

A Study of the Effectiveness  
of  
Strieter-Lite<sup>®</sup> Wild Animal Highway  
Warning Reflector Systems

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June 28, 2002

## EXECUTIVE SUMMARY

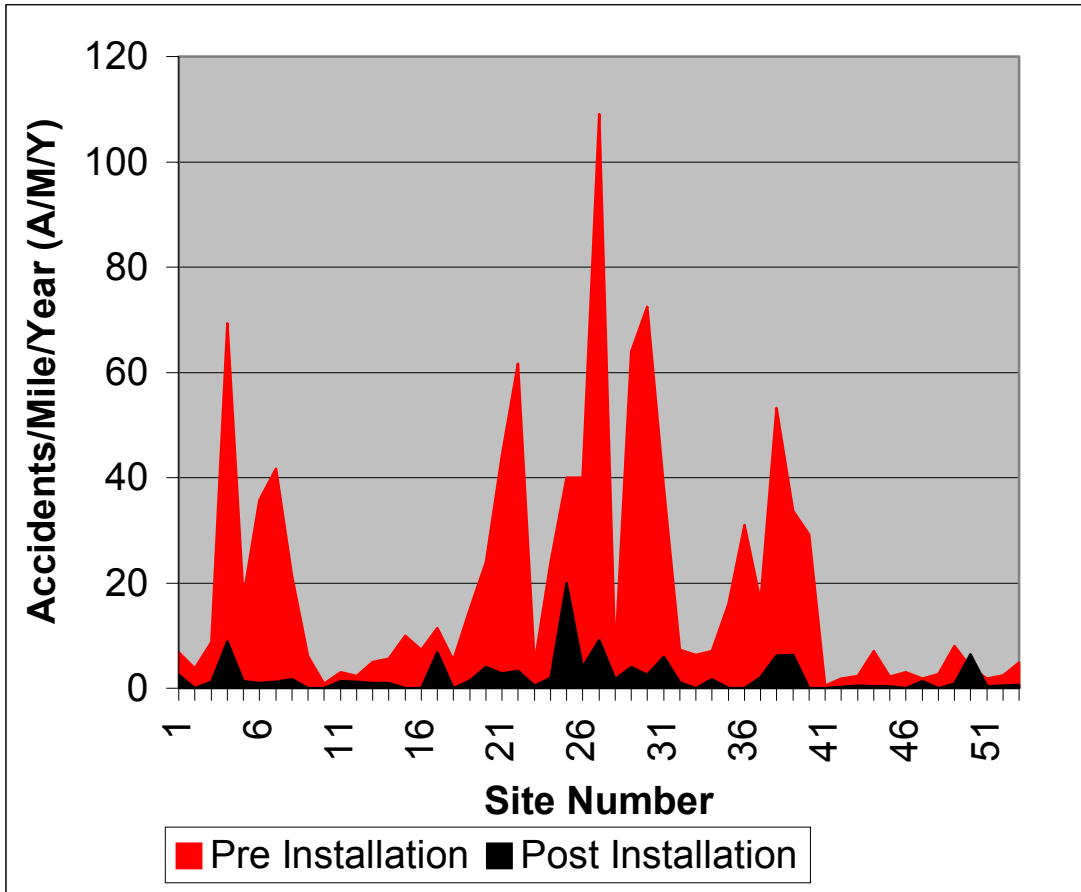
The Strieter Corporation is the World distributor of Strieter-Lite® Wild Animal Highway Warning Reflector Systems. The Strieter-Lite® reflector is a new design patented in 1994 based on the concept of the Swareflex Wildlife Reflectors, which were originally developed in 1973 and tested in Austria. According to company literature, the reflectors, if properly installed and maintained, will significantly reduce the number of accidents involving motor vehicles and deer.

The Strieter Corporation requested a statistical analysis of a collection of reports that include data about the number of accidents before and after the installation of the Strieter-Lite® and Swareflex reflectors. The reports came from various highway and transportation agencies located in the United States and Canada (see Table 1).

| State or Province |    | Sites |
|-------------------|----|-------|
| British Columbia  | BC | 13    |
| Colorado          | CO | 1     |
| Georgia           | GA | 1     |
| Illinois          | IL | 1     |
| Iowa              | IA | 4     |
| Kansas            | KS | 1     |
| Maryland          | MD | 5     |
| Michigan          | MI | 4     |
| Minnesota         | MN | 14    |
| New Jersey        | NJ | 2     |
| New York          | NY | 1     |
| Virginia          | VA | 1     |
| Wisconsin         | WI | 1     |
| Washington        | WA | 4     |

**Table 1 – Data Sources**

Examining the reported rate of accidents before and after the installation of the reflectors, it seems obvious that the reflectors are effective. This is dramatically illustrated in the graph shown in Figure 1.



**Figure 1 - Accident Rates before and after installation of reflectors**

For each site, the graph shows the rate of accidents before the installation of the reflectors (red) and after the installation of the reflectors (black). Even though the effectiveness seems to be obvious, a more scientific basis for such a conclusion is necessary. To accomplish this need, the Strieter Corporation requested a study to analyze the data statistically. This report contains the results of the study, which indicated reductions ranging from 78% to 90%.

## **THE STUDY**

Various highway and transportation agencies located in the United States and Canada provided reports that included data about the number of accidents involving deer and vehicle collisions before and after installation of the Strieter-Lite reflectors.

