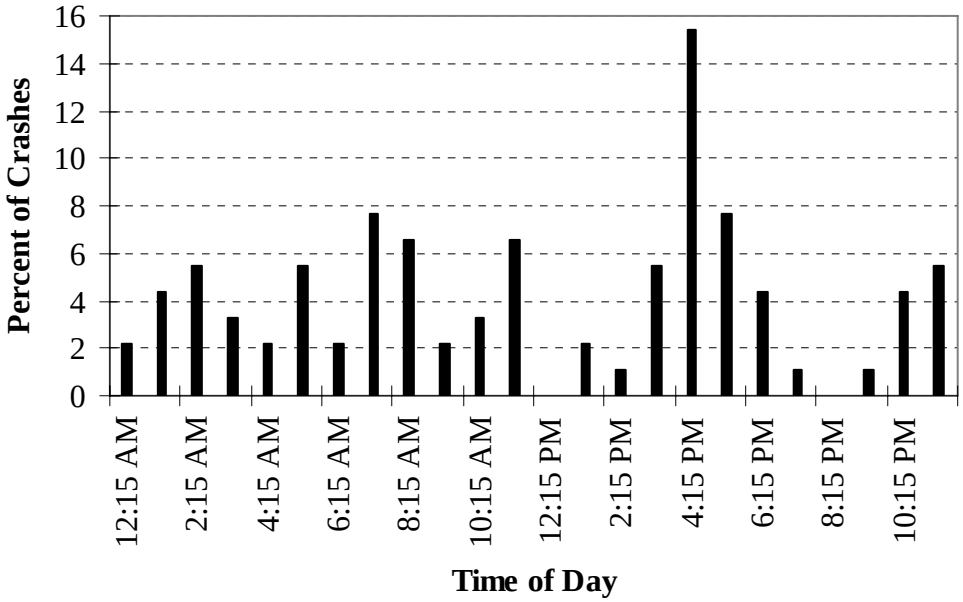

Figure 4-28. Histogram of drowsy driving crashes on S.R. 36.

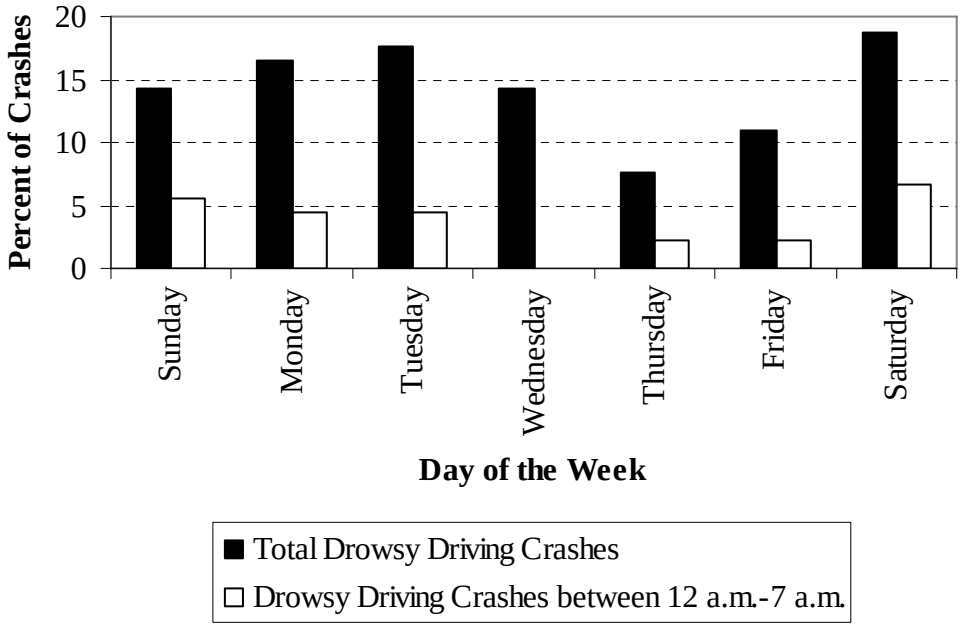

Figure 4-29. Drowsy driving crashes by day of the week on S.R. 36.

4.7.3 Vehicle Type, Object Struck, and Severity

Semi-trucks represented approximately 1.1 percent of all vehicles involved in drowsy driving crashes on S.R. 36. As has been identified from the results of other highways in this chapter, the most common vehicle type involved in drowsy driving crashes was the passenger car as outlined in Table 4-40. The total number of vehicles in which a driver was responsible for a crash or partially responsible for a drowsy driving crash summed to 94 crashes, 3 vehicles more than the total number of crashes as some cases the police report indicated that two drivers were responsible for the crash.

Table 4-40. Vehicle Types of Drowsy Drivers on S.R. 36

Vehicle Type of Person(s) Responsible for Crash	Number of Vehicles	Percent of Vehicles
Passenger Car/Pickup	86	91.4
Passenger Car/Pickup with Trailer	1	1.1
Truck/Tractor and Trailer	1	1.1
No Vehicle Type Recorded	6	6.4
Total	94	100.0

A number of objects along a highway which drivers hit, and which are recorded in the UDOT crash database, are listed in Table 4-41. The first and second most frequently hit objects on S.R. 36 were fences and utility poles, which were struck by 18.1 and 16.0 percent of drowsy drivers, respectively. None of the other highway results in this chapter identified a utility pole as one of the most frequently hit objects. This is likely due to the rural area of that S.R. 36 spans. Also hit frequently was a dirt embankment or mountainside, which occurred in almost 15 percent of the drowsy driving crashes. No object was struck in 31.9 percent of the crashes.

Table 4-41. Objects Struck by Drowsy Drivers on S.R. 36

Object Struck by Person(s) Responsible for Crash	Number of Vehicles	Percent of Vehicles
Fence	17	18.1
Utility Pole	15	16.0
Dirt Embankment/Ditch/Berm (Mountainside)	14	14.9
Delineator Post	7	7.4
Tree/Shrubbery	3	3.2
Curb or Safety Island	2	2.1
Sign Post	2	2.1
Bridge Culvert or Other Highway Structure	1	1.1
Building/Other Structure (Wall)	1	1.1
Other	1	1.1
Wild Animal	1	1.1
No Object Struck	30	31.8
Total	94	100.0

To determine if the distribution of drowsy driving crashes on S.R. 36 was skewed towards Utah residents more than out-of-state visitors, license plate data from police reports were analyzed for the timeframe 1996-2004. This analysis incorporated 62 crashes. Utah residents represented 98.4 percent of drivers responsible for the fatigue-related crashes in this study while 1.6 percent were recorded as out-of-state drivers.

Severity of drowsy driving crashes as indicated in the literature review tends to be worse than other crashes. Table 4-42 indicates a percentage for each severity type among solely drowsy driving crashes as well as a percentage for each severity level generated from all crashes on S.R. 36 from 1992-2004. As noted, drowsy driving crashes yielded a greater percentage of fatal crashes when compared to all fatal crashes on this highway. Furthermore, severity levels of crashes involving drowsy driving were worse overall with fewer crashes yielding “No Injury.”

Table 4-42. Severity of Drowsy Driving Crashes Versus All Crashes on S.R. 36

Severity	Drowsy Driving Crashes	All Crashes
Fatal	2.2	1.1
Broken Bones or Bleeding Wound	16.5	8.5
Bruises and Abrasions	16.5	8.9
Possible Injury	17.6	15.3
No Injury	47.2	66.2
Total	100.0	100.0

4.7.4 Directional Distribution

The trends in directional distribution of drowsy driving crashes were calculated and are illustrated in Figure 4-30. Of the 91 drowsy driving crashes, 37.8 percent occurred in the northbound direction while the 62.2 percent were in the southbound direction. A large increase in crashes is identifiable following M.P. 50 near Tooele.

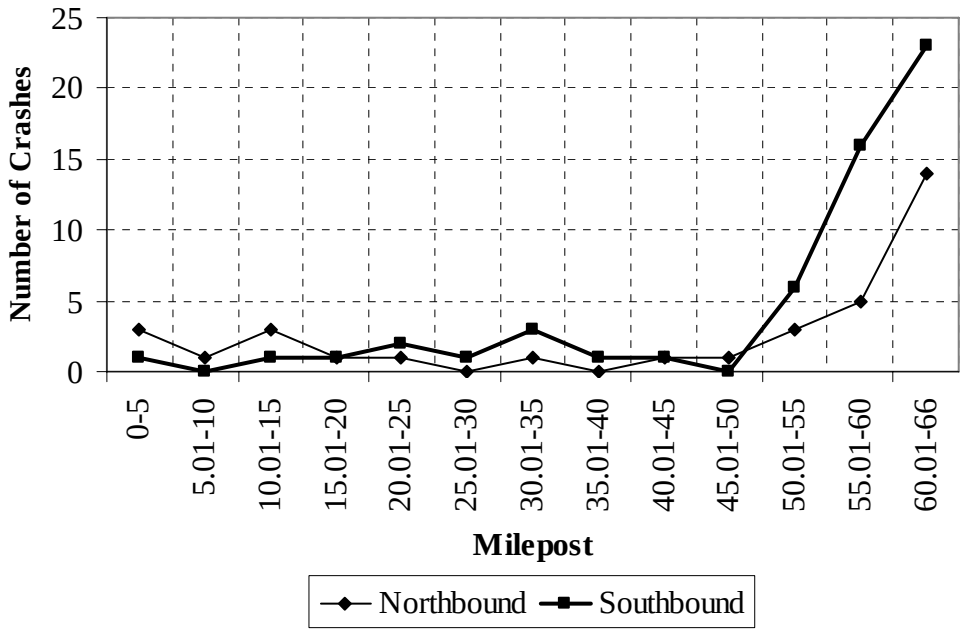

Figure 4-30. Directional distribution of drowsy driving crashes on S.R. 36.

4.8 Critical Corridor Summary

The previous sections discussed the critical corridor results as well as drowsy driving trends and statistics for each Interstate freeway, U.S. Route, and S.R. highway containing critical corridors. Statistics included: drowsy driving crash consequences, roadway alignment impact, time of day and day of week of drowsy driving crashes, vehicle type and object struck in drowsy driving crashes, and a comparison of the severity of drowsy driving crashes versus all crashes. Table 4-43 is provided to easily compare a few of the most important statistics from the various facilities studied.

Table 4-43. Drowsy Driving Crash Summary

Facility	Drowsy Driving Crashes	Single-vehicle Crashes		Fatal Crashes		Run-Off-Road Crashes		Crashes on Curves	
		No.	Percent	No.	Percent	No.	Percent	No.	Percent
I-15	3,883	3,194	82.3	147	3.8	2,924	75.3	898	23.1
I-70	899	864	96.1	75	8.3	781	86.9	312	34.7
I-80	922	818	88.7	57	6.2	735	79.7	230	24.9
I-84	160	143	89.4	6	3.8	124	77.5	65	40.6
U.S. 89	877	628	71.6	18	2.1	567	64.7	157	17.9
U.S. 91	271	179	66.1	5	1.8	176	64.9	25	9.2
S.R. 36	91	73	80.2	2	2.2	71	78.0	13	14.3
Total	7,103	5,899	83.0	310	4.4	5,378	75.7	1,700	23.9

4.9 Under-Reported Drowsy Driving Crashes

As identified through the literature, it is believed that drowsiness as a primary factor in crashes where the driver fell asleep is under-reported because in many cases no evidence suggests the driver fell asleep behind the wheel (McCartt et al. 2000). Using the crash data obtained from the UDOT crash database, the percent of total crashes in which sleep or fatigue were not identified as primary contributors was estimated for several highways. The data used to determine whether or not drowsiness may have been a causal factor in a crash were: time of day, primary contributor, secondary contributor,

crash result, vehicle type, and crash severity. These crash characteristics were identified in the literature and in this chapter as those most representative of drowsy driving crashes.

All crashes reported in six 5-mile corridors were reviewed; two corridors from each of the following freeways: I-15, I-70, and I-80. In judging each crash, more weight was given to time of day, crash result, primary contributor, and secondary contributor, while the other characteristics typical of drowsy driving crashes were used in a supporting role. Of the 582 crashes reviewed, police officers cited a secondary contributor in 150 (25.8 percent) crashes of which 13 crashes were designated as asleep, fatigue, or ill. If the reporting officer cited asleep, fatigue, or ill as a secondary contributor and no evidence of alcohol was identified in the crash report, then the crash was assumed to be caused by a drowsy driver. In cases where a secondary contributor was not recorded, the crash results along with the time of day were used as a method to gage whether a crash may have been fatigue-related.

Crashes which occurred between the hours of 11 p.m. and 7 a.m. and which the driver ran off the roadway were generally considered drowsy driving crashes unless alcohol or some physical car problem such as defective tires was indicated in the police report. Other crashes which were possibly caused by drowsy driving included crashes in which the police report outlined excessive speed coupled with a severe crash result such as a fatality or broken bones.

The results of this analysis are outlined in Table 4-44. Under-reported drowsy driving crashes were estimated at a minimum to be approximately 8 percent with a possible maximum of 18 percent. Even with the enormous amounts of data available in the UDOT crash database, it is possible that these values are still conservative. Until police officers are trained to recognize drowsy driving crashes and until drivers involved in crashes are willing to admit their sleepiness behind the wheel, it is estimated that drowsy driving crashes will continue to be under-reported.

Table 4-44. Estimated Percentage of Under-reported Drowsy Driving Crashes

Facility	Critical Corridor	Estimated Percentage of Under-reported Drowsy Driving Crashes
I-15	M.P. 90 – 95	15
	M.P. 190 – 195	14
I-70	M.P. 135 – 140	18
	M.P. 160 – 165	8
I-80	M.P. 35 – 40	17
	M.P. 70 – 75	18

4.10 Results Summary

The corridors most prone to drowsy driving crashes during the 3-year analysis encompassing the years 2002-2004 were identified and illustrated on Utah state maps. Discussion of drowsy driving statistics for each facility was given. Statistics for each roadway included: drowsy driving crash results, roadway alignment impact, time of day and day of week of drowsy driving crashes, vehicle type and object struck in drowsy driving crashes, and a comparison of the severity of drowsy driving crashes versus all crashes. Brief discussion was provided regarding curves in roadway alignment which may be considered dangerous based upon the number of crashes at a given location. To determine which type(s) of countermeasures may be suitable for the drowsy driving corridors discussed in this chapter, a detailed review of the existing drowsy driving countermeasures employed by UDOT was undertaken and is presented in Chapter 5

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5 EXISTING COUNTERMEASURES

Over the past decade the state of Utah has taken a proactive approach to reduce crashes, specifically fatalities, on all Utah highways. In order to accomplish this goal, UDOT has implemented several countermeasures to prevent drivers from causing serious crashes. Four existing countermeasures undertaken by UDOT are discussed in this chapter as well as other countermeasures considered by UDOT but not yet implemented. The first existing countermeasure is aimed directly at drowsy drivers through drowsy driving freeway signage. The purpose of these signs is to warn drivers of the adverse affects of driving while drowsy. The second countermeasure discussed relates to rumble strips, which UDOT has added to miles of highway as a physical means to prevent drivers from drifting out of lanes and running off of highways. The third countermeasure outlined is the use of cable barriers placed in between opposing traffic patterns to prevent vehicles from crossing the median into on-coming traffic. The final countermeasure used by UDOT to help reduce drowsy driving crashes is that of a rest area. Other countermeasures not yet implemented by UDOT are also provided. In conjunction with the drowsy driving countermeasures mentioned, the results of two before-after crash rate analyses are provided. The first before-after analysis discusses the safety effectiveness of the drowsy driving freeway signage while the second analysis illustrates the effect on drowsy driving crashes before and after the installation of the Grassy Mountain rest area.

5.1 Drowsy Driving Freeway Signage

Utah is known for having beautiful national parks and scenic byways, but as with all states, Utah has miles of monotonous highway corridors. In an effort to reduce the

number of drowsy driving crashes, UDOT has installed drowsy driving freeway signage on three Interstates, namely I-80, I-70 and I-15.

