      2.17 R
 23  64.9541  55.5339  1.5671    9.4202      2.10 R

R denotes an observation with a large standardized residual.

Grouping Information Using Tukey Method and 95.0% Confidence

B/A   N  Mean  Grouping
B     9  87.0  A
A    17  55.5    B

Means that do not share a letter are significantly different.
```

Test and CI for Two Variances: Speed (kph) vs Before/After

Method

Null hypothesis	Sigma(A) / Sigma(B) = 1
Alternative hypothesis	Sigma(A) / Sigma(B) < 1
Significance level	Alpha = 0.05

Statistics

Before/After	N	StDev	Variance
A	11416	14.605	213.314
B	3560	22.209	493.256

Ratio of standard deviations = 0.658
Ratio of variances = 0.432

95% One-Sided Confidence Intervals

Distribution of Data	Upper Bound for StDev Ratio	Upper Bound for Variance Ratio
Normal	0.672	0.452
Continuous	0.637	0.406

Tests

Method	DF1	DF2	Test Statistic	P-Value
F Test (normal)	11415	3559	0.43	0.000
Levene's Test (any continuous)	1	14974	1064.72	0.000

Results for: Worksheet 4

One-way ANOVA: Speed (kph) versus Sign No. for After Data

Source	DF	SS	MS	F	P
Sign No.	1	10832	10832	51.00	0.000
Error	11414	2424145	212		
Total	11415	2434977			

S = 14.57 R-Sq = 0.44% R-Sq(adj) = 0.44%

Level	N	Mean	StDev	Individual 95% CIs For Mean Based on Pooled StDev
1	1251	44.25	14.31	(------*-----)
2	10165	47.37	14.61	(--*-)

Pooled StDev = 14.57

Grouping Information Using Tukey Method

Sign No.	N	Mean	Grouping
2	10165	47.37	A
1	1251	44.25	B

Means that do not share a letter are significantly different.
Tukey 95% Simultaneous Confidence Intervals
All Pairwise Comparisons among Levels of Sign No.

```
Individual confidence level = 95.00%


Sign No. = 1 subtracted from:

Sign
No.    Lower  Center  Upper  ---+---------+---------+---------+------
2       2.26    3.12   3.97                      (------*------)
                          ---+---------+---------+---------+------
                           0.0       1.2       2.4       3.6
```

Results for: Worksheet 3

One-way ANOVA: Speed (kph) versus Before/After

```
Source           DF       SS      MS        F      P
Before/After      1   670064  670064  2394.37  0.000
Error         14974  4190474     280
Total         14975  4860537

S = 16.73   R-Sq = 13.79%   R-Sq(adj) = 13.78%


                           Individual 95% CIs For Mean Based on
                           Pooled StDev
Level      N   Mean  StDev  -------+---------+---------+---------+--
A      11416  47.03  14.61  (*)
B       3560  62.74  22.21                                  (*-)
                           -------+---------+---------+---------+--
                               50.0      55.0      60.0      65.0

Pooled StDev = 16.73


Grouping Information Using Tukey Method

Before/After      N   Mean  Grouping
B              3560  62.74  A
A             11416  47.03    B

Means that do not share a letter are significantly different.


Tukey 95% Simultaneous Confidence Intervals
All Pairwise Comparisons among Levels of Before/After

Individual confidence level = 95.00%


Before/After = A subtracted from:

Before/After  Lower  Center  Upper  --+---------+---------+---------+-------
B             15.08   15.71  16.34                                  (*-)
                                    --+---------+---------+---------+-------
                                    0.0       5.0      10.0      15.0
```

APPENDIX B: SP-100 Weekly Summary of Data

Statistics Summary Report

IN STEALTH MODE (USE: MAINTENANCE)

Location: PA South Sign 02
Address: Section crew
Speed Limit: 60
Data Session: New Statistics Sign 1 Nov 06 2012
Report Period: 7/17/2012 to 7/19/2012
Total Vehicle 2,837

Hour	Total Vehicles	Average Vehicles	Total Violations	% Violations	Min. Speed	Max. Speed	Avg. Speed	85% Speed
00-01	0	0	0	0%	0	0	0	0
01-02	0	0	0	0%	0	0	0	0
02-03	0	0	0	0%	0	0	0	0
03-04	0	0	0	0%	0	0	0	0
04-05	0	0	0	0%	0	0	0	0
05-06	0	0	0	0%	0	0	0	0
06-07	0	0	0	0%	0	0	0	0
07-08	0	0	0	0%	0	0	0	0
08-09	151	25	61	27%	15	105	48	0
09-10	369	62	201	53%	15	115	63	75
10-11	429	72	203	51%	15	125	63	85
11-12	375	62	182	57%	15	115	63	85
12-13	342	57	160	50%	15	115	64	85
13-14	395	66	203	57%	15	135	69	95
14-15	301	50	157	37%	15	125	54	95
15-16	312	52	145	31%	15	115	58	95
16-17	154	26	75	24%	15	115	41	85
17-18	4	1	0	0%	45	55	48	75
18-19	0	0	0	0%	0	0	0	0
19-20	1	0	0	0%	25	25	25	0
20-21	4	1	0	0%	15	55	38	0
21-22	0	0	0	0%	0	0	0	0
22-23	0	0	0	0%	0	0	0	0
23-24	0	0	0	0%	0	0	0	0
	2,837	474	1,387	16%	18	100	53	86

Count by speed Bins

Speed	Count
0...10	0
10...20	66
20...30	122
30...40	278
40...50	447
50...60	537
60...70	427
70...80	302
80...90	268
90...100	210
100...11	135
110...12	38
120...13	6
130...14	1
Total:	2,837

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Statistics Summary Report

IN STEALTH MODE (USE: MAINTENANCE)

Location: PA South Sign 02
Address: Section crew
Speed Limit: 60
Data Session: New Statistics Sign 1 Nov 06 2012
Report Period: 7/23/2012 to 7/23/2012
Total Vehicle 806

Hour	Total Vehicles	Average Vehicles	Total Violations	% Violations	Min. Speed	Max. Speed	Avg. Speed	85% Speed
00-01	0	0	0	0%	0	0	0	0
01-02	0	0	0	0%	0	0	0	0
02-03	0	0	0	0%	0	0	0	0
03-04	0	0	0	0%	0	0	0	0
04-05	0	0	0	0%	0	0	0	0
05-06	0	0	0	0%	0	0	0	0
06-07	0	0	0	0%	0	0	0	0
07-08	0	0	0	0%	0	0	0	0
08-09	0	0	0	0%	0	0	0	0
09-10	0	0	0	0%	0	0	0	0
10-11	96	14	53	55%	15	115	64	0
11-12	131	19	123	94%	35	115	87	85
12-13	191	27	78	41%	15	115	60	105
13-14	160	23	31	19%	15	125	50	95
14-15	155	22	58	37%	15	115	56	65
15-16	35	5	0	0%	15	45	33	85
16-17	38	5	0	0%	45	55	45	45
17-18	0	0	0	0%	0	0	0	0
18-19	0	0	0	0%	0	0	0	0
19-20	0	0	0	0%	0	0	0	0
20-21	0	0	0	0%	0	0	0	0
21-22	0	0	0	0%	0	0	0	0
22-23	0	0	0	0%	0	0	0	0
23-24	0	0	0	0%	0	0	0	0
	806	115	343	10%	6	29	56	80

Count by speed Bins

Speed	Count
0...10	0
10...20	17
20...30	25
30...40	119
40...50	178
50...60	124
60...70	86
70...80	73
80...90	60
90...100	59
100...110	52
110...120	12
120...130	1
Total:	806

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Statistics Summary Report

IN DISPLAY MODE (USE: MAINTENANCE)

Location: PA South Sign 02
Address: Section crew
Speed Limit: 60

Data Session: New Statistics Sign 1 Nov 06 2012
Report Period: 7/30/2012 to 7/30/2012
Total Vehicle 450

Hour	Total Vehicles	Average Vehicles	Total Violations	% Violations	Min. Speed	Max. Speed	Avg. Speed	85% Speed
00-01	0	0	0	0%	0	0	0	0
01-02	0	0	0	0%	0	0	0	0
02-03	0	0	0	0%	0	0	0	0