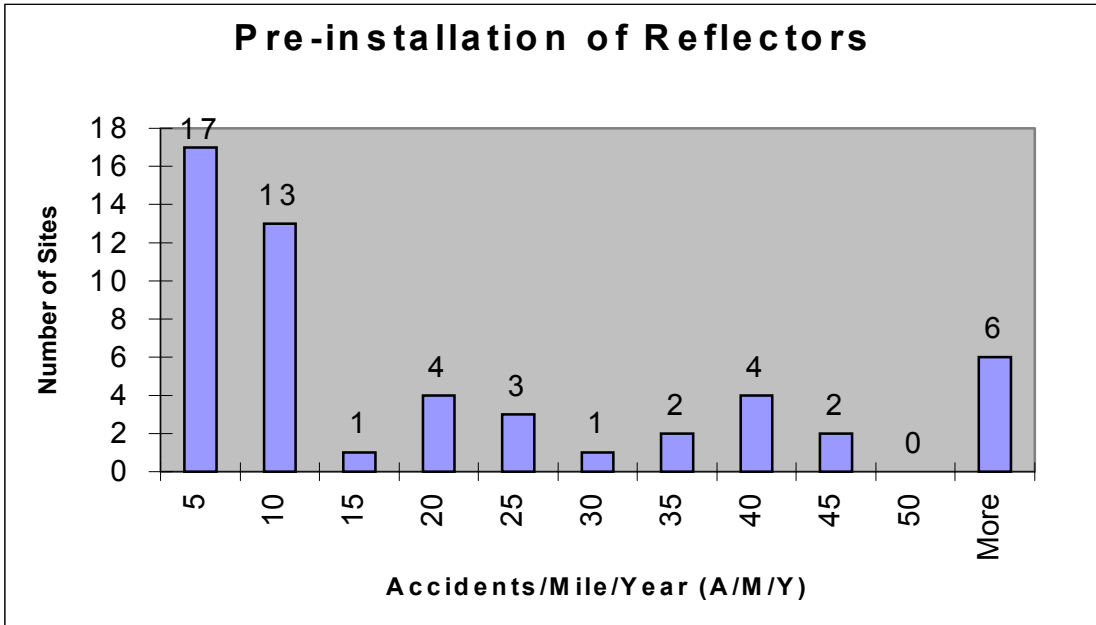
Experimental design and data collection methodologies varied from report to report. The reports also varied as to the length of the control sections and the pre-installation and post-installation time frames. The purpose of the analysis is to determine scientifically the effectiveness of the reflectors based on the reported data, which can be viewed in Appendix 7.

For the purpose of this analysis, an accident is a collision between a vehicle and a deer. Since the numbers of collisions, between vehicles and deer were recorded for different lengths of time at sites of different lengths, they were converted to comparable numbers by computing the rate of accidents per mile per year (A/M/Y). The objective of this analysis is to test whether the installation of the Strieter-Lite® reflectors reduced A/M/Y at the sites where the reflectors are installed.

The data analysis involves sample observations from two statistical populations that are defined as follows.

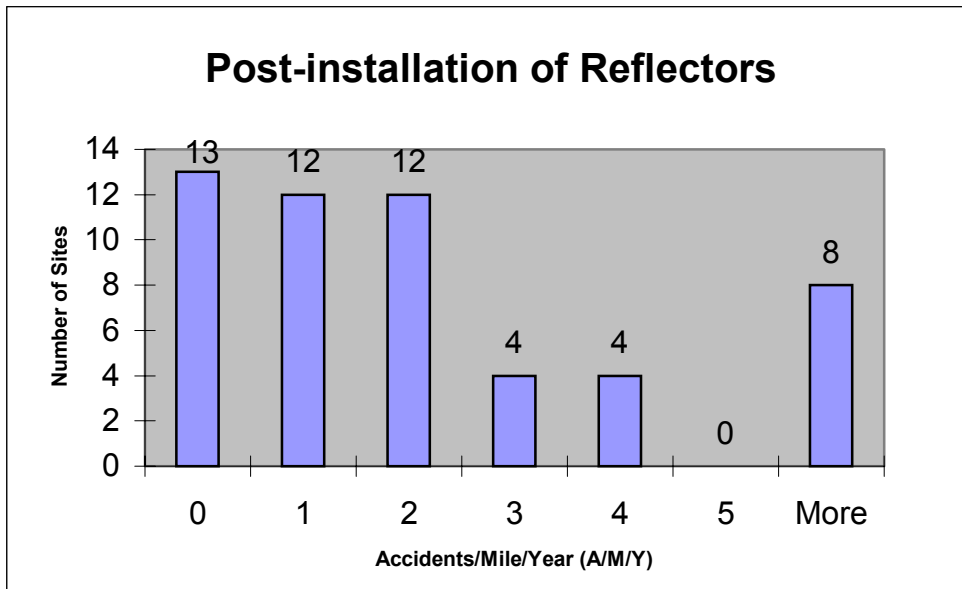
- Population 1 is the A/M/Y before the installation of the reflectors.
- Population 2 is the A/M/Y after the installation of the reflectors.

Figure 2 is a graph showing the distribution of A/M/Y before the installation of reflectors at the test sites (Population 1).



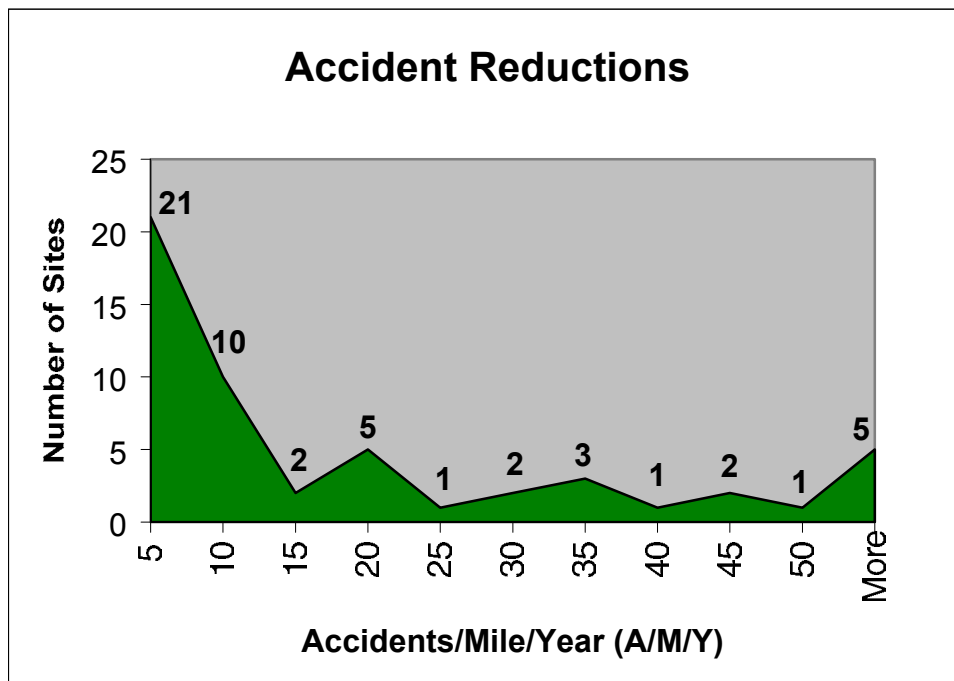
**Figure 2 – A/M/Y Prior to Installation of Strieter-Lite® Reflectors (Population 1)**