5.1.1 Interstate 80

The first 100 miles of I-80 seems to encompass some of the flattest land in the world. Long, straight stretches of highway coupled with a barren desert landscape have long posed a problem to travelers who traverse this corridor of freeway. In the early years of this decade, the UHP approached UDOT with a proposal to add signage to I-80 cautioning drivers to be aware of drowsy driving. This proposal came as consequence of UHP officers having years of experience investigating crash scenes in which drivers seemed to have fallen asleep at the wheel or suffered from severe fatigue.

UDOT reacted to officer requests and in April 2004 the work of installing drowsy driving signs throughout the first 100 miles of I-80 was underway. Installation of three series of signs, each series consisting of three signs, and one single drowsy driving sign was completed on July 21, 2004. The location and caption of each sign is outlined in Table 5-1 while an illustration of each sign is provided in Figure 5-1. Figure 5-2 illustrates the location of all drowsy driving signs, rest areas, and view areas on Interstates 15, 70, 80, and 84. A detailed analysis of the safety effectiveness of the signs on I-80 will be discussed in Section 5.2.

Table 5-1. Location and Caption of Drowsy Driving Signs on I-80

Direction	M.P.	Sign Caption
Eastbound	26.3	Drowsy Driving Causes Crashes
	26.6	Drowsy Drivers Next Exit 15 Miles
	26.8	Drowsy Drivers Pull Over If Necessary
	49.5	Drowsy Driving Causes Crashes
	49.8	Drowsy Drivers Next Exit 5 Miles
	50.0	Drowsy Drivers Pull Over If Necessary
Westbound	46.0	Drowsy Drivers Pull Over If Necessary
	46.3	Drowsy Drivers Next Exit 5 Miles
	46.6	Drowsy Driving Causes Crashes
	95.0	Drowsy Driving Causes Crashes

a)

b)

c)

(Photos by Grant Schultz 2007)

Figure 5-1. Typical examples of drowsy driving signage on I-80.

Figure 5-2. Location of drowsy driving signage, rest areas, and view areas on I-15, I-70, I-80, and I-84.

5.1.2 Interstate 70

I-70 was the second Interstate freeway in Utah to have drowsy driving signs posted along one corridor. Installation of the 3-sign series was completed in late February 2005. The signs are located in the eastbound direction 50 miles west of Green River as identified in Figure 5-2. Table 5-2 identifies the location and sign caption of each drowsy driving sign. The signs are exactly the same as those installed along I-80 as depicted in Figure 5-1. The second sign in the series indicates an exit 2 miles down road, which is the Eagle Canyon view area at M.P. 115.5. The view area has parking and restrooms for public use.

Table 5-2. Location and Caption of Drowsy Driving Signs on I-70

Direction	M.P.	Sign Caption
Eastbound	113.1	Drowsy Drivers Pull Over If Necessary
	113.5	Drowsy Drivers Next Exit 2 Miles
	114.0	Drowsy Driving Causes Crashes

5.1.3 Interstate 15

I-15 is the most recent Interstate freeway in Utah to have drowsy driving signs posted along various corridors. Unlike I-70 and I-80, the drowsy driving signage on I-15 does not appear in 3-sign sets, but rather single signs placed at many locations. The signs are approximately 10 feet in length and 5 feet tall. The sign caption for all 12 signs reads "Drowsy Drivers Use Next Exit." This sign caption is different than for the drowsy driving signs posted on I-70 and I-80. In similar fashion to those signs posted along I-70, the I-15 signs are located near rest areas or rural off ramps thus encouraging drowsy drivers to exit immediately rather than continue driving as indicated in Figure 5-2. The Kannaraville and Lunt Park rest areas are located at M.P. 45 and 88, respectively. The signs posted at northbound M.P. 68 and 133 as well as southbound M.P. 189 correspond to public/private rest areas where UDOT and local service stations provide amenities,

including restrooms, water fountains, and gasoline. All of the signs are located south of Salt Lake City in rural areas. Table 5-3 identifies the M.P., location description, and date of installation of each sign while Figure 5-3 illustrates a typical drowsy driving sign along I-15.

Table 5-3. M.P., Location, and Date of Installation of Drowsy Driving Signs on I-15

Direction	M.P.	Description of Location	Date of Installation
Northbound	43	Before Kannaraville Rest Area	1/9/07
	68	Before Summit Truck Stop	2/21/07
	133	Before Cove Fort Chevron Rest Area	12/8/06
	205	Before Mills Exit	10/31/06
	232	Before Mona Exit	10/31/06
	247	Before Payson Exit	12/6/06
Southbound	51	Before Kannaraville Rest Area	1/8/07
	93	Before Lunt Park Rest Area	12/12/06
	189	Before Scipio Eagles Landing Rest Area	12/14/06
	208	Before Mills Exit	10/31/06
	234	Before Mona Exit	10/31/06
	249	Before Payson Exit	12/6/06

(Photo by Hunter Young 2007)

Figure 5-3. Typical drowsy driving signage on I-15.

5.2 I-80 Before-After Crash Studies

To determine the effectiveness of the drowsy driving freeway signage as well as the effectiveness of the rest area located at M.P. 54, two before-after crash rate analyses were conducted. The results of each analysis are discussed in the subsections that follow. The first subsection provides background as to time related trends before and after the installation of the signs. The second subsection discusses the traditional before-after analysis for the drowsy driving signs while the third subsection identifies the effectiveness of the signs using a modified traditional before-after analysis. The fourth subsection uses comparison groups as the basis for predicting the "after" crash rate had the drowsy driving signs not been implemented. Lastly, the fifth subsection identifies the traditional before-after analysis for drowsy driving crashes near the rest area at M.P. 54.

5.2.1 Time Trend Background

To aid in visualizing any time related trends before and after the installation of the drowsy driving signs, crash rates in the 10 miles directly following each series of signs were calculated. Figure 5-4 illustrates the crash rates for eastbound I-80 for M.P. 15-25 as well as M.P. 25-35 following the signs. The same information is provided for the signs near M.P. 50 in Figure 5-5. Figure 5-6 shows the crash rates for westbound I-80 for M.P. 35-45 and for M.P. 45-55 following the signs. The same information is provided in Figure 5-7 surrounding the single sign located at M.P. 95. From these figures, it can be determined if the crash rates after the drowsy driving signs were installed were regressing toward the mean or if a sharp change in the crash rate occurred which may be partly attributed to the signs themselves.

The crash rates in all of the following figures verify that crash rates are extremely volatile. From Figure 5-4, it can be seen that the crash rates from eastbound M.P. 25-35 are higher on average than those from M.P. 15-25. This may be due to the fact that drivers may have stopped to rest in Wendover or at the Salt Flats rest area at M.P. 10 and then become drowsier with more time behind the wheel. Similar fluctuations in crash rates occurred at all locations studied, but specifically in the vicinity of M.P. 50.

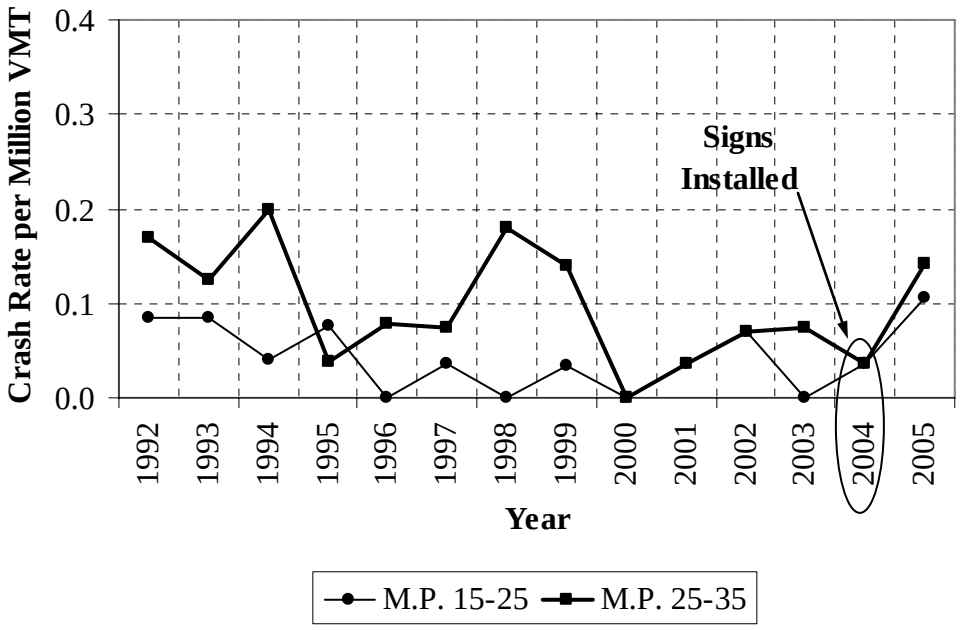


Figure 5-4. Eastbound I-80 crash rates for M.P. 15-25 and M.P. 25-35.

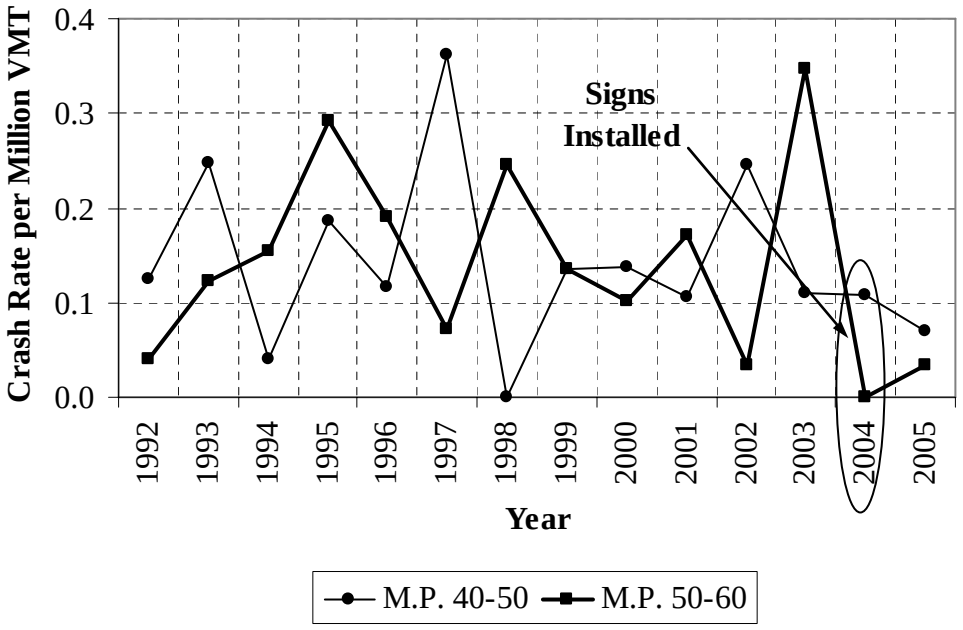


Figure 5-5. Eastbound I-80 crash rates for M.P. 40-50 and M.P. 50-60.

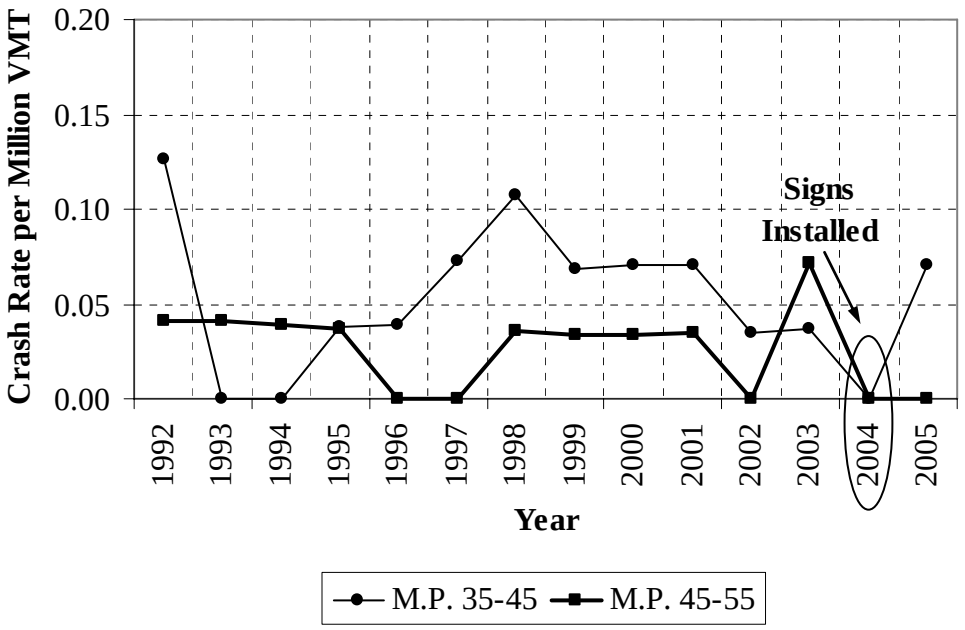


Figure 5-6. Westbound I-80 crash rates for M.P. 35-45 and M.P. 45-55.

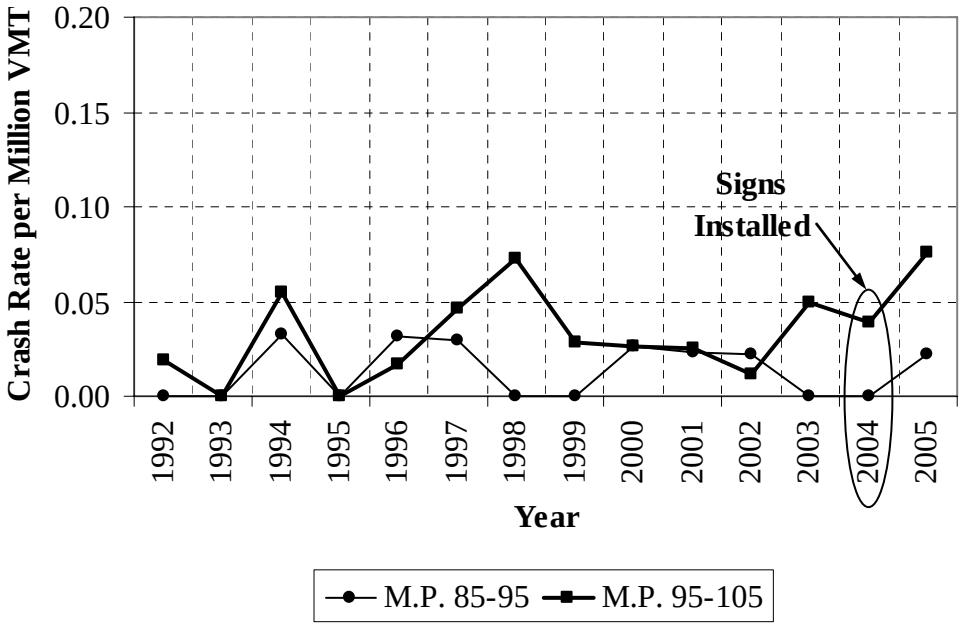


Figure 5-7. Westbound I-80 crash rates for M.P. 85-95 and M.P. 95-105.

5.2.2 Traditional Before-After Crash Rate Analysis of Drowsy Driving Signs

As discussed in Section 3.5, a before-after crash analysis of drowsy driving crashes for I-80 west of Salt Lake City was conducted for this research. The "before" timeframe includes drowsy driving crashes from August 21, 2002 through December 31, 2003 while the "after" time period incorporates the time period of August 21, 2004 through December 31, 2005. Figure 5-8 illustrates the before-after crash rate analysis for eastbound I-80 along with the location of the drowsy driving signage for comparison purposes.

Figure 5-8 presents several interesting trends based upon the short timeframe analysis conducted. The first series of drowsy driving signs appears near M.P. 26 for eastbound travelers while the second series of signs appears near M.P. 50, only four miles before the Grassy Mountain rest area. The pre-sign crash rate from M.P. 50 to M.P. 60 was consistently near 0.50 crashes per million VMT, but the "after" analysis indicates that in the 10 miles following the drowsy driving signage the crash rate decreased significantly. In fact, in the 10-mile corridor after the drowsy driving signs at eastbound M.P. 50 there was a 90 percent reduction in the drowsy driving crash rate (80.5 percent reduction in the number of crashes) whereas for the 10-mile corridor following the signs at M.P. 26 there was only a 2 percent reduction in the crash rate (No reduction in the number of crashes).