03-04	0	0	0	0%	0	0	0	0
04-05	0	0	0	0%	0	0	0	0
05-06	0	0	0	0%	0	0	0	0
06-07	0	0	0	0%	0	0	0	0
07-08	0	0	0	0%	0	0	0	0
08-09	0	0	0	0%	0	0	0	0
09-10	49	7	0	0%	15	45	28	0
10-11	80	11	2	2%	15	75	33	45
11-12	97	14	1	1%	15	65	34	45
12-13	71	10	0	0%	15	55	34	45
13-14	97	14	0	0%	15	55	28	45
14-15	56	8	0	0%	15	45	28	35
15-16	0	0	0	0%	0	0	0	0
16-17	0	0	0	0%	0	0	0	0
17-18	0	0	0	0%	0	0	0	0
18-19	0	0	0	0%	0	0	0	0
19-20	0	0	0	0%	0	0	0	0
20-21	0	0	0	0%	0	0	0	0
21-22	0	0	0	0%	0	0	0	0
22-23	0	0	0	0%	0	0	0	0
23-24	0	0	0	0%	0	0	0	0
	450	64	3	0%	4	14	31	43

Count by speed Bins

Speed	Count
0...10	0
10...20	68
20...30	150
30...40	145
40...50	67
50...60	17
60...70	2
70...80	1
Total:	450

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Statistics Summary Report

IN DISPLAY MODE(USE: MAINTENANCE)

Location: PA South Sign 02
Address: Section crew
Speed Limit: 60

Data Session: New Statistics Sign 1 Nov 06 2012
Report Period: 9/25/2012 to 9/27/2012
Total Vehicle 398

Hour	Total Vehicles	Average Vehicles	Total Violations	% Violations	Min. Speed	Max. Speed	Avg. Speed	85% Speed
00-01	0	0	0	0%	0	0	0	0
01-02	0	0	0	0%	0	0	0	0
02-03	0	0	0	0%	0	0	0	0
03-04	0	0	0	0%	0	0	0	0
04-05	0	0	0	0%	0	0	0	0
05-06	0	0	0	0%	0	0	0	0
06-07	0	0	0	0%	0	0	0	0
07-08	0	0	0	0%	0	0	0	0
08-09	0	0	0	0%	0	0	0	0
09-10	0	0	0	0%	0	0	0	0
10-11	0	0	0	0%	0	0	0	0
11-12	45	8	3	7%	35	65	49	0
12-13	123	20	48	39%	25	85	57	55
13-14	122	20	47	39%	15	95	58	65
14-15	107	18	9	8%	15	85	47	75
15-16	1	0	0	0%	15	15	15	55
16-17	0	0	0	0%	0	0	0	0
17-18	0	0	0	0%	0	0	0	0
18-19	0	0	0	0%	0	0	0	0
19-20	0	0	0	0%	0	0	0	0
20-21	0	0	0	0%	0	0	0	0
21-22	0	0	0	0%	0	0	0	0
22-23	0	0	0	0%	0	0	0	0
23-24	0	0	0	0%	0	0	0	0
	398	66	107	4%	4	14	45	62

Count by speed Bins

Speed	Count
0...10	0
10...20	13
20...30	4
30...40	21
40...50	99
50...60	154
60...70	75
70...80	21
80...90	10
90...100	1
Total:	398

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Statistics Summary Report

IN DISPLAY MODE (USE: MAINTENANCE)

Location: PA South Sign 02
Address: Section crew
Speed Limit: 60

Data Session: New Statistics Sign 1 Nov 06 2012
Report Period: 10/5/2012 to 10/5/2012
Total Vehicle 512

Hour	Total Vehicles	Average Vehicles	Total Violations	% Violations	Min. Speed	Max. Speed	Avg. Speed	85% Speed
00-01	0	0	0	0%	0	0	0	0
01-02	0	0	0	0%	0	0	0	0
02-03	0	0	0	0%	0	0	0	0
03-04	0	0	0	0%	0	0	0	0
04-05	0	0	0	0%	0	0	0	0
05-06	0	0	0	0%	0	0	0	0
06-07	0	0	0	0%	0	0	0	0
07-08	0	0	0	0%	0	0	0	0
08-09	126	42	15	12%	15	95	41	0
09-10	137	46	11	8%	15	75	41	55
10-11	114	38	12	11%	15	85	43	55
11-12	135	45	20	15%	15	95	45	55
12-13	0	0	0	0%	0	0	0	0
13-14	0	0	0	0%	0	0	0	0
14-15	0	0	0	0%	0	0	0	0
15-16	0	0	0	0%	0	0	0	0
16-17	0	0	0	0%	0	0	0	0
17-18	0	0	0	0%	0	0	0	0
18-19	0	0	0	0%	0	0	0	0
19-20	0	0	0	0%	0	0	0	0
20-21	0	0	0	0%	0	0	0	0
21-22	0	0	0	0%	0	0	0	0
22-23	0	0	0	0%	0	0	0	0
23-24	0	0	0	0%	0	0	0	0
	512	171	58	2%	2	15	42	55

Count by speed Bins

Speed	Count
0...10	0
10...20	28
20...30	75
30...40	131
40...50	142
50...60	78
60...70	39
70...80	9
80...90	8
90...100	2
Total:	512

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Statistics Summary Report

IN DISPLAY MODE (USE: PAVEMENT MARKINGS)

Location: PA South Sign 02
Address: Section crew
Speed Limit: 60

Data Session: New Statistics Sign 2 Nov 5 2012
Report Period: 7/5/2012 to 7/5/2012