Figure 3 is a graph showing the A/M/Y after the reflectors were installed. Note the horizontal scale is different from that of Figure 2. It shows that thirteen sites reported no collisions after the reflectors were installed.



**Figure 3 – A/M/Y After Installation of Strieter-Lite® Reflectors (Population 2)**

The data collected for this test have another characteristic that needs to be considered when selecting the type of statistical test to use. The samples from the two populations are not independent; the data are paired observations. We have before and after observations on the same stretch of highway. Of interest, then, is the difference between the numbers of collisions before and after the reflectors were installed. Figure 4 illustrates the differences (reduction in collisions) for the paired observations.



**Figure 4 - Differences between the paired observations of populations 1 and 2**

A simple visual scan of the data before and after installation of the reflectors seems to indicate that the reflectors do indeed result in a reduction of collisions between vehicles and deer on the roads where the reflectors are installed. To “prove” that this observation is not mere chance but that there is actually a reduction in collisions after the reflectors are installed, we need to compare the two populations using a statistical test. The characteristic of the populations that is of greatest interest in this case is the location of the populations; that is, central tendency, or where the populations tend to be positioned

on a number scale. The usual statistical tests for this comparison require an assumption that the populations are “normal”; that is, the distribution of the values in the population form an approximate bell shape. From the graphs shown in figures 2 and 3, it is apparent that the populations in this case do not appear to be normally distributed since they are skewed right. An appropriate test to compare the locations of the populations would be a “distribution free” or non-parametric test. Tests of this type do not require an assumption that the data are normally distributed. We can test for a difference in location of the two populations – not necessarily their means or other population characteristics (i.e., parameters). Therefore, a nonparametric statistical method was employed to test the hypothesis that the reflectors reduced A/M/Y. An appropriate choice for a statistical test for the case presented here is the Wilcoxon matched-pairs signed rank test for the following reasons:

1. the objective is to compare the locations of two populations,
2. the data is quantitative,
3. the differences are not normally distributed,
4. the samples are matched pairs.

A more complete explanation of the test can be found in Appendix 1.

We tested the hypothesis that the installation of reflectors reduced A/M/Y, i.e., the location of population 1 was to the right of the location of population 2. In other words, the pre-installation A/M/Y are greater than the post-installation A/M/Y. Our null hypothesis was the status quo, i.e., there was not a difference in the locations of the two populations.

The results of three tests can be found in appendices 2, 3, and 4 and are summarized in the following table.

| Test results | Sample size | Test statistic | P-value             |
|--------------|-------------|----------------|---------------------|
| Appendix 2   | 4           | 0              | 0.0625 <sup>a</sup> |
| Appendix 3   | 35          | 4.979          | 0                   |
| Appendix 4   | 53          | 6.237          | 0                   |

**Table 2 - Test Results**

The first test (see Appendix 2) was based on the four test sites in Washington State since their test was the most empirical. It produced a test statistic that is likely to be observed less than 6.3% of the time if the null hypothesis were true. This is strong evidence supporting the research hypothesis, i.e. the installation of reflectors reduced A/M/Y.

The second test included 35 pairs where the pre-installation A/M/Y was less than twenty. This was used as a conservative approach. The third test included all 53 matched pairs. Since the sample sizes are large, i.e., greater than 30, the test statistics are approximately normally distributed. Both tests provided overwhelming evidence supporting the research hypothesis. If the null hypothesis were true, the probability of observing a test statistic at least as extreme as that produced in the test is virtually zero. In other words, these two tests conclusively supported the hypothesis that the installation of Strieter-Lite® reflectors reduced the collisions between vehicles and deer.

Descriptive statistics about the sample data are shown in Appendix 5. These provide a basis for estimating the number and percentage of reductions in A/M/Y using confidence intervals. The confidence intervals can be interpreted as follows. Lower Confidence Limits (LCL) and Upper Confidence Limits (UCL) are calculated based on the sample size, mean, standard deviation, and confidence level.

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<sup>a</sup> See Appendix 6



| Sample Size | Mean A/M/Y | Standard Deviation | Confidence Level | LCL A/M/Y | UCL A/M/Y |
|-------------|------------|--------------------|------------------|-----------|-----------|
| 35          | 6.17       | 4.51               | 95%              | 4.68      | 7.66      |
| 53          | 19.78      | 23.26              | 95%              | 13.52     | 26.04     |

**Table 3 – Confidence Interval Estimates of Pre-Installation A/M/Y**

| Sample Size | Mean A/M/Y | Standard Deviation | Confidence Level | LCL A/M/Y | UCL A/M/Y |
|-------------|------------|--------------------|------------------|-----------|-----------|
| 35          | 5.13       | 4.41               | 95%              | 3.67      | 6.59      |
| 53          | 17.53      | 21.56              | 95%              | 11.73     | 23.33     |

**Table 4 – Confidence Interval Estimates of Reductions in A/M/Y**

Considering the more conservative sample of 35 sites (with pre-installation A/M/Y less than twenty), we can be 95% confident that the mean number of reductions lies between 3.67 and 6.59 A/M/Y or 78% - 86%. Considering the sample of all 53 sites, we can be 95% confident that the mean number of reductions lies between 11.73 and 23.33 A/M/Y or 87% - 90%.