Figure 5-8 indicates that 15 miles following the second series of freeway signage the crash rate increased drastically during the "after" period. From approximately M.P. 70 to M.P. 85, the drowsy driving crash rate steadily increased followed by a sharp decrease in the crash rate from M.P. 85 to M.P. 100. The drowsy driving crash rate during the "before" time period however was relatively consistent with a mean crash rate of 0.1 drowsy driving crashes per million VMT. It is possible that whatever effect the drowsy driving signs have on a driver are temporary and quickly forgotten, especially 15 miles down the highway.

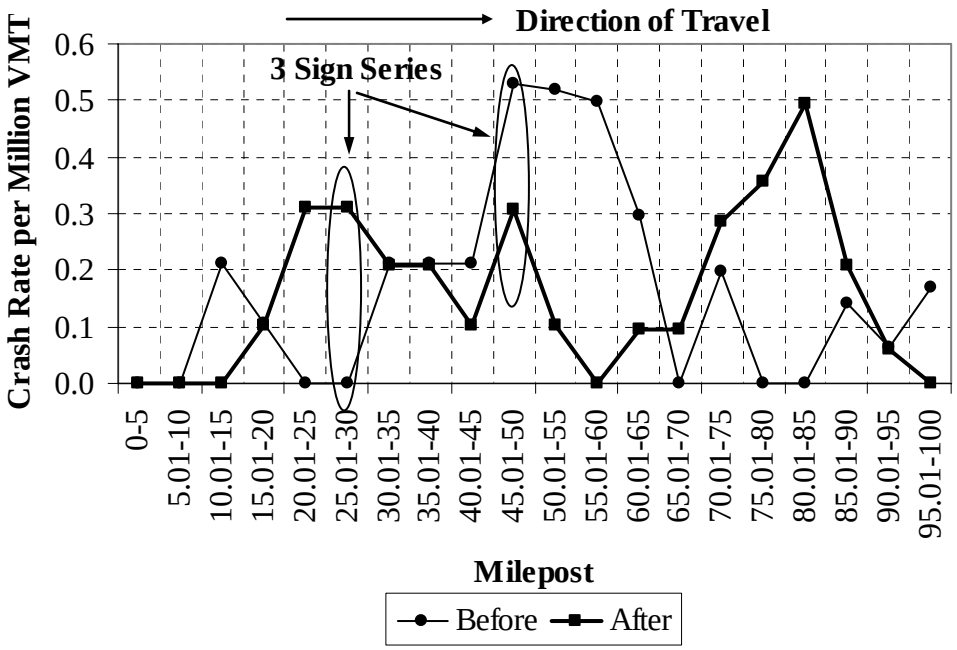


Figure 5-8. Eastbound I-80 before-after drowsy driving crash rate analysis for drowsy driving signage.

Figure 5-9 illustrates the before-after crash rate analysis for westbound I-80 along with the location of the drowsy driving signage from Figure 5-1 at M.P. 46; the single sign located at M.P. 95 corresponds to Figure 5-1a. Figure 5-9 indicates that the westbound I-80 drowsy driving crash rate did not fluctuate nearly as much as the eastbound traffic previously discussed. The "after" analysis identifies a relatively flat trend in the fatigue-related crash rate beginning at M.P. 15 and ending at M.P. 90. This trend is drastically different than that outlined in the "after" period for the eastbound traffic during the same stretch of highway.

The 3-sign series in the westbound direction is located at M.P. 46, 5 miles from the nearest freeway off-ramp. Little reduction in the drowsy driving crash rate resulted in the vicinity of the drowsy driving signs, although very little room for improvement was available for the time period studied. At M.P. 95 stands one drowsy driving sign. No crashes occurred in this area in the "before" or "after" time period. In the 5-mile corridor following the signs, the crash rate decreased from 0.213 to 0.103 crashes per million VMT, a 51.6 percent reduction in crash rate but only a difference of one actual crash.

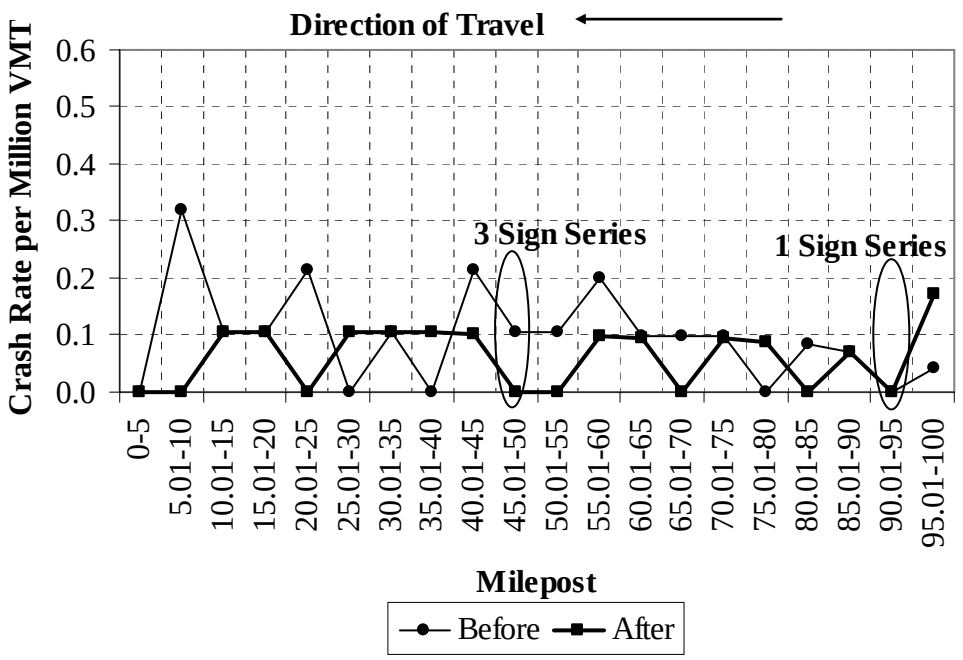


Figure 5-9. Westbound I-80 before-after drowsy driving crash analysis for drowsy driving signage.

Crash data of any type varies considerably from year to year; therefore, no concrete conclusions can be established from either Figure 5-8 or Figure 5-9. Although some observational trends were identified within the scope of this traditional before-after analysis, to determine the effectiveness of the signs required that an estimation of the number of crashes following sign installation be made and used as a benchmark rather than assuming that the number of crashes during the "before" time period is what would have occurred during the "after" period had the signs not been installed. Hauer (1997) indicates that "this way of predicting reflects a naive and usually unrealistic belief that the passage of time (from the 'before" to the 'after' period) was not associated with changes that affected the safety of the entity under scrutiny" (pp. 73). For this reason the modified traditional before-after analysis and comparison group studies were conducted.

It should also be noted from the traditional before-after method that the change in the number of crashes reflects not only the effect of the drowsy driving signage, but also the effect of factors such as traffic, weather, driver behavior, police report accuracy, and other possibly unknown factors. It is not known what part of the change can be attributed

to the drowsy driving signs and what part is due to the various other influences outlined. Furthermore, it should be noted that the change in the number of crashes may be due to the spontaneous regression to the mean and not necessarily due to the drowsy driving signage.

5.2.3 Modified Traditional Before-After Crash Rate Analysis

Hauer (1997) provides a method for estimating the number of crashes which may have occurred during the "after" timeframe had the signs not been implemented. To generate this predicted value, the drowsy driving crashes in the two 10-mile corridors following each series of drowsy driving signage were combined to calculate the percent change in drowsy driving crashes in both the eastbound and westbound directions. In both Table 5-4 and Table 5-5 are the estimated parameters and estimates of the standard deviations for eastbound and westbound I-80, respectively. The parameters are defined as follows (Hauer 1997):

($\hat{\lambda}$) = estimated number of crashes in "after" period,

($\hat{\pi}$) = estimated predicted number of crashes in "after" period had the drowsy driving sign treatment not been applied,

($\hat{\delta}$) = the reduction in the expected frequency of drowsy driving crashes ($\hat{\pi} - \hat{\lambda}$),

($\hat{\theta}$) = the estimated index of effectiveness ($\hat{\lambda} / \hat{\pi}$), and

($\hat{\sigma}$) = standard deviation of random variable.

Combining the drowsy driving crashes from eastbound M.P. 27 to M.P. 37 and from M.P. 50 to M.P. 60, it was determined that 5 crashes occurred during the after period while the predicted number of crashes was calculated to be 9.2 crashes. Therefore, the reduction was estimated to be 46.4 percent with a standard deviation of 24.8 percent. The calculations for determining the predicted number of crashes during the "after" period had the treatment not been applied are located in Appendix B.

Table 5-4. Summary of Estimated Values for Eastbound I-80

Estimates of Parameters			Estimates of Standard Deviations		
$\hat{\lambda}$	5	crashes	$\hat{\sigma}\{\hat{\lambda}\}$	2.2	crashes
$\hat{\pi}$	9.2	crashes	$\hat{\sigma}\{\hat{\pi}\}$	1.2	crashes
$\hat{\delta}$	4.2	crashes	$\hat{\sigma}\{\hat{\delta}\}$	2.6	crashes
$\hat{\theta}$	0.536		$\hat{\sigma}\{\hat{\theta}\}$	0.248	
Percent Reduction	46.4 %				

The actual number of crashes during the "after" time period (8/21/04 to 12/31/05) combining the drowsy driving crashes from westbound M.P. 37 to M.P. 47 and from M.P. 85 to M.P. 95 was 3 crashes while the predicted number of crashes was calculated to be 3.0 crashes. Therefore, the reduction in crashes was zero, but as explained hereafter, it was estimated that the percent reduction was 5.3 percent with a standard deviation of 57.5 percent.

Table 5-5. Summary of Estimated Values for Westbound I-80

Estimates of Parameters			Estimates of Standard Deviations		
$\hat{\lambda}$	3	crashes	$\hat{\sigma}\{\hat{\lambda}\}$	1.7	crashes
$\hat{\pi}$	3.0	crashes	$\hat{\sigma}\{\hat{\pi}\}$	0.7	crashes
$\hat{\delta}$	0.0	crashes	$\hat{\sigma}\{\hat{\delta}\}$	1.9	crashes
$\hat{\theta}$	0.947		$\hat{\sigma}\{\hat{\theta}\}$	0.575	
Percent Reduction	5.3 %				

Although the change in crashes from the "before" to the "after" time period was determined to be zero, a percent reduction was calculated. Hauer (1997) indicates that even if the estimated "after" number of crashes ($\hat{\lambda}$) and estimated predicted number of crashes ($\hat{\pi}$) are unbiased estimates of the *actual* number of "after" crashes (λ) and *actual* number of crashes had the signs not be installed (π), respectively, the ratio of (λ / π) is a biased estimate of the index of effectiveness (θ). To compensate for the bias

index of effectiveness, an adjustment was made with an approximately unbiased estimator for the index of effectiveness as given by Equation 5-1 (Hauer 1997).

$$\hat{\theta} = \frac{\left(\hat{\lambda}/\hat{\pi}\right)}{\left[1+\left(VAR(\hat{\pi})/(\hat{\pi})^2\right)\right]} \tag{5-1}$$

where: $\hat{\theta}$ = estimated index of effectiveness ($\hat{\lambda}/\hat{\pi}$),

$\hat{\lambda}$ = estimated number of crashes in "after" period,

$\hat{\pi}$ = estimated predicted number of crashes in "after" period had the drowsy driving sign treatment not been applied, and

VAR ($\hat{\pi}$) = estimated variance of $\hat{\pi}$.

The estimated variance of $\hat{\pi}$ in Equation 5-1 was determined using Equation 5-2 (Hauer 1997).

$$\text{VAR}(\hat{\pi}) = \sum r_d(j)^2 K(j) \tag{5-2}$$

where: VAR ($\hat{\pi}$) = estimated variance of $\hat{\pi}$,

$r_d(j)$ = ratio of durations, and

K(j) = number of drowsy driving crashes in each "before" time period.

The ratio of durations in Equation 5-2 was determined using Equation 5-3 (Hauer 1997).

$$r_d(j) = \frac{D_a}{D_b} \tag{5-3}$$

where: D_a = duration of after period for entity j, and

D_b = duration of before period for entity j.

5.2.4 Comparison Group Before-After Crash Rate Analysis

According to Hauer (1997), "it is customary to account for the influence of all [causal] factors by making use of the comparison group device" (pp. 115). The purpose of using a comparison group is fairly straight forward. It is a method of prediction that takes into account "unrecognized, and/or unmeasured, and/or ill-understood factors" (Hauer 1997, pp. 115). The term comparison group stems from the fact that drivers in the data used for this analysis were not assigned at random to read and/or implement the actions outlined in the captions of the drowsy driving signage. As such, this study was purely observational and a comparison group, not a control group, was utilized.

Hauer (1997) provides a four-step procedure to calculating a percent reduction in the number of drowsy driving crashes. To begin, comparison groups were selected and incorporated the following sections of highway: southbound I-15 M.P. 0-20, southbound I-15 M.P. 168-188, eastbound I-70 M.P. 130-150, and westbound I-80 M.P. 0-20. Each comparison group consisted of 20 miles since each group was compared to 20 miles of drowsy driving data on I-80 (two 10-mile corridors following the location of the drowsy driving signage). The comparison groups used in the analyses were selected for two reasons. First, the mean of the estimated odds ratio for each group was "close" to 1 and second, the corridors are similar in topography and roadway alignment to those corridors studied on I-80.

The comparison groups served two purposes. First, as a means of comparing drowsy driving trends from one location in the state to those of I-80 and second, as a means to help calculate the variance of the predicted "after" number of crashes ($\hat{\pi}$). The number of drowsy driving crashes for time periods beginning on August 21st and ending

on December 31st of the following year for the years studied were calculated after which the actual odds ratio (ω) was sought using Equation 5-4 (Hauer 1997).

$$\omega = \frac{r_C}{r_T} \tag{5-4}$$

where: r_C = the ratio of the expected accident counts for the comparison group, and

r_T = the ratio of the expected accident counts for the treatment group.

Equations 5-5 and 5-6 define the variable r_C and r_T from Equation 5-4 as given by Hauer (1997).

$$r_C = \frac{\nu}{\mu} \tag{5-5}$$

where: r_C = the ratio of the expected accident counts for the comparison group,

ν = expected crash count of comparison group during "after" time, and

μ = expected crash count of comparison group during "before" time.

$$r_T = \frac{\lambda}{\kappa} \tag{5-6}$$

where: r_T = the ratio of the expected accident counts for the treatment group,

λ = expected crash count of treatment group during "after" time, and

κ = expected crash count of treatment group during "before" time.

With insufficient data to determine the actual odds ratio, an approximate unbiased estimate of the odds ratio (o) for a given year was calculated using Equation 5-7 (Hauer 1997). Table 5-6 is provided as an example of the composite number of crashes from the four comparison groups used to calculate the variance of the predicted "after" number of crashes ($\hat{\pi}$). The mean of the estimated odds ratio is 0.959.

$$o = \frac{\left[(K \times N) / (L \times M) \right]}{\left[1 + \left(\frac{1}{L} \right) + \left(\frac{1}{M} \right) \right]} \tag{5-7}$$

where: o = approximate unbiased estimate of odds ratio (ω)

K = crash count of treatment group during "before" time,

N = crash count of comparison group during "after" time,

L = crash count of treatment group during "after" time, and

M = crash count of comparison group during "before" time.

Table 5-6. Summary of Odds Ratios and Variance of Omega

Group	**Number of Crashes**		**Odds Ratio (*o*)**
	Treatment Group	**Comparison Group**	
Time Periods	**EB I-80 M.P. 27-37 & 50-60**	**Sum of Groups 1-4**	
8/21/92 - 12/31/93	6	19	
8/21/94 - 12/31/95	11	21	0.527
8/21/96 - 12/31/97	6	26	1.869
8/21/98 - 12/31/99	11	27	0.502
8/21/00 - 12/31/01	8	34	1.490
8/21/02 - 12/31/03	13	25	0.409
8/21/04 - 12/31/05	5	30	2.516
Mean of Odds Ratios			0.959
Sample Variance			0.452
K	55	M	152
L	5	N	30
Overall Odds Ratio			1.799
VAR(ω)			0.19

VAR(ω) for eastbound I-80 was 0.19 while for westbound I-80 it was less than zero; therefore, 0.00 was used for VAR(ω) for the westbound direction. Using a spreadsheet, $\hat{\lambda}$, $\hat{\pi}$, $\hat{\delta}$, $\hat{\theta}$, and a percent reduction in drowsy driving crashes were calculated for both eastbound and westbound I-80 and are summarized in Appendix B.