Total Vehicle 211

Hour	Total Vehicles	Average Vehicles	Total Violations	% Violations	Min. Speed	Max. Speed	Avg. Speed	85% Speed
00-01	0	0	0	0%	0	0	0	0
01-02	0	0	0	0%	0	0	0	0
02-03	0	0	0	0%	0	0	0	0
03-04	0	0	0	0%	0	0	0	0
04-05	0	0	0	0%	0	0	0	0
05-06	0	0	0	0%	0	0	0	0
06-07	0	0	0	0%	0	0	0	0
07-08	0	0	0	0%	0	0	0	0
08-09	0	0	0	0%	0	0	0	0
09-10	0	0	0	0%	0	0	0	0
10-11	0	0	0	0%	0	0	0	0
11-12	73	18	11	15%	15	85	44	0
12-13	137	34	16	12%	15	105	48	65
13-14	1	0	0	0%	15	15	15	55
14-15	0	0	0	0%	0	0	0	0
15-16	0	0	0	0%	0	0	0	0
16-17	0	0	0	0%	0	0	0	0
17-18	0	0	0	0%	0	0	0	0
18-19	0	0	0	0%	0	0	0	0
19-20	0	0	0	0%	0	0	0	0
20-21	0	0	0	0%	0	0	0	0
21-22	0	0	0	0%	0	0	0	0
22-23	0	0	0	0%	0	0	0	0
23-24	0	0	0	0%	0	0	0	0
	211	52	27	1%	2	9	36	60

Count by speed Bins

Speed	Count
0...10	0
10...20	4
20...30	23
30...40	40
40...50	56
50...60	61
60...70	22
70...80	2
80...90	2
90...100	0
100...110	1
Total:	211

Generated on November 13, 2012 at 9:18 AM

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Statistics Summary Report

IN DISPLAY MODE (USE: PAVEMENT MARKINGS)

Location: PA South Sign 02
Address: Section crew
Speed Limit: 60

Data Session: New Statistics Sign 2 Nov 5 2012
Report Period: 7/11/2012 to 7/12/2012
Total Vehicle 434

Hour	Total Vehicles	Average Vehicles	Total Violations	% Violations	Min. Speed	Max. Speed	Avg. Speed	85% Speed
00-01	0	0	0	0%	0	0	0	0
01-02	0	0	0	0%	0	0	0	0
02-03	0	0	0	0%	0	0	0	0
03-04	0	0	0	0%	0	0	0	0
04-05	0	0	0	0%	0	0	0	0
05-06	0	0	0	0%	0	0	0	0
06-07	0	0	0	0%	0	0	0	0
07-08	0	0	0	0%	0	0	0	0
08-09	76	19	3	4%	25	85	43	0
09-10	73	15	20	30%	15	95	48	55
10-11	185	37	22	12%	15	85	42	65
11-12	71	14	13	18%	15	95	49	55
12-13	16	3	0	0%	15	25	19	65
13-14	4	1	0	0%	15	15	15	25
14-15	9	2	0	0%	25	45	34	15
15-16	0	0	0	0%	0	0	0	0
16-17	0	0	0	0%	0	0	0	0
17-18	0	0	0	0%	0	0	0	0
18-19	0	0	0	0%	0	0	0	0
19-20	0	0	0	0%	0	0	0	0
20-21	0	0	0	0%	0	0	0	0
21-22	0	0	0	0%	0	0	0	0
22-23	0	0	0	0%	0	0	0	0
23-24	0	0	0	0%	0	0	0	0
	434	91	58	3%	5	19	36	47

Count by speed Bins

Speed	Count
0...10	0
10...20	44
20...30	51
30...40	86
40...50	103
50...60	92
60...70	39
70...80	8
80...90	8
90...100	3
Total:	434

Generated on November 13, 2012 at 9:20 AM

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Statistics Summary Report

IN DISPLAY MODE (USE: PAVEMENT MARKINGS)

Location: PA South Sign 02
Address: Section crew
Speed Limit: 60

Data Session: New Statistics Sign 2 Nov 5 2012
Report Period: 8/8/2012 to 8/9/2012
Total Vehicle 3,789

Hour	Total Vehicles	Average Vehicles	Total Violations	% Violations	Min. Speed	Max. Speed	Avg. Speed	85% Speed
00-01	0	0	0	0%	0	0	0	0
01-02	0	0	0	0%	0	0	0	0
02-03	0	0	0	0%	0	0	0	0
03-04	0	0	0	0%	0	0	0	0
04-05	0	0	0	0%	0	0	0	0
05-06	0	0	0	0%	0	0	0	0
06-07	0	0	0	0%	0	0	0	0
07-08	0	0	0	0%	0	0	0	0
08-09	369	369	30	8%	15	85	40	0
09-10	192	96	23	8%	15	75	39	55
10-11	959	480	97	10%	15	95	42	55
11-12	443	443	65	15%	15	85	46	55
12-13	478	478	80	17%	15	85	48	55
13-14	410	410	4	1%	15	65	35	65
14-15	428	428	6	1%	15	65	35	45
15-16	184	184	3	2%	15	75	38	45
16-17	326	326	3	1%	15	65	34	45
17-18	0	0	0	0%	0	0	0	0
18-19	0	0	0	0%	0	0	0	0
19-20	0	0	0	0%	0	0	0	0
20-21	0	0	0	0%	0	0	0	0
21-22	0	0	0	0%	0	0	0	0
22-23	0	0	0	0%	0	0	0	0
23-24	0	0	0	0%	0	0	0	0
	3,789	3,214	311	3%	6	29	40	52

Count by speed Bins

Speed	Count
0...10	0
10...20	297
20...30	627