## SUMMARY and CONCLUSION

The objective of this study was to test whether the installation of the Strieter-Lite® reflectors reduced accidents at the sites where the reflectors are installed. Before and after data from 53 sites were analyzed statistically. Since the data were reported for different time periods for sites of different lengths, the reported data were "normalized" by converting to accidents per mile per year (A/M/Y). This facilitated the comparison of results from the different sites. The sample data conclusively supported the hypothesis that the installation of Strieter-Lite® reflectors reduced accidents, involving collisions between vehicles and deer, by 78 – 90%.

## Statistical Analysis software

The following software was used to prepare this report:

- Microsoft Excel
- Data Analysis Plus (a statistical analysis add-in for Excel)
- SPSS

## About the author

Robert H. Grenier

|                           |                               |
|---------------------------|-------------------------------|
| BA Mathematics            | Millikin University           |
| MS Mathematics            | Western Washington University |
| Executive MBA             | University of Iowa            |
| Ph.D. Information Systems | Nova Southeastern University  |

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## **Appendix 1 – Rationale of the Wilcoxon Matched-Pairs Signed Rank Test**

The Wilcoxon matched-pairs signed-rank test utilizes information about the relative magnitude as well as the direction of the differences within pairs of observed data. The test does not just consider the direction of a difference, but also gives more weight to a pair with a large difference than to a pair with a small difference.

For each matched pair we calculate the difference between the pair's values under two conditions (or treatments). Each pair has one difference. After all differences have been computed, the differences are ranked without respect to sign (negative or positive). Note that the direction of the ranking -- smallest to largest or largest to smallest -- makes no difference in the final test results. After the differences have been ranked, then the sign of the difference is affixed to each rank.

The null hypothesis being tested is that there is no difference in the treatments; that is, there is no difference in the number of collisions before and after installation of the reflectors. Now if the treatments were equivalent, we would expect to find some of the larger differences favoring no reflectors installed and some favoring the installation of reflectors. That is, some of the larger ranks would come from negative differences and some would come from positive differences. Thus, if we summed the ranks having a plus sign and summed the ranks having a minus sign, we would expect the two sums to be about equal under the null hypothesis. But if the sum of the positive ranks is very much different from the sum of the negative ranks, we would infer that the treatments are different. That is, we would infer that installation of the reflectors does make a difference in the number of collisions, and thus we would reject the null hypothesis.

Reference: Sidney Siegel, **Nonparametric Statistics**, McGraw-Hill Book Co., New York, 1956.  
pp. 75 – 83.

## **Appendix 2 – A/M/Y for the state of Washington sites**

### **Wilcoxon Signed Rank Test**

| <i>Site</i> | <i>Pre-reflector</i> | <i>Post-reflector</i> | <i>Difference</i> | <i> Difference </i> | <i>Rank</i> |
|-------------|----------------------|-----------------------|-------------------|---------------------|-------------|
| 36          | 30.99                | 0.00                  | 30.99             | 30.99               | 3           |
| 37          | 16.57                | 2.07                  | 14.50             | 14.50               | 1           |
| 38          | 53.21                | 6.26                  | 46.95             | 46.95               | 4           |
| 39          | 33.63                | 6.31                  | 27.33             | 27.33               | 2           |

*Number of Nonzero Differences = 4<sup>a</sup>*

*T+ = 10*

*T- = 0*

*Test Statistic Z = 0*

*P-Value = 0.0625*

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<sup>a</sup> Number of data points

### Appendix 3 – A/M/Y where pre-installation A/M/Y < 20

#### Wilcoxon Signed Rank Test

| Site | Pre-reflector | Post-reflector | Difference | Difference | Rank |
|------|---------------|----------------|------------|------------|------|
| 41   | 0.47          | 0.00           | 0.47       | 0.47       | 2    |
| 10   | 0.83          | 0.00           | 0.83       | 0.83       | 3    |
| 47   | 1.79          | 1.34           | 0.45       | 0.45       | 1    |
| 42   | 1.83          | 0.24           | 1.58       | 1.58       | 6    |
| 51   | 1.86          | 0.31           | 1.55       | 1.55       | 5    |
| 45   | 2.24          | 0.36           | 1.88       | 1.88       | 9    |
| 43   | 2.35          | 0.50           | 1.84       | 1.84       | 8    |
| 12   | 2.35          | 1.17           | 1.17       | 1.17       | 4    |
| 52   | 2.38          | 0.45           | 1.94       | 1.94       | 10   |
| 48   | 2.68          | 0.00           | 2.68       | 2.68       | 12   |
| 46   | 3.02          | 0.00           | 3.02       | 3.02       | 13   |
| 11   | 3.10          | 1.34           | 1.75       | 1.75       | 7    |
| 2    | 3.79          | 0.00           | 3.79       | 3.79       | 14   |
| 50   | 4.02          | 6.44           | -2.41      | 2.41       | 11   |
| 23   | 4.78          | 0.43           | 4.35       | 4.35       | 18   |
| 53   | 4.83          | 0.64           | 4.18       | 4.18       | 16   |
| 13   | 5.00          | 1.00           | 4.00       | 4.00       | 15   |
| 18   | 5.33          | 0.00           | 5.33       | 5.33       | 22   |
| 14   | 5.58          | 1.00           | 4.58       | 4.58       | 19   |
| 9    | 6.10          | 0.00           | 6.10       | 6.10       | 24   |
| 28   | 6.28          | 1.67           | 4.60       | 4.60       | 20   |
| 33   | 6.33          | 0.00           | 6.33       | 6.33       | 26   |
| 1    | 6.79          | 2.50           | 4.29       | 4.29       | 17   |
| 44   | 7.04          | 0.40           | 6.64       | 6.64       | 27   |
| 34   | 7.08          | 1.67           | 5.42       | 5.42       | 23   |
| 16   | 7.33          | 0.00           | 7.33       | 7.33       | 29   |
| 32   | 7.33          | 1.07           | 6.27       | 6.27       | 25   |
| 49   | 8.05          | 0.80           | 7.24       | 7.24       | 28   |
| 3    | 8.78          | 1.22           | 7.56       | 7.56       | 30   |
| 15   | 10.00         | 0.00           | 10.00      | 10.00      | 31   |
| 17   | 11.49         | 6.84           | 4.65       | 4.65       | 21   |
| 19   | 15.13         | 1.47           | 13.66      | 13.66      | 32   |
| 35   | 16.00         | 0.00           | 16.00      | 16.00      | 34   |
| 37   | 16.57         | 2.07           | 14.50      | 14.50      | 33   |
| 5    | 17.33         | 1.33           | 16.00      | 16.00      | 35   |