For eastbound I-80, the index of effectiveness was calculated to be 0.371; therefore, the percent reduction is assumed to be 62.9 percent. Westbound I-80 yielded an index of effectiveness of 0.776, thus the percent reduction in drowsy driving crashes for the 20 miles studied is 22.4 percent.

A *t*-ratio was calculated for both eastbound and westbound directions and used in conjunction with a *t*-distribution table to determine whether or not the reduction in crashes was statistically significant. The *t*-ratio was determined using Equation 5-8 (Ramsey and Schafer 2002).

$$t = \frac{o_{overall} - 1.0}{\sqrt{\frac{s_{before}^2}{n_{after}}}} \tag{5-8}$$

where: t = t-ratio,

$o_{overall}$ = overall odds ratio for time periods,

s_{before}^2 = sample variance of "before" time period, and

n_{after} = sample size of "after" time period.

Using a one-sided *t*-distribution table with four degrees of freedom, it was determined that the *p*-value for the 20 miles of highway analyzed in the eastbound direction was 0.15 while in the westbound direction of I-80 it was not calculated due to a negative *t*-ratio. Neither corridor was statistically significant.

5.2.5 Drowsy Driving Signage Before-After Crash Rate Analysis Summary

Three before-after methods were discussed in the previous subsections to determine the effectiveness of the drowsy driving freeway signage. The methods incorporated were the traditional method, the modified traditional method, and the comparison group method. The results of each method are outlined in Table 5-7.

Table 5-7. Summary of Drowsy Driving Signage Before-After Analyses

Method	Reduction in Number of Crashes (%)		Standard Deviation (%)		Number of Crashes Reduced	
	EB	WB	EB	WB	EB	WB
Traditional	45.0	12.5	52.6	25.0	9.0	0.0
Modified Traditional	46.4	5.3	24.8	57.5	4.2	0.0
Comparison Group	62.9	22.4	19.9	46.4	5.8	0.5

5.2.6 Traditional Before-After Crash Rate Analysis at Milepost 54 Rest Area

In addition to the drowsy driving signage crash rate analysis discussed, a before-after crash rate analysis of drowsy driving crashes west of Salt Lake City was conducted in the vicinity of the Grassy Mountain rest area as illustrated in Figure 5-2. The impact of the Grassy Mountain rest area at M.P. 54, which was constructed in 2000, is shown in Figure 5-10. The location of the rest area is identified as well for comparison purposes. Figure 5-10 demonstrates that the crash rate for the "before" timeframe of 1997-1999 as well as the "after" time period of 2001-2003. During the first 25 to 30 miles the crash rates are relatively low, but quickly increase from M.P. 25 to a peak near M.P. 50. The corridor directly following the rest area did demonstrate a decrease in the drowsy driving crash rate although it was not large. From M.P. 60 to M.P. 65, the crash rate was higher during the "after" period even though the overall trend during the "after" period showed a decrease in the crash rate. As seen in Figure 5-10, a large difference was identified between the "before" and "after" time periods in the vicinity of M.P. 70 to M.P. 85. Figure 5-11 represents the drowsy driving crash rate for westbound I-80 from M.P. 0 to M.P. 100. Westbound I-80 yielded more conservative crash rates for the 5-mile segments studied compared to the eastbound crash rates.

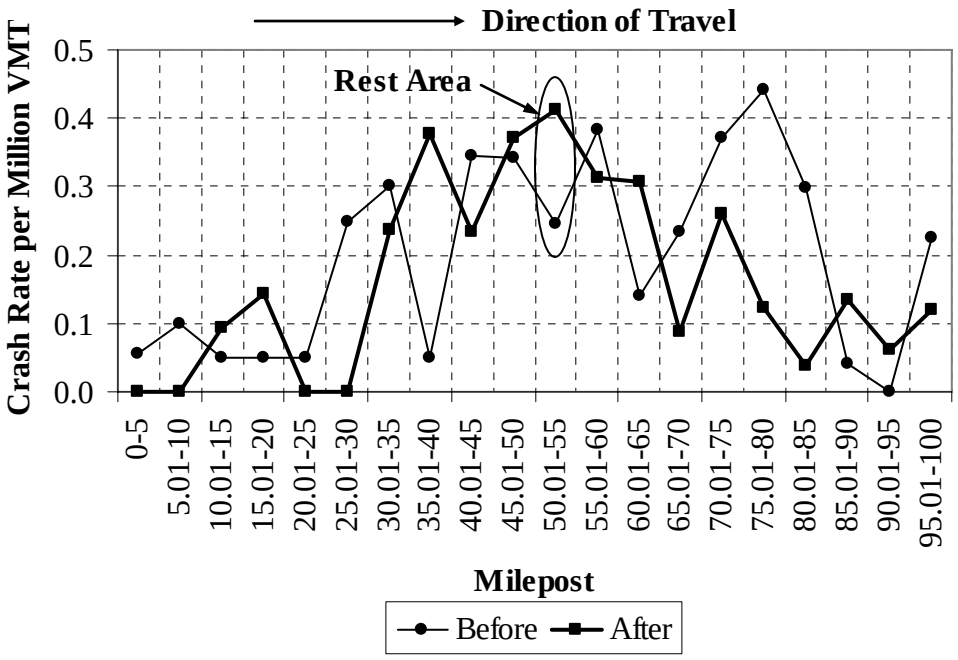


Figure 5-10. Eastbound drowsy driving crash rate analysis for M.P. 54 rest area.

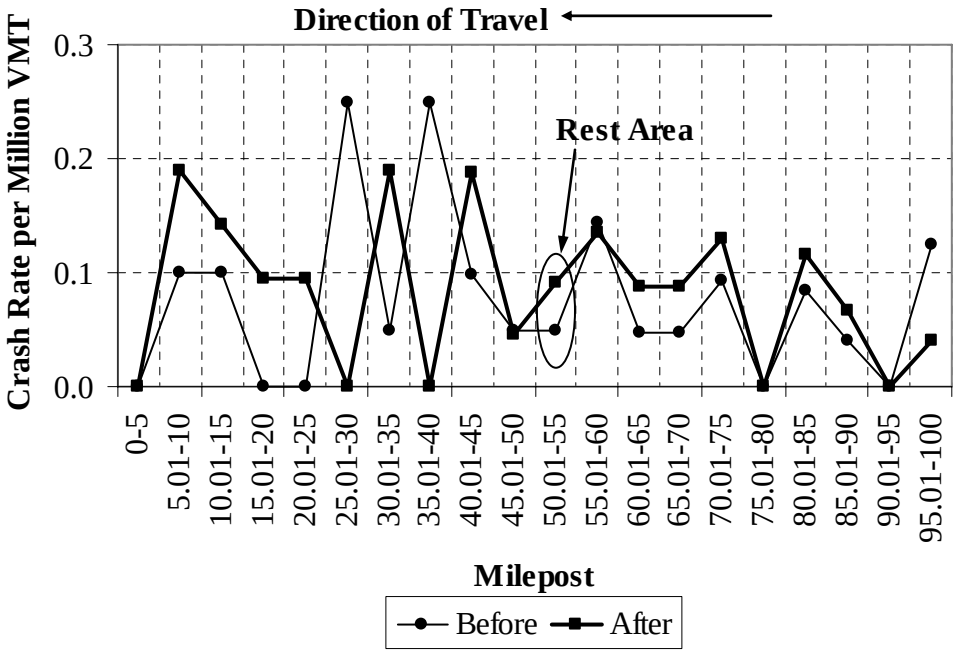


Figure 5-11. Westbound drowsy driving crash rate analysis for M.P. 54 rest area.

In the vicinity of the rest area and directly downstream, no drastic reduction in drowsy driving crash rates is noticeable. In fact, the "after" period crash rates for most segments supersede the "before" crash rates. The most notable trend occurred in the "after" time period as the crash rate increased as drivers approached and traversed the Salt Flats area prior to entering Wendover, Utah on the Nevada border. Crash rates in the vicinity following each rest area have been calculated to verify any trends. Figure 5-12 illustrates the crash rates for eastbound I-80 for the 10-mile segments before (M.P. 45-55) and after (M.P. 55-65) the rest area. The same information for westbound crash rates is provided in Figure 5-13 where the before segment is M.P. 55-65 while the after segment is M.P. 45-55.

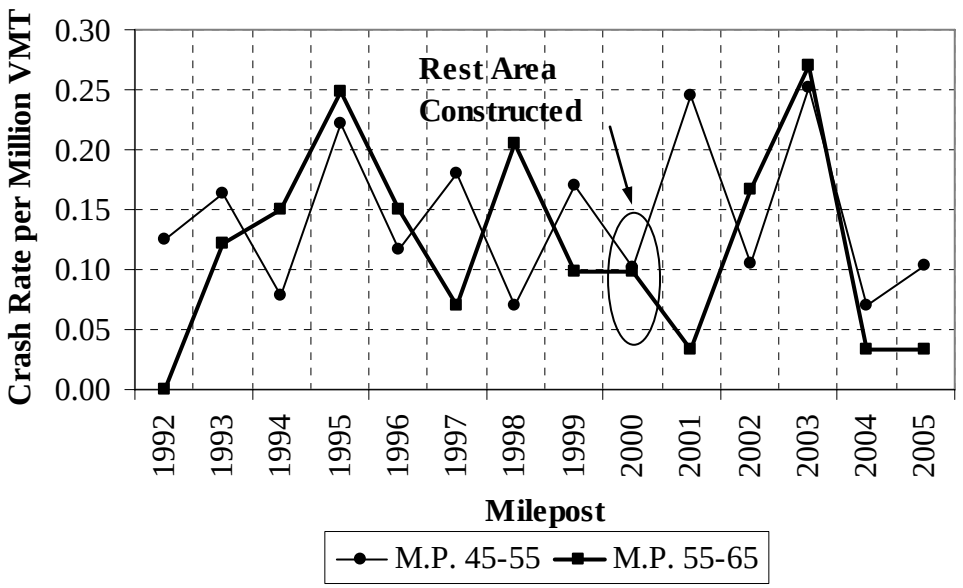


Figure 5-12. Eastbound I-80 crash rates for M.P. 45-55 and M.P. 55-65.

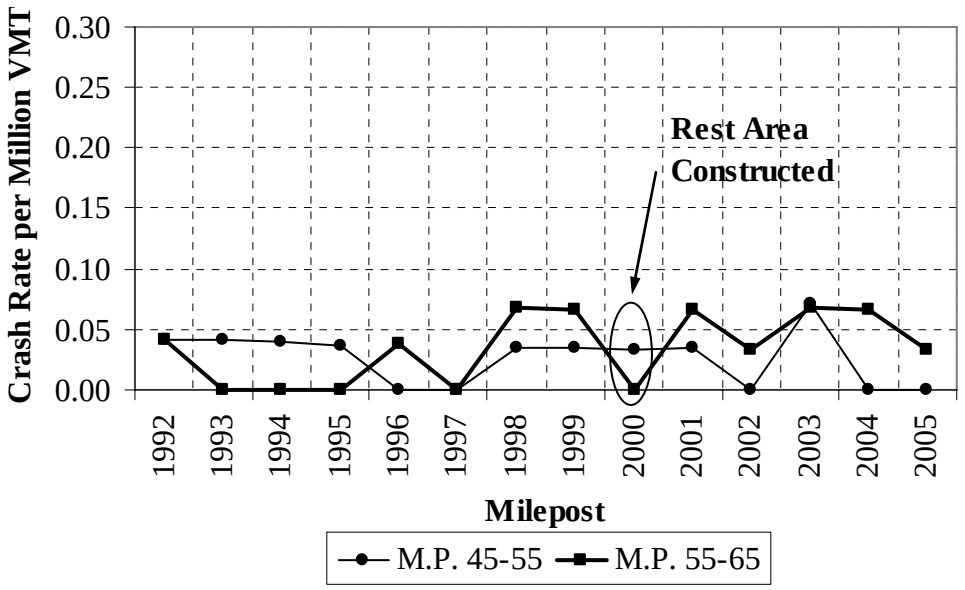


Figure 5-13. Westbound I-80 crash rates for M.P. 45-55 and M.P. 55-65.

5.3 Rumble Strips

Fatigue driving is one reason that many motorists have run-off-road crashes. The three specific run-off-road types of crashes as mentioned in Chapter 4 include "Ran Off Roadway-Thru Median," "Ran Off Roadway-Right," and "Ran Off Roadway-Left." Of the 38,648 run-off-road crashes in Utah on Interstate freeways, U.S. Routes, and S.R. highways from 1992-2004, 8,263 (21.4 percent) were caused by drivers who were asleep, fatigued, or ill. To reduce the number of run-off-road crashes and fatalities, UDOT implemented a policy that all Interstate highways are to have rumble strips installed. No formal policy has been established for U.S. routes or S.R. highways. Rumble strips on these highways must be justified through crash history data or engineering experience.

UDOT currently uses five types of rumble strips, namely continuous, skip, rolled, concrete-edge, and concrete-full. Approximately 77 percent of Interstates in Utah have rumble strips, although only 63 percent of the rumble strips are in "acceptable" or "marginal" condition according to Roland Stanger (Personal communication, June 11, 2007) of the FHWA. The number of miles and type of rumble strip for the Interstate

freeways are outlined according to direction of travel in Table 5-8. No similar rumble strip inventory is available for U.S. routes or S.R. highways. The rumble strip inventory as summarized in Table 5-8 was conducted in May 2004. No rumble strip inventory has been conducted since May 2004, but it was determined that approximately 100 miles of shoulder rumble strip has been added to I-70 since the May 2004 inventory. I-215 is a belt route encircling much of Salt Lake City; therefore, the designation of "Inside Lanes" and "Outside Lanes" is used in Table 5-8. "Inside Lanes" encompasses southbound M.P. 0-6, westbound 6-14, northbound 14-27, and eastbound 27-29. "Outside Lanes" is exactly the opposite directions using the same M.P. markers.

According to the number of miles of rumble strip identified in Table 5-8, I-80 had the highest percentage of roadway with rumble strips as of May 2004. Approximately 90 percent of I-80 had rumble strips while the Interstate freeway with the least percentage of roadway with rumble strips was I-84 with approximately 64 percent.

Cheng et al. (1994) evaluated the effectiveness of rumble strips on highway shoulders in Utah from a safety perspective and concluded that highway segments with continuous rumble strips on asphalt near the travel lane had lower crash rates than highway segments with concrete discontinuous rumble strips offset from the travel lane. Furthermore, they reported that the discontinuous design proved to be less effective in alerting drivers to potentially dangerous driving patterns. Along with a reduction in run-off-road crashes, the severity of the crashes studied also diminished (Cheng et al 1994).