30...40	872
40...50	976
50...60	706
60...70	257
70...80	45
80...90	8
90...100	1
Total:	3,789

Generated on November 13, 2012 at 9:23 AM

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Statistics Summary Report

IN DISPLAY MODE (USE: PAVEMENT MARKINGS)

Location: PA South Sign 02
Address: Section crew
Speed Limit: 60

Data Session: New Statistics Sign 2 Nov 5 2012
Report Period: 8/15/2012 to 8/16/2012
Total Vehicle 1,112

Hour	Total Vehicles	Average Vehicles	Total Violations	% Violations	Min. Speed	Max. Speed	Avg. Speed	85% Speed
00-01	0	0	0	0%	0	0	0	0
01-02	0	0	0	0%	0	0	0	0
02-03	0	0	0	0%	0	0	0	0
03-04	0	0	0	0%	0	0	0	0
04-05	0	0	0	0%	0	0	0	0
05-06	0	0	0	0%	0	0	0	0
06-07	0	0	0	0%	0	0	0	0
07-08	0	0	0	0%	0	0	0	0
08-09	0	0	0	0%	0	0	0	0
09-10	0	0	0	0%	0	0	0	0
10-11	0	0	0	0%	0	0	0	0
11-12	170	170	24	14%	15	75	46	0
12-13	270	135	43	14%	15	105	49	55
13-14	322	322	109	34%	35	85	57	65
14-15	350	350	143	41%	35	105	59	65
15-16	0	0	0	0%	0	0	0	0
16-17	0	0	0	0%	0	0	0	0
17-18	0	0	0	0%	0	0	0	0
18-19	0	0	0	0%	0	0	0	0
19-20	0	0	0	0%	0	0	0	0
20-21	0	0	0	0%	0	0	0	0
21-22	0	0	0	0%	0	0	0	0
22-23	0	0	0	0%	0	0	0	0
23-24	0	0	0	0%	0	0	0	0
	1,112	977	319	4%	4	15	53	62

Count by speed Bins

Speed	Count
0...10	0
10...20	5
20...30	29
30...40	93
40...50	247
50...60	419
60...70	230
70...80	60
80...90	25
90...100	2
100...110	2
Total:	1,112

Generated on November 13, 2012 at 9:26 AM

SafePace™ 100 Management Software by Traffic Logix®

Statistics Summary Report

IN DISPLAY MODE (USE: PAVEMENT MARKINGS)

Location: PA South Sign 02
Address: Section crew
Speed Limit: 60

Data Session: New Statistics Sign 2 Nov 5 2012
Report Period: 8/20/2012 to 8/23/2012
Total Vehicle 1,214

Hour	Total Vehicles	Average Vehicles	Total Violations	% Violations	Min. Speed	Max. Speed	Avg. Speed	85% Speed
00-01	0	0	0	0%	0	0	0	0
01-02	0	0	0	0%	0	0	0	0
02-03	0	0	0	0%	0	0	0	0
03-04	0	0	0	0%	0	0	0	0
04-05	0	0	0	0%	0	0	0	0
05-06	0	0	0	0%	0	0	0	0
06-07	0	0	0	0%	0	0	0	0
07-08	0	0	0	0%	0	0	0	0
08-09	0	0	0	0%	0	0	0	0
09-10	8	8	0	0%	25	55	39	0
10-11	169	169	9	5%	15	105	38	55
11-12	46	46	6	13%	15	85	47	55
12-13	100	100	6	6%	25	95	44	55
13-14	205	68	29	13%	15	105	44	55
14-15	426	142	43	11%	15	95	44	55
15-16	260	130	29	12%	15	115	45	55
16-17	0	0	0	0%	0	0	0	0
17-18	0	0	0	0%	0	0	0	0
18-19	0	0	0	0%	0	0	0	0
19-20	0	0	0	0%	0	0	0	0
20-21	0	0	0	0%	0	0	0	0
21-22	0	0	0	0%	0	0	0	0
22-23	0	0	0	0%	0	0	0	0
23-24	0	0	0	0%	0	0	0	0
	1,214	663	122	2%	5	27	43	55

Count by speed Bins

Speed	Count
0...10	0
10...20	44
20...30	184
30...40	306
40...50	314
50...60	244
60...70	86
70...80	18
80...90	7
90...100	7
100...110	3
110...120	1
Total:	1,214

Generated on November 13, 2012 at 9:35 AM

SafePace™ 100 Management Software by Traffic Logix®

Statistics Summary Report

IN DISPLAY MODE (USE: PAVEMENT MARKINGS)

Location: PA South Sign 02
Address: Section crew
Speed Limit: 60

Data Session: New Statistics Sign 2 Nov 5 2012
Report Period: 8/31/2012 to 8/31/2012
Total Vehicle 409

Hour	Total Vehicles	Average Vehicles	Total Violations	% Violations	Min. Speed	Max. Speed	Avg. Speed	85% Speed
00-01	0	0	0	0%	0	0	0	0
01-02	0	0	0	0%	0	0	0	0
02-03	0	0	0	0%	0	0	0	0
03-04	0	0	0	0%	0	0	0	0
04-05	0	0	0	0%	0	0	0	0
05-06	0	0	0	0%	0	0	0	0
06-07	0	0	0	0%	0	0	0	0
07-08	0	0	0	0%	0	0	0	0
08-09	47	47	2	4%	15	65	36	0
09-10	41	41	4	10%	15	65	41	55