### **Appendix 3 – A/M/Y where pre-installation A/M/Y < 20**

*Number of Nonzero Differences = 35<sup>a</sup>*

*T+ = 619*

*T- = 11*

*Large Sample Approximation*

*Test Statistic Z = 4.979*

*P-Value < .001*

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<sup>a</sup> Number of data points

## Appendix 4 – A/M/Y for all 53 sites

### Wilcoxon Signed Rank Test

| Site | Pre-reflector | Post-reflector | Difference | Difference | Rank |
|------|---------------|----------------|------------|------------|------|
| 1    | 6.79          | 2.50           | 4.29       | 4.29       | 17   |
| 2    | 3.79          | 0.00           | 3.79       | 3.79       | 14   |
| 3    | 8.78          | 1.22           | 7.56       | 7.56       | 30   |
| 4    | 69.33         | 8.89           | 60.44      | 60.44      | 51   |
| 5    | 17.33         | 1.33           | 16.00      | 16.00      | 34   |
| 6    | 35.71         | 0.95           | 34.76      | 34.76      | 44   |
| 7    | 41.67         | 1.16           | 40.51      | 40.51      | 46   |
| 8    | 21.30         | 1.70           | 19.60      | 19.60      | 36   |
| 9    | 6.10          | 0.00           | 6.10       | 6.10       | 24   |
| 10   | 0.83          | 0.00           | 0.83       | 0.83       | 3    |
| 11   | 3.10          | 1.34           | 1.75       | 1.75       | 7    |
| 12   | 2.35          | 1.17           | 1.17       | 1.17       | 4    |
| 13   | 5.00          | 1.00           | 4.00       | 4.00       | 15   |
| 14   | 5.58          | 1.00           | 4.58       | 4.58       | 19   |
| 15   | 10.00         | 0.00           | 10.00      | 10.00      | 31   |
| 16   | 7.33          | 0.00           | 7.33       | 7.33       | 29   |
| 17   | 11.49         | 6.84           | 4.65       | 4.65       | 21   |
| 18   | 5.33          | 0.00           | 5.33       | 5.33       | 22   |
| 19   | 15.13         | 1.47           | 13.66      | 13.66      | 32   |
| 20   | 24.00         | 4.00           | 20.00      | 20.00      | 37   |
| 21   | 44.29         | 2.86           | 41.43      | 41.43      | 47   |
| 22   | 61.67         | 3.33           | 58.33      | 58.33      | 49   |
| 23   | 4.78          | 0.43           | 4.35       | 4.35       | 18   |
| 24   | 24.00         | 2.00           | 22.00      | 22.00      | 39   |
| 25   | 40.00         | 20.00          | 20.00      | 20.00      | 38   |
| 26   | 40.00         | 4.00           | 36.00      | 36.00      | 45   |
| 27   | 109.09        | 9.09           | 100.00     | 100.00     | 53   |
| 28   | 6.28          | 1.67           | 4.60       | 4.60       | 20   |
| 29   | 64.00         | 4.00           | 60.00      | 60.00      | 50   |
| 30   | 72.50         | 2.50           | 70.00      | 70.00      | 52   |
| 31   | 38.00         | 6.00           | 32.00      | 32.00      | 43   |
| 32   | 7.33          | 1.07           | 6.27       | 6.27       | 25   |
| 33   | 6.33          | 0.00           | 6.33       | 6.33       | 26   |
| 34   | 7.08          | 1.67           | 5.42       | 5.42       | 23   |
| 35   | 16.00         | 0.00           | 16.00      | 16.00      | 35   |
| 36   | 30.99         | 0.00           | 30.99      | 30.99      | 42   |
| 37   | 16.57         | 2.07           | 14.50      | 14.50      | 33   |
| 38   | 53.21         | 6.26           | 46.95      | 46.95      | 48   |
| 39   | 33.63         | 6.31           | 27.33      | 27.33      | 40   |
| 40   | 29.17         | 0.00           | 29.17      | 29.17      | 41   |
| 41   | 0.47          | 0.00           | 0.47       | 0.47       | 2    |

**Appendix 4 – A/M/Y for all 53 sites**

|    |      |      |       |      |    |
|----|------|------|-------|------|----|
| 42 | 1.83 | 0.24 | 1.58  | 1.58 | 6  |
| 43 | 2.35 | 0.50 | 1.84  | 1.84 | 8  |
| 44 | 7.04 | 0.40 | 6.64  | 6.64 | 27 |
| 45 | 2.24 | 0.36 | 1.88  | 1.88 | 9  |
| 46 | 3.02 | 0.00 | 3.02  | 3.02 | 13 |
| 47 | 1.79 | 1.34 | 0.45  | 0.45 | 1  |
| 48 | 2.68 | 0.00 | 2.68  | 2.68 | 12 |
| 49 | 8.05 | 0.80 | 7.24  | 7.24 | 28 |
| 50 | 4.02 | 6.44 | -2.41 | 2.41 | 11 |
| 51 | 1.86 | 0.31 | 1.55  | 1.55 | 5  |
| 52 | 2.38 | 0.45 | 1.94  | 1.94 | 10 |
| 53 | 4.83 | 0.64 | 4.18  | 4.18 | 16 |