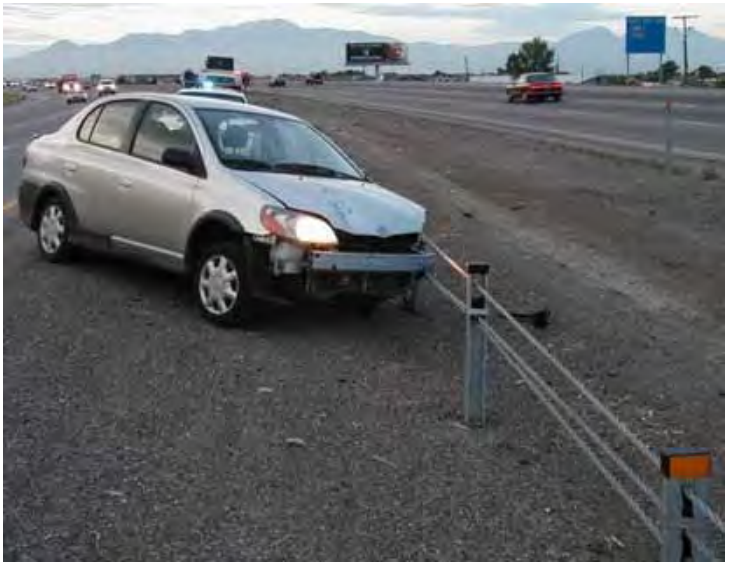
Table 5-8. Rumble Strip Summary for Interstate Freeways (Roland Stanger, personal communication, June 11, 2007)

	Number of Miles									
	I-15		I-70		I-80		I-84		I-215	
Rumble Strip Type	Northbound	Southbound	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound	Inside Lanes	Outside Lanes
Continuous	131.9	131.5	12.7	14.0	33.5	26.3	0.0	0.0	0.0	0.0
Skip	32.8	32.1	18.7	18.5	25.0	27.6	7.7	7.7	0.0	0.0
Rolled	72.8	76.2	88.5	67.9	80.2	92.6	16.1	8.4	0.0	0.0
Concrete-edge	82.1	73.5	42.8	41.5	34.0	34.2	31.3	31.1	20.0	20.0
Concrete-full	2.0	12.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	321.6	325.4	162.7	141.9	172.7	180.7	55.1	47.2	20.0	20.0

5.4 Cable Median Barrier

Another mitigation technique implemented by UDOT in late 2003 was the addition of cable barriers in the median between opposing directions of travel. The cable barrier has been installed mostly in urban areas where high traffic volumes in opposing directions have posed the greatest threat to cross-over crashes. As of August 2005, cable median barrier had been installed on I-215 in Salt Lake County, four locations in Utah County, and one location in Southern Utah (Braceras 2005). Although the cable median barriers installed do not specifically aid in the prevention of drowsy driving crashes similar to the drowsy driving freeway signage and rumble strips, they drastically reduce the probability of head-on collisions as a result of crossing the median into oncoming traffic and thus reduce the severity of many crashes.

For example, in the years prior to the cable being installed in Utah County, an average of five fatalities and 22 serious injuries occurred. In the year and a half following installation of the cable median barrier, only one serious injury and no fatalities were reported (Braceras 2005). Figure 5-14 illustrates a typical section of cable median barrier in Utah after having been struck by a vehicle.



(Source: Stutts et al. 2005)

Figure 5-14. Example of cable median barrier in Utah.

5.5 Rest Areas

The state of Utah has many locations where drivers can relax and take a break from the monotony of driving long distances. Utah has 63 locations where drivers can use a restroom, stretch, take photos, buy food, and obtain tourists information about Utah. Of the 63 facilities which comprise the rest facility system, five are welcome centers, five are public/private partnership rest areas, six are public/public facilities, 10 are view areas, 13 are port-of-entry facilities, and 24 are rest areas. The rest areas are separated into two categories. First, traditional state owned and maintained facilities and second, public/private rest areas in which private businesses and UDOT enter into a partnership to provide amenities to traveling motorists 24-hours a day 365 days a year (UDOT 2006b). Utah has five public/private rest areas, all of which are located in rural areas on the I-15 corridor south of Salt Lake City as previously shown in Figure 5-2. Figure 5-15 illustrates the freeway signage used to denote a public/private partnership rest area.

Of the 39 rest area, welcome center, and view area facilities currently in operation, 10 are less than 10 years old while of the remaining 29 rest areas, welcome centers, and view areas, 25 are over 25 years old (UDOT 2007b). Although the overall condition of these facilities is deteriorating, the state of Utah has a maintenance contract with a private company to ensure that the facilities operate in a clean, safe, and efficient manner. Currently roadside facilities such as parking areas, view areas with no services, pull-outs, points of interest, and brake check areas are not recognized as official elements of the highway rest facility system.

(Source: UDOT 2007b)

Figure 5-15. Example of the freeway signage denoting a public/private rest area.

Only the locations of rest areas and view areas on Interstates 15, 70, 80, and 84 were illustrated previously in Figure 5-2 from Section 5.1.1 while Table 5-9 summarizes the location and type of facility for each welcome center, rest area, and view area for all Interstates as well as for U.S. 89 since these are the highways on which drowsy driving corridors were located in Chapter 4.

Table 5-9. Rest Area Summary

Highway	Location of Facility	Type of Facility
I-15	NB M.P. 3	St. George Welcome Center
	NB & SB M.P. 45	Kannaraville Rest Area
	NB & SB M.P. 88	Lunt Park Rest Area
	NB & SB M.P. 112	Public/Private Partnership
	NB & SB M.P. 135	Public/Private Partnership
	NB & SB M.P. 167	Public/Private Partnership
	NB & SB M.P. 188	Public/Private Partnership
	NB & SB M.P. 262	Public/Private Partnership
	NB M.P. 363	Perry Rest Area
	SB M.P. 369	Brigham City Welcome Center
I-70	WB M.P. 84	Ivie Creek Rest Area
	EB & WB M.P. 102	Sand Bench View Area
	EB & WB M.P. 114	Devil's Canyon View Area
	EB & WB M.P. 120	Ghost Rocks View Area
	EB & WB M.P. 141	Black Dragon View Area
	EB M.P. 144	Spotted Wolf View Area
	EB M.P. 180	Crescent Junction Rest Area
	WB M.P. 180	Thompson Welcome Center
	WB M.P. 225	Harley Dome View Area
I-80	EB & WB M.P. 10	Salt Flats Rest Area
	EB & WB M.P. 54	Grassy Mountain Rest Area
	EB & WB M.P. 170	Echo Canyon Rest Area/Welcome Center
I-84	EB M.P. 91	Weber Canyon Rest Area
	WB M.P. 94	Mountain Green Rest Area
U.S. 89	NB & SB M.P. 495	Bear Lake Overlook
	NB & SB M.P. 184	Hoover Rest Area
	NB & SB M.P. 95	Shingle Creek Rest Area

5.6 Other Countermeasures

Through discussion with the UDOT TAC, it was determined that other countermeasures not currently in place in Utah and/or not specifically identified in the literature review of Chapter 2 may be considered for future use. These countermeasures include in-lane pavement markings, enforcement of seat belt laws as well as other pertinent laws, variable message signs, and the use of radar as a means to set off radar detectors in vehicles thus capturing the attention of drivers.

The pavement marking technique would supplement the current drowsy driving highway signage and possibly read "AVOID FATIGUE DRIVING" in the middle of the travel lane. The intention of the markings is to command drivers' respect and help them realize the serious nature of drowsy driving. Besides pavement markings, a continued emphasis by law enforcement agencies to promote safe driving and the use of seat belts is necessary in order to save lives. It is imperative that the current NHTSA "CLICK IT OR TICKET" campaign nationwide continue in an effort to reduce the severity of all crashes, including drowsy driving crashes. Other possibilities may include a greater emphasis on public reporting of erratic driving which may be attributed to drowsy drivers.

UDOT currently has 69 variable message signs, also referred to as electronic roadway signs, which are used throughout the state to relay up-to-the-minute information to motorists already on the highway (UDOT 2007c). These signs could be employed as a method to alert drivers of drowsy driving or encourage drowsy drivers to pull off of the road immediately. The final mitigation technique mentioned was the use of radar to possibly wake up drowsy drivers via in-vehicle radar detectors. To better understand how widespread the use of radar detectors is among drivers, two questions regarding radar detectors were included as part of an observational survey conducted and summarized in detail in Chapter 6. Although the radar detector method of capturing drivers' attention appears conceivable, it was determined from the results of the survey that more than 97 percent of surveyed drivers did not have radar detectors in their vehicles.

5.7 Existing Countermeasures Summary

Four existing countermeasures undertaken by UDOT were discussed in this chapter. First, discussion was provided on drowsy driving freeway signage on Interstates 15, 70, and 80. The purpose of these signs is to warn drivers of the adverse affects of driving while fatigued. Second, rumble strips were discussed as a physical means to prevent drivers from drifting out of lanes and running off of highways. Third, the use of cable barriers placed in between opposing traffic patterns to prevent vehicles from crossing the median into on-coming traffic was given. Fourth, the role of rest areas with a summary of the location of rest areas on Interstates 15, 70, 80, and 84 as well as U.S. 89 was given followed by a discussion of countermeasures not yet implemented by UDOT to reduce drowsy driving crashes. The results of two before-after crash rate analyses were presented. The existing countermeasures discussed in this chapter form the basis of the drowsy driving countermeasures to be recommended in the critical corridors as discussed in Chapter 7.

6 PUBLIC SURVEY: DROWSY DRIVING

To maintain safety and order on highways, traffic engineers must understand and interpret drivers' reactions toward traffic control devices. A public survey was written and implemented to evaluate the feelings and concerns of drivers with respect to the drowsy driving freeway signage that UDOT has implemented and which was discussed in Chapter 5. Questions in the survey were designed to decipher drivers' opinions about drowsy driving, and specifically along the I-80 corridor. The background and results of the public survey are discussed in detail in this chapter. Also, the results of 14 Chi-Square tests are presented followed by discussion on the limitations of the survey.

6.1 Public Survey Background

Surveys were conducted at the westbound Salt Flats rest area at M.P. 10 as illustrated in Figure 6-1 as well as at the eastbound Grassy Mountain rest area at M.P. 54 as illustrated in Figure 6-2. The rest areas were chosen as appropriate sites for the survey for two reasons. First, each rest area is located downstream of at least one 3-sign series of drowsy driving signage and second, the travel patterns exhibited by drivers in the region. Eastbound drivers are required to cover longer distances between major urbanized areas, which intuitively results in longer travel times. Both rest areas have various amenities, including restrooms, picnic tables, water fountains, and telephone services. Truck parking is also available for semi-trailer trucks and recreational vehicles.

The questionnaire was divided into two sections. The first portion of the survey was used to determine why drivers stopped to use the rest area facilities and if the drowsy driving signs along the freeway had any impact on the drivers' decision to stop. The second part of the survey was aimed at understanding drowsy driving characteristics such

as the average number of people in the vehicle when the driver was drowsy, the consequences, if any, of the driver's drowsiness, the types of countermeasures implemented by drivers to maintain an alert state of mind, and the frequency of how often one drives while drowsy. The questionnaire form used in the survey consisted of two sides with the front side shown in Figure 6-3 and the backside in Figure 6-4.

a)

b)

(Photos by Hunter Young and Grant Schultz 2007)

Figure 6-1. I-80 westbound Salt Flats rest area at M.P. 10.

a)

b)

(Photos by Hunter Young 2007)

Figure 6-2. I-80 eastbound Grassy Mountain rest area at M.P. 54.

PUBLIC SURVEY: DROWSY AND FATIGUE DRIVING

This is a **completely anonymous** survey conducted for the Utah Department of Transportation to determine drivers' opinions of drowsy driving. This questionnaire consists of 23 questions and takes approximately five minutes to complete. **Completing this survey is voluntary and you may withdraw at any time without penalty.** Please answer each question honestly. Participants must be at least 18 years old, or have parental consent. The return of this survey is your consent to participate in the research.

1. Gender: ☐ Male ☐ Female

   Age: ☐ 16-17 ☐ 18-25 ☐ 26-35 ☐ 36-50 ☐ Over 50

2. How often do you drive a motor-vehicle? (*Check one*)
   ☐ a.) Everyday ☐ b.) A few times a week
   ☐ c.) A few times a month ☐ d.) Rarely

3. How often do you drive on Interstate 80 in Utah? (*Check one*)
   ☐ a.) Everyday ☐ b.) A few times a week
   ☐ c.) A few times a month ☐ d.) Rarely

4. When you do drive this corridor, do you generally drive alone? (*Check one*)
   ☐ a.) Yes ☐ b.) No

5. Why did you stop at this rest stop? (*Check all that apply*)
   ☐ a.) Needed to use the restroom ☐ b.) Felt sleepy/drowsy
   ☐ c.) Wanted to stretch/exercise ☐ d.) Wanted to eat
   ☐ e.) Other (*please specify*): _____

6. Did you see any yellow-blue drowsy driving signs along the freeway? If no, move ahead to question 9. (*Check one*)
   ☐ a.) Yes ☐ b.) No

7. Of the following three signs, which one was most prominent to you? (*Check one*)
   ☐ a.)

   ☐ b.)

   ☐ c.)

   ☐ d.) One sign did not stand out more than the other two.

8. Did the drowsy driving signs in question 7 above contribute to your decision to stop at this rest stop? (*Check one*)
   ☐ a.) Definitely ☐ b.) Somewhat ☐ c.) Not at all

9. Have you seen drowsy driving signs on other freeways in Utah? (*Check one*)
   ☐ a.) Yes ☐ b.) No

10. Have you seen drowsy driving signs on other freeways in other states? If no, move ahead to question 12. (*Check one*)
    ☐ a.) Yes ☐ b.) No

Figure 6-3. Drowsy driving public survey (front side).

11. If so, where have you seen similar signs? (*Please specify*)

_____

12. On average, how many hours do you drive between stops? (*Check one*)
☐ a.) ½ hour ☐ b.) 1 hour ☐ c.) 2 hours
☐ d.) 3 hours ☐ e.) > 3 hours

13. How many hours did you sleep the night before your current trip? (*Check one*)
☐ a.) < 3 hours ☐ b.) 3-5 hours ☐ c.) 5-7 hours
☐ d.) 7-9 hours ☐ e.) > 9 hours

14. How many hours on average do you sleep each night? (*Check one*)
☐ a.) < 3 hours ☐ b.) 3-5 hours ☐ c.) 5-7 hours
☐ d.) 7-9 hours ☐ e.) > 9 hours

15. Have you ever driven while drowsy? If no, move ahead to question 20. (*Check one*)
☐ a.) Yes ☐ b.) No

16. How many people, including yourself, were usually in the vehicle at the time(s) you were driving drowsy? (*Check one*)
☐ a.) 1 ☐ b.) 2 ☐ c.) 3 ☐ d.) 4 ☐ e.) > 4

17. What was the consequence of your driving while drowsy? (*Check all that apply*)
☐ a.) Drifted out of lane ☐ b.) Ran off the road
☐ c.) Hit another vehicle ☐ d.) Hit a fixed object
☐ e.) No consequence
☐ f.) Other (*Please specify*): _____

18. If you do feel sleepy or drowsy, how do you stay alert when driving? (*Check all that apply*)
☐ a.) Drink caffeinated beverage ☐ b.) Eat something
☐ c.) Listen to the radio/CD ☐ d.) Smoke
☐ e.) Talk to passenger/yourself ☐ f.) Stop driving
☐ g.) Open window/turn on AC ☐ h.) Slap/hit yourself
☐ i.) Other (*Please specify*): _____

19. From the drowsy driver countermeasures in question 18, how often do you do these things to stay alert when driving? (*Check one*)
☐ a.) 1-3 times per year ☐ b.) 4-6 times per year
☐ c.) 7-9 times per year ☐ d.) > 9 times per year

20. Where did your current trip originate? (*Please specify city and state*)

_____

21. What is your current destination? (*Please specify city and state*)

_____

22. Do you drive with a radar detector in your vehicle? (*Check one*)
☐ a.) Yes ☐ b.) No

23. If so, is it generally turned on? (*Check one*)
☐ a.) Yes ☐ b.) No

Thank you for completing this survey!