10-11	76	76	12	16%	15	85	46	55
11-12	62	62	5	8%	15	95	41	65
12-13	183	183	22	12%	15	85	43	55
13-14	0	0	0	0%	0	0	0	0
14-15	0	0	0	0%	0	0	0	0
15-16	0	0	0	0%	0	0	0	0
16-17	0	0	0	0%	0	0	0	0
17-18	0	0	0	0%	0	0	0	0
18-19	0	0	0	0%	0	0	0	0
19-20	0	0	0	0%	0	0	0	0
20-21	0	0	0	0%	0	0	0	0
21-22	0	0	0	0%	0	0	0	0
22-23	0	0	0	0%	0	0	0	0
23-24	0	0	0	0%	0	0	0	0
	409	409	45	2%	3	16	41	58

Count by speed Bins

Speed	Count
0...10	0
10...20	24
20...30	62
30...40	102
40...50	102
50...60	74
60...70	30
70...80	10
80...90	4
90...100	1
Total:	409

Generated on November 13, 2012 at 9:37 AM

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Statistics Summary Report

IN DISPLAY MODE (USE: PAVEMENT MARKINGS)

Location: PA South Sign 02
Address: Section crew
Speed Limit: 60

Data Session: New Statistics Sign 2 Nov 5 2012
Report Period: 9/4/2012 to 9/5/2012
Total Vehicle 2,416

Hour	Total Vehicles	Average Vehicles	Total Violations	% Violations	Min. Speed	Max. Speed	Avg. Speed	85% Speed
00-01	0	0	0	0%	0	0	0	0
01-02	0	0	0	0%	0	0	0	0
02-03	0	0	0	0%	0	0	0	0
03-04	0	0	0	0%	0	0	0	0
04-05	0	0	0	0%	0	0	0	0
05-06	0	0	0	0%	0	0	0	0
06-07	0	0	0	0%	0	0	0	0
07-08	39	39	4	10%	25	65	47	0
08-09	365	365	43	12%	25	75	46	55
09-10	235	235	38	16%	15	115	49	55
10-11	289	144	84	46%	15	115	61	65
11-12	241	241	123	51%	15	115	62	65
12-13	186	186	92	49%	15	115	61	75
13-14	290	290	98	34%	15	115	51	75
14-15	372	372	60	16%	15	105	48	65
15-16	399	399	137	34%	15	105	56	65
16-17	0	0	0	0%	0	0	0	0
17-18	0	0	0	0%	0	0	0	0
18-19	0	0	0	0%	0	0	0	0
19-20	0	0	0	0%	0	0	0	0
20-21	0	0	0	0%	0	0	0	0
21-22	0	0	0	0%	0	0	0	0
22-23	0	0	0	0%	0	0	0	0
23-24	0	0	0	0%	0	0	0	0
	2,416	2,271	679	11%	6	39	53	65

Count by speed Bins

Speed	Count
0...10	0
10...20	52
20...30	124
30...40	292
40...50	559
50...60	710
60...70	397
70...80	161
80...90	60
90...100	39
100...110	15
110...120	7
Total:	2,416

Generated on November 13, 2012 at 9:39 AM

SafePace™ 100 Management Software by Traffic Logix®

Statistics Summary Report

IN DISPLAY MODE (USE: PAVEMENT MARKINGS)

Location: PA South Sign 02
Address: Section crew
Speed Limit: 60

Data Session: New Statistics Sign 2 Nov 5 2012
Report Period: 9/13/2012 to 9/14/2012
Total Vehicle 453

Hour	Total Vehicles	Average Vehicles	Total Violations	% Violations	Min. Speed	Max. Speed	Avg. Speed	85% Speed
00-01	0	0	0	0%	0	0	0	0
01-02	0	0	0	0%	0	0	0	0
02-03	0	0	0	0%	0	0	0	0
03-04	0	0	0	0%	0	0	0	0
04-05	0	0	0	0%	0	0	0	0
05-06	0	0	0	0%	0	0	0	0
06-07	0	0	0	0%	0	0	0	0
07-08	0	0	0	0%	0	0	0	0
08-09	0	0	0	0%	0	0	0	0
09-10	28	14	3	11%	25	65	45	0
10-11	38	38	6	16%	15	85	45	55
11-12	94	94	2	2%	15	95	34	65
12-13	146	73	10	9%	15	75	42	45
13-14	71	71	16	23%	15	95	48	55
14-15	76	76	5	7%	15	85	42	65
15-16	0	0	0	0%	0	0	0	0
16-17	0	0	0	0%	0	0	0	0
17-18	0	0	0	0%	0	0	0	0
18-19	0	0	0	0%	0	0	0	0
19-20	0	0	0	0%	0	0	0	0
20-21	0	0	0	0%	0	0	0	0
21-22	0	0	0	0%	0	0	0	0
22-23	0	0	0	0%	0	0	0	0
23-24	0	0	0	0%	0	0	0	0
	453	366	42	3%	4	21	43	57

Count by speed Bins

Speed	Count
0...10	0
10...20	19
20...30	83
30...40	123
40...50	115
50...60	71
60...70	32
70...80	4
80...90	4
90...100	2
Total:	453

Generated on November 13, 2012 at 9:41 AM

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Statistics Summary Report

IN DISPLAY MODE (USE: PAVEMENT MARKINGS)

Location: PA South Sign 02
Address: Section crew