*Number of Nonzero Differences = 53<sup>a</sup>*

*T+ = 1420*

*T- = 11*

*Large Sample Approximation*

*Test Statistic Z = 6.237*

*P-Value < .001*

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<sup>a</sup> Number of data points



## Appendix 5 – Descriptive Statistics

| <b>All 53 sites</b>     | <b>A/M/Y</b>  |                |            |
|-------------------------|---------------|----------------|------------|
|                         | Pre-reflector | Post-reflector | Difference |
| Mean                    | 19.78         | 2.25           | 17.53      |
| Standard Error          | 3.20          | 0.47           | 2.96       |
| Median                  | 7.33          | 1.16           | 6.64       |
| Mode                    | 7.33          | 0.00           | 20.00      |
| Standard Deviation      | 23.26         | 3.43           | 21.56      |
| Sample Variance         | 541.21        | 11.74          | 464.77     |
| Kurtosis                | 3.34          | 13.30          | 3.44       |
| Skewness                | 1.78          | 3.16           | 1.82       |
| Range                   | 108.62        | 20.00          | 102.41     |
| Minimum                 | 0.47          | 0.00           | -2.41      |
| Maximum                 | 109.09        | 20.00          | 100.00     |
| Sum                     | 1048.41       | 119.32         | 929.09     |
| Count                   | 53            | 53             | 53         |
| Confidence Level(95.0%) | 6.41          | 0.94           | 5.94       |

| <b>35 selected sites</b> | <b>A/M/Y</b>  |                |            |
|--------------------------|---------------|----------------|------------|
|                          | Pre-reflector | Post-reflector | Difference |
| Mean                     | 6.17          | 1.04           | 5.13       |
| Standard Error           | 0.76          | 0.26           | 0.75       |
| Median                   | 5.33          | 0.50           | 4.35       |
| Mode                     | 7.33          | 0.00           | #N/A       |
| Standard Deviation       | 4.51          | 1.56           | 4.41       |
| Sample Variance          | 20.36         | 2.42           | 19.45      |
| Kurtosis                 | 0.81          | 8.69           | 1.09       |
| Skewness                 | 1.18          | 2.84           | 1.14       |
| Range                    | 16.86         | 6.84           | 18.41      |
| Minimum                  | 0.47          | 0.00           | -2.41      |
| Maximum                  | 17.33         | 6.84           | 16.00      |
| Sum                      | 215.86        | 36.28          | 179.58     |
| Count                    | 35            | 35             | 35         |
| Confidence Level(95.0%)  | 1.55          | 0.53           | 1.52       |

## Appendix 6

The table shows all possible outcomes of a Wilcoxon Signed-Ranks Test when the number of observations is 4.

### Illustration for Deriving the P-value

|       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|       | +1 | +1 | +1 | +1 | -1 | +1 | +1 | -1 | +1 | -1 | -1 | +1 | -1 | -1 | -1 | -1 |
|       | +2 | +2 | +2 | -2 | +2 | +2 | -2 | -2 | -2 | +2 | +2 | -2 | +2 | -2 | -2 | -2 |
|       | +3 | +3 | -3 | +3 | +3 | -3 | -3 | +3 | +3 | -3 | +3 | -3 | -3 | +3 | -3 | -3 |
|       | +4 | -4 | +4 | +4 | +4 | -4 | +4 | +4 | -4 | +4 | -4 | -4 | -4 | -4 | +4 | -4 |
| $T_+$ | 10 | 6  | 7  | 8  | 9  | 3  | 5  | 7  | 4  | 6  | 5  | 1  | 2  | 3  | 4  | 0  |
| $T_-$ | 0  | 4  | 3  | 2  | 1  | 7  | 5  | 3  | 6  | 4  | 5  | 9  | 8  | 7  | 6  | 10 |