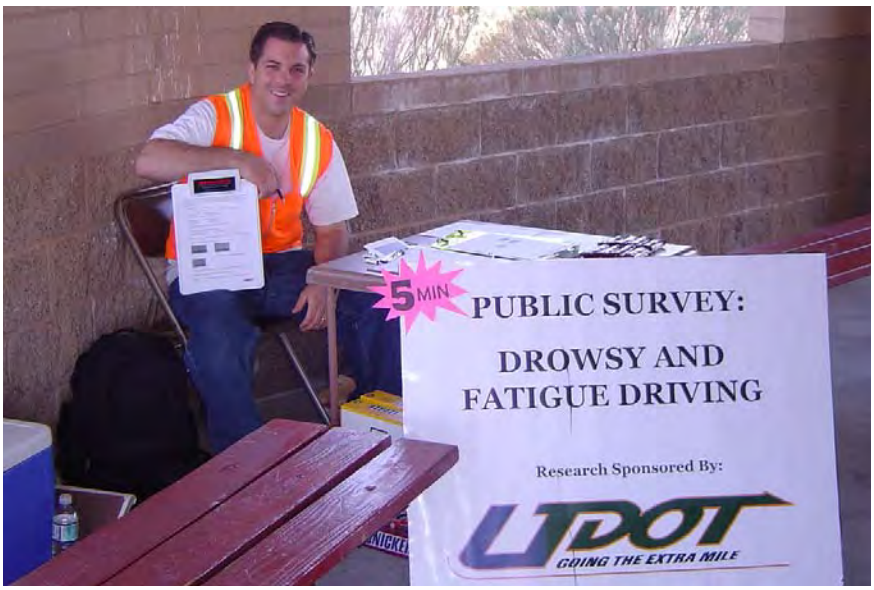
If you have any questions about this survey, you may contact Dr. Grant Schultz at (801) 422-6332. If you have any questions regarding your rights as a participant in this research project, you may contact Dr. Renea Beckstrand, Chair of the Institutional Review Board for Human Subjects, 422 SWKT, Brigham Young University, Provo, UT 84602, (801) 422-3873, renea_beckstrand@byu.edu.

Figure 6-4. Drowsy driving public survey (backside).

Once the survey was written and revised, dates were established on which to conduct the survey. In order for the surveys to yield meaningful results, 200 completed surveys at each of the two rest areas were sought. This goal was completed over a span of four days, specifically Monday, April 30, 2007 through Thursday, May 3, 2007, during which time 405 surveys were completed. All drivers who exited their vehicles were approached and asked to complete the survey. As an incentive for filling out the survey, participants were offered a bottle of water or a candy bar. To grasp drivers' attention and provide professional service, a sign was made indicating the purpose of the survey as illustrated in Figure 6-5. Table 6-1 summarizes pertinent data of the survey information.

Table 6-1. Drowsy Driving Public Survey Information

Location	Day of Week	Beginning Time	Ending Time	Number of Completed Surveys
WB M.P. 10	Monday	11:45 a.m.	7:15 p.m.	104
WB M.P. 10	Tuesday	8:00 a.m.	4:30 p.m.	100
EB M.P. 54	Tuesday	5:15 p.m.	7:30 p.m.	25
EB M.P. 54	Wednesday	8:30 a.m.	8:00 p.m.	142
EB M.P. 54	Thursday	8:15 a.m.	11:45 a.m.	34



(Photo by Grant Farnsworth 2007)

Figure 6-5. Drowsy driving public survey sign.

6.2 Public Survey Results

Of the 405 people surveyed, 331 (81.7 percent) were male while 74 (18.3 percent) were female. Of those surveyed, none were under 18, 25 (6.2 percent) were between the ages of 18 and 25, 57 (14.1 percent) were between the ages of 26 and 35, 114 (28.1 percent) were between the ages of 36 and 50, and 209 (51.6 percent) were over the age of 50. Table 6-2 and Table 6-3 summarize the gender and age of the participants, respectively.

Of those surveyed, 378 (93.3 percent) indicated that they drive a motor vehicle everyday, 17 (4.2 percent) only drive a few times a week, seven (1.7 percent) said they only drive a few times a month, while three (0.7 percent) said they rarely drive. Of those surveyed, 25 (6.2 percent) indicated that they drive everyday on I-80 in Utah, 47 (11.6 percent) a few times a week, 125 (30.9 percent) a few times a month, and 208 (51.4 percent) rarely drive on I-80 in Utah. In addition, 176 (43.5 percent) said that they usually travel alone on I-80 while the complement, 229 (56.5 percent), indicated that they drive with at least one other person in the vehicle.

Table 6-2. Gender Summary of Survey Participants

Gender	Responses	Percentage
Male	331	81.7
Female	74	18.3
Total	405	100.0

Table 6-3. Age Summary of Survey Participants

Age	Responses	Percentage
16-17	0	0.0
18-25	25	6.2
26-35	57	14.1
36-50	114	28.1
>50	209	51.6
Total	405	100.0

6.2.1 Drowsy Driving Freeway Signage Results

The data provided in Table 6-4 identifies the reasons for which rest area patrons stopped. To quantify the number of people whose decision to stop at a rest area due to drowsiness was influenced by the drowsy driving signage, the number of drivers who indicated feeling sleepy/drowsy as a reason for stopping was identified from Table 6-4. The total percentages for both westbound and eastbound driver responses sums to more than 100 percent as drivers were permitted to select multiple reasons for stopping.

Table 6-4. Drivers' Reasons for Stopping at a Rest Area

Why did you stop at this rest stop?	Westbound M.P. 10		Eastbound M.P. 54		Total	
	Responses	Percentage	Responses	Percentage	Responses	Percentage
Use restroom	154	75.5	163	81.1	317	78.3
Stretch	88	43.1	102	50.7	190	46.9
Take photos	24	11.8	1	0.5	25	6.2
Felt drowsy	16	7.8	29	14.4	45	11.1
Eat	4	2.0	7	3.5	11	2.7
Walk the dog	4	2.0	3	1.5	7	1.7
Work	3	1.5	0	0.0	3	0.7
No reason	2	1.0	1	0.5	3	0.7
Smoke	1	0.5	1	0.5	2	0.5
Check engine	1	0.5	0	0.0	1	0.2
Use phone	0	0.0	2	1.0	2	0.5
Check trailer load	0	0.0	1	0.5	1	0.2
Wash face	0	0.0	1	0.5	1	0.2
Access trunk	0	0.0	1	0.5	1	0.2
Caravan stopped	0	0.0	1	0.5	1	0.2
Check tires	0	0.0	1	0.5	1	0.2
Total	297	145.7	314	156.2	611	150.9

To determine how the drowsy driving signs may have played a role in a driver's decision to stop before taking the survey, the following question was asked, "Did you see any yellow-blue drowsy driving signs along the freeway? If no, move ahead to question 9." Since more signs are posted in the eastbound direction, the results are summarized by

direction of travel in Table 6-5. The vast majority of all survey participants saw the drowsy driving signs. Those persons who did see the signage were then asked if the signs contributed to their decision to stop at one of the rest areas. Table 6-6 includes the responses of how survey participants answered this question.

Table 6-5. Drivers Who Saw Drowsy Driving Signage

Did you see any drowsy driving signs?	Westbound M.P. 10		Eastbound M.P. 54		Total	
	Responses	Percentage	Responses	Percentage	Responses	Percentage
Yes	190	93.1	197	98.0	387	95.6
No	14	6.9	4	2.0	18	4.4
Total	204	100.0	201	100.0	405	100.0

Table 6-6. Drowsy Driving Sign Impact on Drivers' Decision to Stop at a Rest Area

Did the signs contribute to your decision to stop?	Westbound M.P. 10		Eastbound M.P. 54		Total	
	Responses	Percentage	Responses	Percentage	Responses	Percentage
Definitely	11	5.8	22	11.2	33	8.5
Somewhat	43	22.6	54	27.4	97	25.1
Not at all	136	71.6	121	61.4	257	66.4
Total	190	100.0	197	100.0	387	100.0

Of those surveyed, 130 indicated that the drowsy driving signs "definitely" or "somewhat" contributed to the driver's decision to exit the freeway and take a break from behind the wheel. This represents slightly more than 32 percent of the 405 people who completed the survey. It is interesting to note that eastbound drivers had 22 more participants identify the signs as a contributing factor to stopping. Three possible reasons for this large difference include: 1) eastbound drivers pass six drowsy driving signs compared to only three or four signs for westbound travelers, 2) the rest area at which the surveys were conducted is only 4 miles down the road of the drowsy driving signs and with only a few minutes of travel time between the signs and the rest area it is possible that more patrons exited the freeway because of the proximity of the two sites, and

3) eastbound drivers usually cover longer distances between major urbanized areas and in many cases travel from California and Nevada before reaching the rest area site.

Although 68 percent of participants who answered the question in Table 6-6 either did not see the signs or responded "not at all," the public sentiment regarding the signage was positive. Many rest area patrons expressed the feeling that the signs would contribute to their decision to stop if they were drowsy. This opinion is reasonable considering the time of day in which the surveys were conducted.

One question the researchers sought to answer was "how many people who acknowledged they were drowsy at the time of the survey also indicated that their decision to stop was influenced by the drowsy driving signage?" From Table 6-4, 16 westbound drivers felt drowsy while in the opposing direction 29 drivers felt drowsy. Table 6-7 shows how the signs contributed to these drowsy drivers' decisions to stop.

Table 6-7. Drowsy Drivers' Reaction to Drowsy Driving Signage

Of drivers who cited drowsiness as one reason for stopping, did the signs contribute to their decision to stop?	Westbound M.P. 10		Eastbound M.P. 54		Total	
	Responses	Percentage	Responses	Percentage	Responses	Percentage
Definitely	1	6.3	9	31.0	10	22.2
Somewhat	8	50.0	14	48.3	22	48.9
Not at all	5	31.3	6	20.7	11	24.4
Did not see signs	2	12.4	0	0.0	2	4.5
Total	16	100.0	29	100.0	45	100.0

From Table 6-7 it can be deduced that 56.3 percent of westbound travelers and 79.3 percent of eastbound travelers who were drowsy cited the signs as a "definite" or "somewhat" definite contributing factor in their decision to stop at the rest areas. The final survey question regarding the signage was asked to determine if any one of the three signs was more prominent than the other two, or if all three signs simply had the same overall effect on drivers. Of the 387 participants who responded to this question, 165

participants (42.6 percent) indicated that the first sign of the 3-sign series (Figure 5-1a) was most prominent; 42 participants (10.9 percent) responded that the second sign (Figure 5-1b) stood out the most while 88 participants (22.7 percent) identified the third sign (Figure 5-1c) as the most prominent. The remaining 92 participants (23.8 percent) felt that one sign did not stand out more than another.

Overall, the drowsy driving signs yielded positive responses both in the statistics provided from the surveys as well as through verbal communication between the investigators and rest area patrons.

6.2.2 General Drowsy Driving Results

The second portion of the survey was aimed at determining how many of the surveyed participants have driven drowsy, the consequences of having driven drowsy, and what do the participants do to keep themselves awake while driving drowsy. Of the 405 completed surveys, 304 participants (75.1 percent) admitted to driving drowsy at some point in their lives while 101 participants (24.9 percent) indicated that they had never driven while drowsy. The latter percentage seemed higher than expected but in large measure may be attributed to how one defines driving while drowsy as this terminology may have different meaning depending on the driver. Four follow-up questions were asked to the 304 people who answered affirmatively to driving drowsy at least once in their life. Table 6-8 indicates how people responded to the question, “How many people, including yourself, were usually in the vehicle at the time(s) you were driving drowsy?” The results from this question collaborate well with drowsy driving crash statistics, which indicate that the vast majority of these types of crashes occur when the driver is the only person in the vehicle. In this observational study, 60.5 percent of drivers indicated that they were alone at the time(s) they drove drowsy.

Table 6-8. Number of People in Vehicle at Time of Drowsy Driving

How many people, including yourself, were usually in the vehicle at the time(s) you were driving drowsy?	Responses	Percentage
1	184	60.5
2	92	30.3
3	15	4.9
4	12	3.9
>4	1	0.4
Total	304	100.0

From this data, the researchers wanted to determine the result of each driver having driven while drowsy. Table 6-9 contains the consequences of those drivers who drove drowsy. Survey participants were asked to indicate all consequences that applied to them, pending a driver drove drowsy on multiple occasions. For this reason the percentages sum to more than 100 percent. The largest response identified was "no consequence." Of those who answered this question, 62.5 percent never had a consequence while another 108 of 304 (35.5 percent) participants cited "drifted out of lane" as the consequence of their drowsy driving episode. It was deduced from these results that the overwhelming majority of drowsy driving experiences do not result in a physical crash although the potential for being in a crash does exists.

Table 6-9. Consequences of Survey Participants' Drowsy Driving

What was the consequence of your driving drowsy?	Responses	Percentage
No consequence	190	62.5
Drifted out of lane	108	35.5
Ran off the road	11	3.6
Other	4	1.2
Hit a fixed object	3	1.0
Hit another vehicle	1	0.3
Total	317	104.1

The final two survey questions related to how drowsy drivers remain alert behind the wheel, as in Table 6-10, and approximately how often those surveyed drive drowsy as outlined in Table 6-11. Drivers were asked to identify all drowsy driving countermeasures which they have employed in the past. For this reason the number of responses is greater than the 304 persons answering this question.

Table 6-10. In-Car Drowsy Driving Countermeasures

If you do feel sleepy or drowsy when driving, how to you stay alert?	Responses	Percentage
Stop driving	179	58.9
Listen to the radio/CD	178	58.6
Open window/turn on AC	178	58.6
Drink caffeinated beverage	168	55.3
Talk to passenger/yourself	103	33.9
Eat something	76	25.0
Slap/hit yourself	49	16.1
Smoke	41	13.5
Eat ice	2	0.7
Stop and exercise	2	0.7
Sing to oneself	2	0.7
Put wet rag on or splash water on face	2	0.7
Talk to someone on the CB radio	1	0.3
Total	981	323.0

Table 6-11. Frequency of Using In-Car Drowsy Driving Countermeasures

From the drowsy driving countermeasures in question 18, how often do you do these things to stay alert when driving?	Responses	Percentage
1-3 times per year	196	64.5
4-6 times per year	36	11.8
7-9 times per year	15	4.9
>9 times per year	57	18.8
Total	304	100.0

As indicated in Table 6-10, drowsy drivers resort to a host of methods to maintain themselves alert behind the wheel. The most popular methods include: opening a window or turning on the air conditioning, listening to the radio, drinking a caffeinated beverage, and stop driving. Of the 304 people who responded to the question posed in Table 6-11, 64.5 percent indicated that they incorporate the drowsy driving countermeasures discussed in Table 6-10 one to three times per year. Surprisingly, the second highest percentage was from those indicating that they use these measures more than nine times per year.

6.3 Chi-Square Tests Results

Survey questions were compared and analyzed using the Chi-square test procedure. The Chi-square test is useful in determining if a correlation exists between drivers' responses to two questions. For example, the test indicates if a male answered a particular question differently compared to a female; however, the test does not specifically identify what that relationship is. The Chi-square test only suggests that substantial evidence of a correlation exists by comparing the actual frequency observed to an expected frequency (Ramsey and Schafer 2002). All Chi-square tests were performed using SAS statistical analysis software with the aid of personnel in the Center for Statistical Consultation and Collaborative Research. The final results of the analyses are provided in Appendix C, where a summary of the results is presented here.

One of the fundamental assumptions associated with the Chi-square test is that each cell used in the analysis should have a value greater than or equal to five. Due to the limited number of responses to some questions, this assumption was not always satisfied, nor was any response from two possible answers combined in an effort to meet this assumption. After performing 14 Chi-Square tests, a few relationships were found with five of the test yielding statistically significant results. The results of the 14 comparisons are discussed in detail in the following subsections.

6.3.1 Relationships with Gender

Of the five Chi-square tests with statistically significant outcomes, only one involved a relationship with gender (question 1). The relationship encountered gender with whether or not the drowsy driving signs contributed to the driver's decision to stop at one of the rest areas (question 8). The results of this analysis yielded a *p*-value of 0.041. From the test, an observation was made that females are more likely to "definitely" stop at a rest stop compared to males. Although approximately the same percentage of both males and females (66 percent) indicated that the drowsy driving signs contributed "not at all" to their decision to stop, only 7 percent of the males responded that the signs "definitely" played a role in their decision to stop compared to 15 percent of the female responses. For this analysis, being female described more drivers that "definitely" pulled off of the freeway due to the drowsy driving freeway signage. The results of this test are located in Appendix C.

Six other comparisons were made with gender, none of which had significant results. Gender was compared to: whether or not the drowsy driving signs were seen along the freeway (question 6), whether or not one of the three drowsy driving signs was more prominent than the others (question 7), the number of hours one drives between stops (question 12), the number of hours the driver slept the night before his/her current trip (question 13), the number of hours of sleep on an average night (question 14), and whether or not a driver has ever driven drowsy (question 15).