Speed Limit: 60

Data Session: New Statistics Sign 2 Nov 5 2012
Report Period: 10/3/2012 to 10/5/2012
Total Vehicle 520

Hour	Total Vehicles	Average Vehicles	Total Violations	% Violations	Min. Speed	Max. Speed	Avg. Speed	85% Speed
00-01	0	0	0	0%	0	0	0	0
01-02	0	0	0	0%	0	0	0	0
02-03	0	0	0	0%	0	0	0	0
03-04	0	0	0	0%	0	0	0	0
04-05	0	0	0	0%	0	0	0	0
05-06	0	0	0	0%	0	0	0	0
06-07	0	0	0	0%	0	0	0	0
07-08	0	0	0	0%	0	0	0	0
08-09	121	121	35	29%	15	95	54	0
09-10	80	80	14	18%	15	105	53	65
10-11	121	121	19	16%	15	115	44	65
11-12	115	115	40	35%	15	105	57	65
12-13	0	0	0	0%	0	0	0	0
13-14	0	0	0	0%	0	0	0	0
14-15	74	74	2	3%	15	85	37	0
15-16	9	9	1	11%	25	75	47	45
16-17	0	0	0	0%	0	0	0	0
17-18	0	0	0	0%	0	0	0	0
18-19	0	0	0	0%	0	0	0	0
19-20	0	0	0	0%	0	0	0	0
20-21	0	0	0	0%	0	0	0	0
21-22	0	0	0	0%	0	0	0	0
22-23	0	0	0	0%	0	0	0	0
23-24	0	0	0	0%	0	0	0	0
	520	520	111	5%	4	24	49	60

Count by speed Bins

Speed	Count
0...10	0
10...20	24
20...30	46
30...40	74
40...50	105
50...60	160
60...70	57
70...80	29
80...90	13
90...100	9
100...110	2
110...120	1
Total:	520

Generated on November 13, 2012 at 9:44 AM

SafePace™ 100 Management Software by Traffic Logix®

APPENDIX C: Benefit Cost Analysis

BENEFIT OF SP-100 Units

ACCIDENT COST VALUES

	Costs in 2001 Dollars	Costs in 2012 Dollars
Property Damage	$6,900	$8,537.53
Personal Injury	$64,000	$79,188.64
Fatal	$4,500,000	$5,567,951.32

Power Model Reduction in Accidents

Fatal Accident	25%
Personal Injury	44%
Property Damage	65%

Accidents (2007-2011 Average)				
4	Fatal Accident	$5,567,951.32	/fatal accident	$22,271,805.28
263	Personal Injury	$79,188.64	/personal injury	$20,826,612.32
368	Property Damage	$8,537.53	/property damage	$3,141,811.04
				$46,240,228.64

ANNUALIZED BENEFIT

Note- The cost/accident is calculated using an average of the inflated values from year one to year four using an inflation rate of 4%. Accident reductions were calculated using the power model relationship between speed and accidents. The calculation is shown below.

Year	Cost/Fatal	Cost/Injury	Cost/PDO
1	$ 4,173,743.41	$ 44,496.26	$ 3,024.97
2	$ 4,514,320.88	$ 48,127.16	$ 3,271.81
3	$ 4,694,893.71	$ 50,052.24	$ 3,402.68
4	$ 4,882,689.46	$ 52,054.33	$ 3,538.79
Total	**$ 18,265,647.46**	**$ 194,729.99**	**$ 13,238.25**
Average	**$ 4,566,411.87**	**$ 48,682.50**	**$ 3,309.56**

Fatal Accident =	4 accidents/	5 years=		0.8
=	0.8 accidents/year	$4,566,411.87 /fatal accident		
=	$3,653,129.49 /year			
Personal Injury =	263 accidents/	5 years=		52.6
=	52.6 accidents/year	$48,682.50 /fatal accident		
=	$2,560,699.38 /year			
Property Damage =	368 accidents/	5 years=		73.6
=	73.6 accidents/year	$3,309.56 /fatal accident		
=	$243,583.87 /year			
Total Benefit =	**$6,457,412.74** /year			

TOTAL FOUR-YEAR BENEFIT

P =A(P/A,i%,n)
P =A[((1+i)^n/(i(1+i)^n)]
P =A[((1+0.04)^4-1)/(0.04(1+0.04)^4)]
P = **$ 23,439,731.68**

COST OF SP-100 Units

COST CONSIDERATIONS

Note- Cost includes materials and installation (equipment and labour) assumming 60 units are purchased on a 4-year cycle. This is based on information obtained from Traffic Logix on average product life.

	2012 Dollars		
Unit Cost	$ 2,500.00	/unit	60 units
Total Cost	$ 150,000.00		

FOUR-YEAR ANNUALIZED COST

A =P(A/P,i%,n)

A =P[(i*(1+i)^n/((1+i)^n-1)]

A =P[(0.04(1+0.04)^4)/((1+0.04)^4-1)]