$$P [ T_+ \geq 10 ] = P [ T_- \leq 0 ] = 1/16 = 0.0625$$

## Appendix 7 – Raw Data

| Site | State | Road            |                          |    |       | Pre-Reflector |        |            |        | Post-Reflector |               |      |            | Accident Reduction |      |        |
|------|-------|-----------------|--------------------------|----|-------|---------------|--------|------------|--------|----------------|---------------|------|------------|--------------------|------|--------|
|      |       | Name            | Site Report Document     | Km | Miles | Report Years  |        | Collisions | A/M/Y  | Installed      | Report Period |      | Collisions | A/M/Y              | %    | A/M/Y  |
| 1    | CO    | US-36           | CO Boulder Dist          |    | 0.70  | 1993          | 1996   | 19         | 6.79   | Dec-96         | 1997          | 2000 | 7          | 2.50               | 63%  | 4.29   |
| 2    | GA    | SR-155          | GA DOT                   |    | 0.50  | 1993          | 1997   | 7          | 3.79   | Mar-97         | 1997          | 1999 | 0          | 0.00               | 100% | 3.79   |
| 3    | IL    | SR-47           | IL Mahomet               |    | 0.41  | 1992          | 1996   | 18         | 8.78   | Jan-98         | 1998          | 1999 | 1          | 1.22               | 86%  | 7.56   |
| 4    | IA    | Dubuque St      | IA City #1               |    | 0.75  | 1996          | 1996   | 52         | 69.33  | Jul-96         | 1997          | 1999 | 20         | 8.89               | 87%  | 60.44  |
| 5    | IA    | Dodge St        | IA City #2               |    | 1.50  | 1998          | 1998   | 26         | 17.33  | Aug-99         | 1999          | 1999 | 2          | 1.33               | 92%  | 16.00  |
| 6    | IA    | SR-76           | IA DOT #1                |    | 1.40  | 1984          | 1986   | 150        | 35.71  | Jan-87         | 1987          | 2000 | 16         | 0.95               | 97%  | 34.76  |
| 7    | IA    | SR-26           | IA DOT #2                |    | 0.54  | 1992          | 1992   | 22.5       | 41.67  | Apr-92         | 1993          | 2000 | 5          | 1.16               | 97%  | 40.51  |
| 8    | KS    | K-4             | KS DOT John Babcock      |    | 0.75  | 88            | Sep-90 |            | 21.30  | Oct-90         | 1991          | 2000 |            | 1.70               | 92%  | 19.60  |
| 9    | MD    | Worthington Ave | MD Baltimore County      |    | 1.50  | 1995          | 1996   | 16         | 6.10   | Sep-96         | 1997          | 1999 | 0          | 0.00               | 100% | 6.10   |
| 10   | MD    | SR-25           | MD Falls Road            |    | 2.00  | 1996          | 1998   | 5          | 0.83   | Nov-98         | 1999          | 2000 | 0          | 0.00               |      | 0.83   |
| 11   | MD    | SR-23           | MD Harford Cnty #1       |    | 2.50  | 1993          | 1994   | 11         | 3.10   | Oct-94         | 1994          | 2000 | 21         | 1.34               | 57%  | 1.75   |
| 12   | MD    | SR-24           | MD Harford Cnty #2       |    | 1.50  | 1993          | 1994   | 5          | 2.35   | Oct-94         | 1994          | 2000 | 11         | 1.17               | 50%  | 1.17   |
| 13   | MD    | MD-156          | MD Harford Cnty #3       |    | 0.80  | 1999          | 1999   | 4          | 5.00   | Oct-99         | 1999          | 2000 | 1          | 1.00               | 80%  | 4.00   |
| 14   | MI    | Old-27          | MI Calhoun Cnty #s1&2    |    | 1.00  | 1996          | 1999   | 13         | 5.58   | Sep-96         | 1999          | 1999 | 1          | 1.00               | 82%  | 4.58   |
| 15   | MI    | Homer Road      | MI Calhoun Cnty #3       |    |       | 1997          | 1997   |            | 10.00  | Sep-98         | 1999          | 1999 | 0          | 0.00               | 100% | 10.00  |
| 16   | MI    | B Drive         | MI Calhoun Cnty #4       |    | 1.00  | 1998          | 1998   | 5.5        | 7.33   | Oct-99         | 1999          | 2000 | 0          | 0.00               | 100% | 7.33   |
| 17   | MI    | Ricketts Rd     | MI Livingston Cnty Goryl |    | 0.50  | 1993          | 1996   | 22         | 11.49  | Nov-96         | 1997          | 1998 | 4          | 6.84               | 40%  | 4.65   |
| 18   | MN    | County Rd 13    | MN New Ulm               |    | 1.50  | 1965          | 1985   | 168        | 5.33   | 85 & 91        | 1986          | 2000 | 0          | 0.00               | 100% | 5.33   |
| 19   | MN    | County Rd 23    | MN Paynesville, Legatt   |    | 2.00  | 1986          | 1989   | 121        | 15.13  | May-90         | 1990          | 1999 | 28         | 1.47               | 90%  | 13.66  |
| 20   | MN    | TH-32           | Pafko Report             |    | 1.00  | 1987          | 1987   | 24         | 24.00  | 1988           | 1988          | 1994 | 28         | 4.00               | 83%  | 20.00  |
| 21   | MN    | TH-71           | Pafko Report             |    | 0.70  | 1987          | 1987   | 31         | 44.29  | 1988           | 1988          | 1994 | 14         | 2.86               | 94%  | 41.43  |
| 22   | MN    | TH-71           | Pafko Report             |    | 0.60  | 1987          | 1987   | 37         | 61.67  | 1988           | 1988          | 1994 | 14         | 3.33               | 95%  | 58.33  |
| 23   | MN    | TH-64           | Pafko Report             |    | 2.30  | 1987          | 1987   | 11         | 4.78   | 1988           | 1988          | 1994 | 7          | 0.43               | 91%  | 4.35   |
| 24   | MN    | TH-75           | Pafko Report             |    | 1.00  | 1987          | 1987   | 24         | 24.00  | 1988           | 1988          | 1994 | 14         | 2.00               | 92%  | 22.00  |
| 25   | MN    | TH-23           | Pafko Report             |    | 1.00  | 1987          | 1987   | 40         | 40.00  | 1988           | 1988          | 1994 | 140        | 20.00              | 50%  | 20.00  |
| 26   | MN    | TH-67           | Pafko Report             |    | 0.75  | 1987          | 1987   | 30         | 40.00  | 1988           | 1988          | 1994 | 21         | 4.00               | 90%  | 36.00  |
| 27   | MN    | TH-75           | Pafko Report             |    | 1.10  | 1987          | 1987   | 120        | 109.09 | 1988           | 1988          | 1994 | 70         | 9.09               | 92%  | 100.00 |
| 28   | MN    | TH-371          | Pafko Report             |    | 2.39  | 1987          | 1987   | 15         | 6.28   | 1988           | 1988          | 1994 | 28         | 1.67               | 73%  | 4.60   |
| 29   | MN    | Th-64           | Pafko Report             |    | 0.25  | 1987          | 1987   | 16         | 64.00  | 1988           | 1988          | 1994 | 7          | 4.00               | 94%  | 60.00  |
| 30   | MN    | TH-169          | Pafko Report             |    | 0.40  | 1987          | 1987   | 29         | 72.50  | 1988           | 1988          | 1994 | 7          | 2.50               | 97%  | 70.00  |
| 31   | MN    | I-94            | Pafko Report             |    | 1.00  | 1987          | 1987   | 38         | 38.00  | 1988           | 1988          | 1994 | 42         | 6.00               | 84%  | 32.00  |
| 32   | NJ    | County Rd 617   | NJ Hunterdon Cnty #1     |    | 1.50  | 1999          | 1999   | 11         | 7.33   | Sep-99         | 1999          | 2000 | 2          | 1.07               | 85%  | 6.27   |