For question 6, no significance was calculated as to whether being male or female played a role in a driver seeing the drowsy driving signs as indicated by a *p*-value of 0.153. The vast majority of both genders indicated seeing the freeway signs. Very similar results were outlined in Table 6-5 independent of gender. Male versus female responses for question 7 dealing with whether one drowsy driving sign stood out more than the others were fairly similar. Approximately 11 percent of each gender indicated that the sign caption "Drowsy Drivers Next Exit 5 Miles" was most prominent to them. This sign caption was the least prominent of the three signs when separated by gender. The greatest spread between male and female responses was in the category of "One sign did not stand out more than the other two." More than 25 percent of males indicated no

preference among the sign captions while only 16 percent of females indicated no preference.

Question 12 asked how many hours a driver drives between stops. No significant difference was determined as the *p*-value associated with this question was 0.369. Of the male drivers, the most popular response (33 percent) was driving greater than three hours between stops followed by driving two hours between stops. More than 39 percent of the females indicated driving two hours between stops as the number one response followed by 30 percent driving about three hours.

Question 13 asked drivers how many hours they slept the night before their current trip. Although no statistically significant results were found with this question, which resulted in a *p*-value of 0.165, the difference in responses between the genders varied sharply. Responses indicated that slightly more than 43 percent of females slept five to seven hours with the second most frequent answer of 38 percent being seven to nine hours. The most popular male responses was the opposite with the most frequent response (45 percent) sleeping seven to nine hours followed by 28 percent indicating five to seven hours of sleep the night before their current trip. A total of 60 people surveyed (16 percent of males and 11 percent of females) responded having slept more than nine hours the night before their trip. These 60 people represent almost 15 percent of all drivers who completed the survey.

Question 14, which was very similar to question 13, asked how many hours of sleep one receives on an average night. As in question 13, the Chi-square test results had a *p*-value greater than 0.05, specifically 0.068. The results indicate that number of hours of sleep on an average night is close to being statistically different between males and females. Responses indicated that 46 percent of females sleep five to seven hours on average with the second most frequent answer of 45 percent being seven to nine hours. The male order of most popular responses was again the opposite with the most frequent response (54 percent) sleeping seven to nine hours followed by 31 percent indicating five to seven hours of sleep on average every night. In contrast to question 13, no females indicated that an average night of sleep consisted of five or less hours whereas 5 percent of males responded that they sleep less than five hours on average.

The final Chi-square test with gender was used to determine if a driver had ever driven while drowsy (question 15). Males and females who responded affirmatively were 77 percent and 75 percent, respectively. With a *p*-value of 0.666, the test strongly indicates that gender is not significant in whether or driver has ever driven while drowsy.

6.3.2 Relationships with Age

Of the five Chi-square tests with statistically significant outcomes, four involved a relationship with age (question 1). Those relationships with age included which drowsy driving sign was most prominent (question 7), the number of hours one drives between stops (question 12), the number of hours slept the night before one's current trip (question 13), and whether one has ever driven while drowsy (question 15).

The results of comparing age with which drowsy driving sign was most prominent (question 7) yielded a statistically significant *p*-value of 0.006. The most prominent drowsy driving sign varied drastically by age group. For the 18-25 year old group, "Drowsy Drivers Pull Over If Necessary" stood out the most with 39 percent of the respondents choosing this option. This particular age group only marked the option "One sign did not stand out more than the other two" 4 percent of the time thereby indicating that the youngest group preferred one of the three signs over the other two. Of the 26-35 year old group, 54.6 percent preferred the sign "Drowsy Driving Causes Crashes." This was also the most frequently reported answer for the age groups of 36-50 (41.0 percent) and greater than 50 (41.2 percent). Almost 31 percent of drivers 26-35 cited "Drowsy Drivers Pull Over If Necessary" as the most prominent.

The two oldest age groups, the 36-50 and greater than 50 age groups, had more respondents indicate that they had no preference between the three signs. Specifically, 26 percent of the 36-50 age bracket responded that they had no preference in one sign while 29 percent of those surveyed who were over 50 years old indicated the same. The overall trend in the responses was that the younger the age of the respondent the more the sign "Drowsy Drivers Pull Over If Necessary" was cited while the older the age of the respondent the more the sign "Drowsy Driving Causes Crashes" was preferred. Only 11 percent of the 387 responses to this question cited "Drowsy Drivers Next Exit 5 Miles" as

the sign which stood out the most. This was verified through conversation between survey respondents and those administering the survey. Multiple remarks were made indicating that the sign "Drowsy Drivers Next Exit 5 Miles" sends drivers the wrong message, the message to keep going. Several survey participants mentioned that more emphasis should be aimed to get drowsy drivers off of the highway immediately rather than encouraging them to continue in a fatigued state for another 5 miles or more behind the wheel.

Question 12 asked how many hours a driver drives between stops. The test indicated significant results with a *p*-value of 0.027. Three of the four groups, namely the 18-25, 26-35, and 36-50 age brackets, responded driving more than three hours between stops while those drivers over 50 years of age cited stopping every two hours as the most frequent response. In the 26-35 year old group, 42 percent of drivers identified driving greater than three hours between stops as compared to only 25 percent of drivers over 50 years of age. The general trend from this test indicates that as drivers become older they are less likely to drive greater lengths of time between stops. This may likely be due to physical discomforts or a desire to stretch one's muscles more often.

Question 13 asked drivers how many hours they slept the night before their current trip. The results were widespread and yielded a *p*-value of 0.008. The first and second most frequent responses of all four age brackets was sleeping seven to nine hours and five to seven hours of sleep, respectively. Of the drivers in the age group of 18-25, 12 percent responded sleeping less than three hours the night before their current trip. By comparison, only 0.5 percent of drivers over 50 cited sleeping less than three hours. It is theorized that lifestyle is the most likely reason that more young adults slept less than three hours. Similarly, 14 percent of 26-35 year old drivers indicated sleeping only between three to five hours the night before their current trip. In contrast to young drivers who slept less, 49 percent of drivers over 50 cited sleeping seven to nine hours the night before their current trip.

The final Chi-square test with age which yielded statistical significance was used to determine if a driver had ever driven while drowsy (question 15). The *p*-value associated with the results was 0.006. Slightly more than half (52 percent) of those 18-25 years old answered affirmatively to having ever driven while drowsy while more than 72

percent of drivers age 50 and greater responded affirmatively. For those drivers between 26-50 years old, 82 percent indicated having driven drowsy at some point while behind the wheel. Although the results from this analysis proved to be statistically significant, they may not be practically important. The survey question was asked in such a way that the results are what could have been anticipated. One might reason that the older a driver is and the more driving exposure one has, the greater the probability of having at least one drowsy driving episode at some point in time. Furthermore, 25 percent of drivers responded negatively implying that they have never driven while drowsy. While for some drivers this may be true, the question of how one defines drowsy driving very easily could have changed the outcome to this question.

Three other comparisons were made with age, none of which had significant results. Age was compared to: whether or not the drowsy driving signs were seen along the freeway (question 6), whether or not the drowsy driving signs contributed to the driver's decision to stop at one of the rest areas (question 8), and the number of hours of sleep on an average night (question 14).

For question 6, no significance was calculated as to whether age played a role in a driver seeing the drowsy driving signs as indicated by a *p*-value of 0.106. The range of percentages based upon age of those indicating that they did see the drowsy driving signs was 92 to 98 percent. Only 18 of the 405 survey participants responded in the negative.

Age was not determined to be a factor in whether or not a driver's decision to stop at the rest area was influenced by the drowsy driving signage (question 8). For the four age brackets, very little difference in how survey participants responded was detected as indicated by a *p*-value of 0.987. Approximately 66 percent of all age groups said that the drowsy driving signs did not contribute to their decision to stop at one of the rest areas while the remaining 34 percent cited that the signs "definitely" or "somewhat" contributed to their decision to stop.

Question 14, which was very similar to question 13, asked how many hours of sleep one receives on an average night. Again, no significant difference was determined by comparing age groups as denoted by a *p*-value of 0.090. For both the age groups 26-35 and 36-50 years old, sleeping seven to nine hours each night was the most frequent response with 42 percent cited this answer. This response increased to 56 percent and 60

percent for the 18-25 and greater than 50 year old groups, respectively. The second most frequent answer for all age groups was sleeping five to seven hours on an average night. Only 10 percent said that they sleep more than nine hours most nights.

After performing 14 Chi-Square tests, several correlations were found with five of the test yielding statistically significant results. Table 6-12 summarizes the Chi-Square tests conducted and their associated *p*-values. The statistically significant questions and *p*-values are identified in bold print according to gender and age.

Table 6-12. Chi-Square Test Summary

Survey Question	***p*-value**	
	Gender	**Age**
Did you see any yellow-blue drowsy driving signs?	0.153	0.106
Which drowsy driving sign was most prominent to you?	0.393	**0.006**
Did the signs contribute to your decision to stop at the rest area?	**0.041**	0.987
On average, how many hours do you drive between stops?	0.369	**0.027**
How many hours did you sleep the night before your current trip?	0.165	**0.008**
How many hours on average do you sleep each night?	0.068	0.090
Have you ever driven while drowsy?	0.666	**0.006**

6.4 Survey Limitations

The public survey overall was successful in understanding drivers' opinions about drowsy driving and the role that the drowsy driving freeway signage played in drivers' decisions to stop at one of the rest areas. However, the survey was not perfect. If it were possible to conduct a similar survey again a question would be added to differentiate truck drivers and passenger vehicles drivers as their driving habits can be drastically different. As for the survey questions actually administered, some needed clarification. Question 13 asked how many hours one slept the night before his/her current trip. This was interpreted as the number of hours one slept the night prior to leaving home, which may have been several days, when the intention was to determine how many hours one slept the night before the survey was administered.

Question 15 asked whether or not a driver had ever driven while drowsy. As indicated previously, the probability that one has had a drowsy driving episode is a function of time behind the wheel, which is in most cases related to age. To yield more meaningful results, the question would be changed to include a finite time period. For example, have you driven drowsy in the past 12 months? This type of question would place all drivers on the same level when answering this question since the responses would be independent of age.

Question 19 asked drivers how often they employ certain in-car drowsy driving countermeasures. The possible choices ranged from one time per year to greater than nine times per year. The answer choices assume that a driver has some type of drowsy driving episode at least once per year, which is not true of all drivers. To enhance the accuracy of this question, the answer choices should include "other" as an option thereby allowing drivers to specify how often they use in-car countermeasures to maintain alertness while driving.

Lastly, the persons administering the surveys wore bright orange vests to make a professional impression upon drivers. However, a number of truck drivers were suspicious of the survey administrators indicating concern for those questions dealing with the number of hours of sleep one receives. For fear of being reported to the police, truck drivers may have provided inaccurate information regarding how much sleep they receive each night for fear of being cited. Thus the results of questions 13 and 14 may be slightly skewed depending on the accuracy of the information provided.

6.5 Public Survey: Drowsy Driving Summary

The results of a public survey conducted at two rest areas along I-80 west of Salt Lake City were discussed. A total of 405 surveys were completed by drivers stopping at the rest areas. Of those surveyed, 130 indicated that the drowsy driving signs "definitely" or "somewhat" contributed to the driver's decision to exit the freeway and take a break from behind the wheel. This represents slightly more than 32 percent of survey participants. After performing 14 Chi-Square tests, several correlations were found with five of the test yielding statistically significant results. Only one significant correlation

involved a relationship with gender (question 1). The relationship encountered with gender was whether or not the drowsy driving signs contributed to the driver's decision to stop at one of the rest areas (question 8). The four remaining statistically significant relationships were correlated with age and included which drowsy driving sign was most prominent (question 7), the number of hours one drives between stops (question 12), the number of hours slept the night before one's current trip (question 13), and whether one has ever driven while drowsy (question 15). Following discussion of the Chi-Square analyses, the limitations of the survey were provided to as a guide from which to learn. Understanding the effectiveness of the signs as outlined in this chapter sets the stage for future recommendations of drowsy driving signage as identified in the following chapter.

7 EVALUATION OF CANDIDATE SITES

Through the literature review (Chapter 2) and study of existing drowsy driving countermeasures in the state of Utah (Chapter 5), various tools have been discussed which may be useful in reducing the number of drowsy driving crashes statewide. These countermeasures form the basis of the tools which may be implemented on any one of the 41 drowsy driving critical corridors discussed in Chapter 4. The following sections discuss each critical corridor with the purpose of outlining which countermeasures currently exist in each corridor to prevent drowsy driving crashes. Following the inventory of drowsy driving countermeasures, limited recommendations of countermeasures are discussed. The recommendations provided in this chapter reflect the view of the authors and not the official views or policies of UDOT.

7.1 Interstate 15

Seven of the nine critical corridors on I-15 are located in rural areas of which two corridors have both northbound and southbound directions that coincide. Many of these rural corridors already have some type of countermeasure to help reduce drowsy driving crashes. Besides the rural segments identified in Chapter 4, two critical corridors on I-15 are located in the urban area north and south of Salt Lake City. Cable median barrier and rumble strips are currently in place throughout the critical corridor from M.P. 255-260 while in the Ogden area from M.P. 340-345 only rumble strips exists. No possible future countermeasures for the Springville/Provo area (M.P. 255-260) are proposed at this time; however, cable median barrier is one possible countermeasure which could be installed for M.P. 340-345 if UDOT justified such a course of action through a study of crash history. Existing countermeasures along with possible mitigation techniques in or near

the drowsy driving corridors have been outlined for both the rural and urban areas in Table 7-1.

One countermeasure not identified in Table 7-1 is the possible use of variable message signs to occasionally warn drowsy drivers to exit a facility immediately. Considering that the two urban critical corridors are located at the extreme ends of the urban area and that some of the drowsy driving crashes occurred in the late afternoon due to commuters returning home after a long work day, this mitigation technique warrants further investigation by UDOT.

Table 7-1. Existing and Future Drowsy Driving Countermeasures on I-15

M.P.	Direction of Travel	Existing Countermeasures	Possible Mitigation Techniques
0 – 5	NB	None	Shoulder Rumble Strips; Drowsy Driving Sign before Welcome Center; Cable Median Barrier from M.P. 2-5
80 – 85	SB	Shoulder Rumble Strips	None Recommended
90 – 95	NB & SB	Shoulder Rumble Strips; Drowsy Driving Sign at SB M.P. 89	Drowsy Driving Sign NB Direction Before Lunt Park Rest Area
170 – 175	SB	Shoulder Rumble Strips	None Recommended
185 – 195	SB	Shoulder Rumble Strips; Drowsy Driving Sign at SB M.P. 189	Drowsy Driving Sign NB Direction Before Scipio Rest Area
190 – 200	NB	Shoulder Rumble Strips	Fix Edge Drop Off
255 – 260	SB	Shoulder Rumble Strips; Cable Median Barrier	None Recommended
340 – 345	NB	None	Shoulder Rumble Strips; Cable Median Barrier

To determine other possible contributing factors in drowsy driving crashes, data gathered from site visits to critical corridors by engineers from Horrocks Engineers was investigated. Site visits were conducted on I-15 from M.P. 80 to M.P. 120 as well as from M.P. 188 to M.P. 223. Within the drowsy driving corridor of southbound M.P. 80 to M.P. 85, the rumble strips were filled in during the last chip seal project (Horrocks

Engineers 2006). It is recommended that the rumble strips be reevaluated to determine if they are currently effective or should be reinstalled anew. For both northbound and southbound from M.P. 90 to M.P. 95, the site visits did not reveal any immediate concerns with edge drop off or sharp clear zone slopes in need of flattening.

In contrast to the good roadway conditions located from M.P. 90 to M.P. 95, the site visits incorporating M.P. 188 to M.P. 223 yielded several locations where edge drop off and steep clear zone slopes are currently a concern. At southbound M.P. 194.9 is located a 1-in. edge drop off while in the northbound direction from M.P. 194.2 to M.P. 199.2 is located an edge drop off ranging from 1-in. to 4-in. The 4-in. edge drop off was recorded at M.P. 198.0 and is illustrated in Figure 7-1. Besides edge drop off as one concern in this area, Horrocks Engineers (2006) identified that the fill slope on the outside of the highway could be flattened to enable a driver to safely reenter the highway despite a clear zone of 30 feet. The specific area in which UDOT may consider flattening the clear zone slope is at northbound M.P. 196.1 and is shown in Figure 7-2.