A = $41,323.51 /year

BENEFIT/COST RATIO

Total Four-Year B/C

Benefit	$	23,439,731.68
Cost	$	150,000.00
Benefit/Cost		156.3

Annualized B/C

Benefit	$	6,457,412.74	/year
Cost	$	41,323.51	/year
Benefit/Cost		156.3	/year

Internal Rate of Return	
Year	Cash Flow
0	$ -150,000.00
1	$ 6,457,412.74
2	$ 6,457,412.74
3	$ 6,457,412.74
4	$ 6,457,412.74
IRR	4305%

APPENDIX D: Data Collection Summary Template

Ministry of Highways and Infrastructure

SP-100 Pilot Project - Summary

Observer: _____

Test Date (MMMM/DD/YY): _____

Start Time (hr:mi): _____

End Time (hr:mi): _____

Time in Stealth Mode (hr:min to hr:min): _____

Type of Work: _____

Comments: _____

Photos Attached: ☐

Miller, Derrick HI

From: Hansen, Doug HI
Sent: Wednesday, January 09, 2013 11:44 AM
To: Miller, Derrick HI
Cc: Whitford, Kurt HI
Subject: FW: Traffic Logix Final Report
Attachments: Final Report.pdf

Derrick, attached is a copy of the report completed on the speed monitoring radar units that has been completed and sent on. Thanks for your initiative on pursuing this.

Doug Hansen, P. Eng.
Executive Director, Northern Region
Ministry of Highways and Infrastructure
Prince Albert, SK
Phone 306-953-3503

From: Hansen, Doug HI
Sent: Wednesday, January 09, 2013 11:41 AM
To: Stearns, David HI
Cc: Stobbs, Ted HI; Ehrmantraut, Jennifer HI; Gerbrandt, Ron HI; Churko, Allan HI; Lazic, Zvjezdan HI; Brodner, Ann HI; Dornstauder, Linda HI
Subject: FW: Traffic Logix Final Report

Attached is the report compiled by the Northern Region regarding the assessment of portable speed monitoring radar units. Our cost per unit was $2169 and the results are very positive. The report includes a literature search done of other agencies in North America (again positive results){good initiative by our intern student}. This is useful information regarding the work zone enhancement initiative.

One of my thoughts was that use of these might be beneficial in conjunction with the photo radar sign – in some cases these will serve notice of vehicle speeds, in other cases the result will be photo radar enforcement.

The Northern Region Compliance staff are testing these this winter as well. They did test them last summer but there were problems with the data. The only feedback I have received regarding the work zone enhancement initiative is that the compliance staff appear to be forgotten and are feeling left out; use of these signs and/or additional pilot projects for them might be a way of addressing this. The PA district crews who tested these last summer are interested in buying more and expanding their test – we can either do this or take a larger provincial approach right now.

Doug Hansen, P. Eng.
Executive Director, Northern Region
Ministry of Highways and Infrastructure
Prince Albert, SK
Phone 306-953-3503

From: Kostic, Bojana HI
Sent: Wednesday, January 09, 2013 11:09 AM
To: Hansen, Doug HI
Cc: Neis, Doug HI; Hawkins, Jason HI
Subject: Traffic Logix Final Report

Hi Doug, as requested please find attached a PDF copy of the Traffic Logix report.

Thanks,

Bojana Kostić, E.I.T.
Senior Project Manager, Asset Management
Saskatchewan Ministry of Highways and Infrastructure
Northern Region, Regional Services Division
Box 3003, 800 Central Avenue
Prince Albert, SK, S6V 6G1
306.953.2403