## Appendix 7 – Raw Data

| Site | State | Road     |                           |     |       | Pre-Reflector |            |       |           | Post-Reflector |            |        |    | Accident Reduction |      |       |
|------|-------|----------|---------------------------|-----|-------|---------------|------------|-------|-----------|----------------|------------|--------|----|--------------------|------|-------|
|      |       | Name     | Site Report Document      | Km  | Miles | Report Years  | Collisions | A/M/Y | Installed | Report Period  | Collisions | A/M/Y  | %  | A/M/Y              |      |       |
| 33   | NJ    | Turnpike | NJ Turnpike Authority     |     | 1.00  | 1997          | 1999       | 19    | 6.33      | Sep-99         | Sep-99     | Mar-01 | 0  | 0.00               | 100% | 6.33  |
| 34   | NY    | Route 26 | NY Lewis County, Lowville |     | 1.20  | 1996          | 1997       | 17    | 7.08      | Nov-97         | 1998       | 1998   | 2  | 1.67               | 76%  | 5.42  |
| 35   | VA    | Teleg Rd | VA Fairfax Cnty           |     | 0.50  | 1996          | 1998       | 24    | 16.00     | Sep-99         | 1999       | 1999   | 0  | 0.00               | 100% | 16.00 |
| 36   | WA    | SR-395   | WA DOT                    |     | 0.50  | Mar-81        | Apr-84     | 11    | 30.99     |                | Mar-81     | Apr-84 | 0  | 0.00               | 100% | 30.99 |
| 37   | WA    | SR-395   | WA DOT                    |     | 0.68  | Mar-81        | Apr-84     | 8     | 16.57     |                | Mar-81     | Apr-84 | 1  | 2.07               | 88%  | 14.50 |
| 38   | WA    | SR-395   | WA DOT                    |     | 0.45  | Mar-81        | Apr-84     | 17    | 53.21     |                | Mar-81     | Apr-84 | 2  | 6.26               | 88%  | 46.95 |
| 39   | WA    | SR-395   | WA DOT                    |     | 0.67  | Mar-81        | Apr-84     | 16    | 33.63     |                | Mar-81     | Apr-84 | 3  | 6.31               | 81%  | 27.33 |
| 40   | WI    | SR-26    | WI Fort Atkinson          |     | 1.20  | 1997          | 1997       | 35    | 29.17     | Aug-97         | 1997       | 2000   | 0  | 0.00               | 100% | 29.17 |
| 41   | BC    | Hwy 16   | BC Smithers, Airport      | 3.4 | 2.11  | 1995          | 1998       | 3     | 0.47      | Aug-98         | 1999       | 2000   | 0  | 0.00               | 100% | 0.47  |
| 42   | BC    | Hwy 16   | BC Smithers, Babine       | 2.2 | 1.37  | 1993          | 1995       | 5     | 1.83      | Aug-95         | 1995       | 2000   | 2  | 0.24               | 87%  | 1.58  |
| 43   | BC    | Hwy 16   | BC Smithers, Bourgon      | 1.6 | 0.99  | 1993          | 1996       | 7     | 2.35      | Aug-96         | 1997       | 2000   | 2  | 0.50               | 79%  | 1.84  |
| 44   | BC    | Hwy 16   | BC Smithers, Donaldson    | 0.8 | 0.50  | 1993          | 1995       | 7     | 7.04      | Aug-95         | 1996       | 2000   | 1  | 0.40               | 94%  | 6.64  |
| 45   | BC    | Hwy 16   | BC Smithers, Juniper      | 1.8 | 1.12  | 1993          | 1995       | 5     | 2.24      | Aug-95         | 1996       | 2000   | 2  | 0.36               | 84%  | 1.88  |
| 46   | BC    | Hwy 16   | BC Smithers, Larch        | 0.8 | 0.50  | 1993          | 1995       | 3     | 3.02      | Sep-95         | 1996       | 2000   | 0  | 0.00               | 100% | 3.02  |
| 47   | BC    | Hwy 16   | BC Smithers, Neil         | 0.6 | 0.37  | 1993          | 1996       | 2     | 1.79      | Aug-96         | 1997       | 2000   | 2  | 1.34               | 25%  | 0.45  |
| 48   | BC    | Hwy 16   | BC Smithers, Quickw       | 0.9 | 0.56  | 1993          | 1995       | 3     | 2.68      | Aug-95         | 1996       | 2000   | 0  | 0.00               | 100% | 2.68  |
| 49   | BC    | Hwy 16   | BC Smithers, Raymond      | 0.5 | 0.31  | 1994          | 1996       | 5     | 8.05      | Aug-96         | 1997       | 2000   | 1  | 0.80               | 90%  | 7.24  |
| 50   | BC    | Hwy 16   | BC Smithers, Telkwa       | 1.0 | 0.62  | 1994          | 1996       | 5     | 4.02      | Aug-96         | 1998       | 2000   | 12 | 6.44               | -60% | -2.41 |
| 51   | BC    | Hwy 16   | BC Smithers, Vanhorn      | 1.3 | 0.81  | 1993          | 1995       | 3     | 1.86      | Aug-96         | 1997       | 2000   | 1  | 0.31               | 83%  | 1.55  |
| 52   | BC    | Hwy 16   | BC Smithers, Vics         | 0.9 | 0.56  | 1993          | 1996       | 4     | 2.38      | Aug-96         | 1997       | 2000   | 1  | 0.45               | 81%  | 1.94  |
| 53   | BC    | Hwy 16   | BC Smithers, Viewpoint    | 0.5 | 0.31  | 1993          | 1995       | 3     | 4.83      | Aug-95         | 1996       | 2000   | 1  | 0.64               | 87%  | 4.18  |