(Photo by Brian Christensen 2006)

Figure 7-1. Example of edge drop off on NB I-15 between M.P. 194 to M.P. 199.

(Photo by Brian Christensen 2006)

Figure 7-2. Example of steep clear zone slope on NB I-15 between M.P. 194 and M.P. 199.

7.2 Interstate 70

From Chapter 4, it was determined that I-70 has seven critical corridors. All seven of the corridors currently have discontinuous shoulder rumble strips as the only type of countermeasure. Although not located in a particular critical corridor, a series of three drowsy driving is signs located near eastbound M.P. 114. This series of signage has resulted in an increase in drivers stopping at the Eagle Canyon view area according to UDOT. Table 7-2 outlines the existing and possible future mitigation techniques for the critical corridors of I-70. No site visits were conducted on I-70, but UDOT's Roadview Explorer program was used to identify possible areas of concern.

It was determined that several areas of I-70 may be prime candidates for drowsy driving countermeasures. It is recommended that near the city of Green River, transverse rumble strips be considered as a means to wake up drowsy drivers before passing the main exit at M.P. 160. It is also recommended that UDOT consider adding in-lane pavement markings for drivers to read while traveling.

Table 7-2. Existing and Future Drowsy Driving Countermeasures on I-70

M.P.	Direction of Travel	Existing Countermeasures	Possible Mitigation Techniques
20 – 25	WB	Shoulder Rumble Strips	Drowsy Driving Sign before Joseph; Cable Median Barrier
95 – 100	WB	Shoulder Rumble Strips	Cable Median Barrier from M.P. 96-97
125 – 135	WB	Shoulder Rumble Strips	None Recommended
135 – 140	EB	Shoulder Rumble Strips	Drowsy Driving Sign EB before Black Dragon View Area with In-lane Pavement Markings to "Avoid Fatigue Driving"
155 – 160	EB	Shoulder Rumble Strips	Transverse Rumble Strips near M.P. 159 before Green River
160 – 165	WB	Shoulder Rumble Strips	Drowsy Driving Sign Before Green River with Transverse Rumble Strips near M.P. 161
225 – 232	EB	Shoulder Rumble Strips	Drowsy Driving Sign Before Harley Dome View Area

7.3 Interstate 80

In similar fashion to I-70, I-80 also has seven critical corridors. Of these corridors, eastbound I-80 has three critical corridors, all of which are relatively close to each other. The drowsy driving signs indicate that drivers should exit the freeway at M.P. 41 at which location drivers can rest. After conducting a site visit to the exit, it was evident from the amount of trash on the off- and on-ramps that the location is being used by both passenger vehicles as well as large semi-trailer trucks. Therefore, it is recommended that UDOT consider construction of a rest area or view area with minimal amenities. Such amenities could strictly be limited to include passenger and truck parking in a paved parking lot, garbage dumpsters, and possibly lighting for drowsy drivers to feel comfortable sleeping during nighttime or early morning hours. This course of action is to provide a location for sleepy drivers to pull off of the highway between the rest areas at M.P. 10 and M.P. 54 and to minimize the volume of litter thrown out of vehicles currently using the ramps as an area to take a brake from driving. This

countermeasure along with other potential drowsy driving mitigation techniques is outlined in Table 7-3.

Table 7-3. Existing and Future Drowsy Driving Countermeasures on I-80

M.P.	Direction of Travel	Existing Countermeasures	Possible Mitigation Techniques
5 – 10	WB	Shoulder Rumble Strips	Drowsy Driving Sign before Salt Flats Rest Area with Transverse Rumble Strips near M.P. 11
20 – 25	WB	Shoulder Rumble Strips	None Recommended
30 – 35	WB	Shoulder Rumble Strips	None Recommended
35 – 40	EB	Shoulder Rumble Strips	Modified Rest Area at Knolls Exit; In-lane Pavement Markings to "Avoid Fatigue Driving"
45 – 50	EB	Shoulder Rumble Strips; Drowsy Driving Signs	Transverse Rumble Strips before Signage
60 – 65	EB	Shoulder Rumble Strips	None Recommended
70 – 75	WB	Shoulder Rumble Strips	Drowsy Driving Sign before Rowley Jct. at M.P. 77

7.4 Interstate 84

The two critical corridors located on I-84 coincide with each other from M.P. 110 to M.P. 115. Although this one stretch of highway was deemed critical, a total of only 10 drowsy driving crashes were recorded between 1992-2004; therefore, it is not recommended that any drowsy driving countermeasure be implemented in this area in addition to the current rumble strips unless justified by UDOT. Continued monitoring of I-84 is recommended to identify if these corridors become worse over time.

7.5 United States Route 89

On U.S. 89, eight of the 12 critical corridors are located in extremely rural areas of Utah. Table 7-4 indicates the existing and possible future drowsy driving countermeasures for the critical corridors. Not identified in Table 7-4, but recommended for all rural areas of U.S. 89 is the use of wider longitudinal edge line pavement markings to help delineate the edge of the highway. An 8-inch edge line width as shown previously in Figure 2-6 is recommended.

Table 7-4. Existing and Future Drowsy Driving Countermeasures on U.S. 89

M.P.	Direction of Travel	Existing Countermeasures	Possible Mitigation Techniques
5 – 10	NB	None	Drowsy Driving Sign before Visitor Center; Centerline Rumble Strips
55 – 60	NB	None	Centerline Rumble Strips; Replace Guardrails
90 – 95	SB	Shoulder Rumble Strips	Drowsy Driving Sign before Shingle Creek Rest Area; Centerline Rumble Strips; Replace Guardrails
105 – 110	NB	None	Centerline Rumble Strips
115 – 125	SB	None	Centerline Rumble Strips
140 – 145	NB & SB	None	View Area and Drowsy Driving Sign with Transverse Ruble Strips near M.P. 141 at S.R. 20 Junction
180 – 185	SB	None	Drowsy Driving Sign before Hoovers Rest Area
325 – 330	NB & SB	None	None Recommended
340 – 353	SB	None	None Recommended
370 – 375	NB	None	None Recommended

Currently, only one portion of one critical corridor has shoulder rumble strips. The one section of rumble strips is found near M.P. 95 and is likely due to a lack of available space since in many locations within critical corridors very little shoulder room

exist to install this type of countermeasure. This was verified through site visits conducted by Horrocks Engineers. It was determined during the visits that the right shoulder width of U.S. 89 in both directions from M.P. 0 to M.P. 108 ranges from a minimum of 0 feet to a maximum of 15 feet with an average right shoulder width of 5 feet (Horrocks Engineers 2007). It is therefore recommended that UDOT consider installing centerline rumble strips throughout appropriate areas from M.P. 0 to M.P. 131 to help reduce the number of run-off-road crashes.

This recommendation is based upon the fact that from the Arizona-Utah border to Panguitch (M.P. 0 to M.P. 131), 211 drowsy driving crashes occurred from 1992 to 2004. Of these, 64 drowsy driving crashes (30.3 percent) were "Ran Off Roadway-Left" crashes indicating that approximately one-third of drowsy drivers crossed over the centerline into oncoming traffic before leaving the highway. Furthermore, 126 crashes (59.7 percent) were "Ran Off Roadway-Right" crashes. With such a high percentage of drowsy driving crashes resulting in vehicles drifting off of the roadway to the right, it is recommended that the guardrails in the critical corridor of northbound M.P. 55 to M.P. 60 be replaced along with the "Texas turn-downs." An example of the current guardrails is provided in Figure 7-3.

(Photo by Brian Christensen 2006)

Figure 7-3. Typical example of current guardrail with "Texas turn-down."

7.6 United States Route 91

U.S. 91 has two critical corridors which coincide with each other between M.P. 20 and M.P. 25. Although this section of the highway does not have shoulder rumble strips, this particular countermeasure may not be the ideal solution due to noise complaints which may arise from residents who live along the route. An educational awareness countermeasure through a single drowsy driving sign is a potential countermeasure which UDOT may consider installing near M.P. 16 along with transverse rumble strips as motorists first enter the Cache valley. M.P. 16 is suggested since it is located away from residents' homes and before drivers arrive at the critical corridor at M.P. 20.

7.7 State Route 36

As identified in Chapter 4, S.R. 36 has two critical corridors. Neither corridor has rumble strips due to the extremely narrow shoulders. Also discussed in Chapter 4 was the low AADT on most portions of S.R. 36. Several 5-mile segments had inflated crash rates as a result of the low volume of traffic on the majority of this highway. The crash rates were not practical or consistent with crash rates calculated for other Utah highways. Further study by UDOT of drowsy driving on S.R. 36 is necessary before implementation of any countermeasure should be considered.

7.8 Evaluation of Candidate Sites Summary

Each of the 41 critical corridors outlined in Chapter 4 were in this chapter along with possible recommendations for drowsy driving countermeasures. It was determined that most of the critical corridors on Interstates have one type of rumble strip while the critical corridors on U.S. and S.R. highways do not have rumble strips. Possible drowsy driving countermeasures identified in this chapter include: shoulder and centerline rumble strips, additional drowsy driving highway signage, cable median barrier, clearing brush

back to create wider shoulders, flattening slopes near shoulders, and using variable message boards in Salt Lake City to promote staying alert behind the wheel. Each countermeasure discussed should be implemented and justified by UDOT on a case-by-case basis to ensure safety on Utah highways and save lives.

8 CONCLUSIONS

The preceding chapters have outlined the background of drowsy and fatigue driving in the state of Utah as well as around the world. The analysis procedure using the UDOT crash database has been set forth as was the method for determining which 5-mile segments of highway were most prone to drowsy driving during the years 2002-2004. The results indicate 41 critical corridors distributed over eight highway facilities, the majority of which are located on I-15, I-70, and I-80. This chapter provides conclusions and outlines future research possibilities aimed at reducing drowsy driving crashes.

8.1 Conclusions

The results of the research indicate that drowsy driving occurs in both rural and urbanized areas alike. Although drowsy driving crashes reportedly represent only 3 percent of all crashes in Utah, they are responsible for approximately 14 percent of all fatal crashes on Interstates, U.S. Routes, and S.R. highways. Furthermore, the total number of drowsy driving crashes may be as high as 15 to 18 percent based on an analysis of potential underreporting of such crashes. While several critical corridors were discovered in urban settings, the majority of the corridors are located in very rural areas with speed limits in excess of 55 mph. The drowsy driving statistics calculated from Utah highways reaffirm many drowsy driving statistics outlined in the literature. For example, drowsy driving crashes typically had two peaks—one in the morning hours near 7 a.m. and one in the mid to late afternoon near 4 p.m. Along with time of day, it was determined that more drowsy driving crashes occurred on weekends than during the middle of the week. Other statistics from Utah highways identified drowsy driving crashes as more severe in nature. For example, on Interstate freeways approximately 6

percent of drowsy driving crashes ended in at least one fatality whereas in all crashes on these facilities combined less than 2 percent of crashes yielded a fatality. It was also estimated from six 5-mile sections of crash data in Chapter 4 that drowsy driving crashes in Utah may be under-reported by as much as 18 percent.

Drowsy driving freeway signage was one specific drowsy driving countermeasure discussed in detail in Chapter 5. The signage is currently found on I-15, I-70, and I-80. The results of a crash rate analysis before and after installation of drowsy driving signs on I-80 west of Salt Lake City yielded promising results in helping to reduce drowsy driving crashes. Three before-after methods were outlined to calculate the effectiveness of the drowsy driving signs for the crash data available following sign installation. It was determined that the eastbound percent reduction in drowsy driving crashes ranged from 45 percent to a high of 63 percent while the westbound direction ranged from 5 percent to 22 percent. Again, the change in the number of crashes reflects not only the effect of the drowsy driving signage, but also the effect of factors such as traffic, weather, driver behavior, police report accuracy, and other possibly unknown factors. It is not known what part of the change can be attributed to the drowsy driving signs and what part is due to the various other influences mentioned.

Besides the drowsy driving signage analysis discussed, a crash rate analysis before and after the construction of the Grassy Mountain rest area yielded positive results for the eastbound direction thus indicating that the rest area may help reduce the number of drowsy driving crashes. In the westbound direction no conclusions could be drawn in light of the volatile change in crash rate between consecutive 5-mile sections. Also identified in Chapter 5 were the effectiveness of rumble strips and cable median barrier in Utah both of which help reduce run-off-road crashes significantly.

Chapter 6 discussed a public survey conducted at two rest areas on I-80 as a supplement to determining the effectiveness of the drowsy driving freeway signage west of Salt Lake City. It was determined that of the 387 surveyed drivers who saw the drowsy driving freeway signs, 33.6 percent indicated that the signs “definitely” contributed or “somewhat” contributed to their decision to stop at one of the two rest areas where surveys were conducted. Also calculated from the survey was the effect that the signs had on drivers who admitted that one reason for stopping at one of the rest areas

was drowsiness. Of the 45 people who cited feeling drowsy as a reason for stopping, 32 (71.1 percent) indicated that the drowsy driving signs "definitely" or "somewhat" contributed to their decision to stop.

Using the results of the public survey, 14 Chi-square tests were conducted to determine trends using gender and age. It was determined that the only significant relationship with gender was whether or not the drowsy driving signs contributed to the driver's decision to stop at one of the rest areas. Other statistically significant results identified trends with age. These included which drowsy driving sign was most prominent, the number of hours one drives between stops, the number of hours slept the night before one's current trip, and whether one has ever driven while drowsy.

Based upon the results of Chapter 4, appropriate drowsy driving countermeasures were outlined in Chapter 7. The recommended countermeasures include: additional shoulder and centerline rumble strips, cable median barrier, replacement of some guardrail, and drowsy driving highway signage. Drowsy driving countermeasures not yet implemented but which should be considered by UDOT are transverse rumble strips, wider longitudinal pavement markings, in-lane pavement markings indicating "AVOID FATIGUE DRIVING," minimizing edge drop off, flattening slopes in clear zones, and adding a modified rest area at M.P. 41 on I-80 where motorists can rest and empty trash in appropriate containers.

8.2 Future Research

Future research is highly recommended for the area of drowsy and fatigue driving in the state of Utah. As the population of Utah continues to increase with time so will the number of drowsy driving crashes. The critical corridors discussed in Chapter 4 may see an increase in length or even become obsolete altogether due to reconstruction of roadway alignments, traffic volume increases, and land use changes. It is recommended that UDOT continue to monitor the safety impacts of the drowsy driving freeway signage currently in place. Furthermore, future research will be necessary to statistically determine the effectiveness of the signage on I-15 and I-70 as well as reevaluate the

effectiveness of the signage on I-80. The results of such a study would be essential to properly reassess the purpose and need of the freeway signs.

Additional future research may be necessary to identify other drowsy driving countermeasures which may currently be unproven in reducing drowsy driving crashes. Examples of such countermeasures may include mid-lane rumble strips on highways with narrow shoulders such as U.S. 89 or the use of in-vehicle countermeasures such as eye-closure monitors or tracking devices that detect lane drift. Other countermeasures which should be considered include transverse rumble strips and wider lane markers to more easily delineate the edge of the outside lanes. It is also recommended that an in-depth study of run-off-road crashes be conducted to determine where cable median barrier may be appropriate where not recommended as part of this research.

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APPENDIX A: 3-, 5-, AND 13-YEAR ANALYSIS RESULTS

Table A-1. I-15 3-Year (2002-2004) Crash Rate Analysis

	Crash Rate per Million Vehicle-Miles Traveled		
	Milepost	**Northbound**	**Southbound**
Rural	0-5	**0.312**	0.087
	5.01-10	0.066	0.019
	10.01-15	0.072	0.092
	15.01-20	0.052	0.139
	20.01-25	0.041	0.102
	25.01-30	0.040	0.180
	30.01-35	0.174	0.194
	35.01-40	0.178	0.059
	40.01-45	0.080	0.080
	45.01-50	0.020	0.080
	50.01-55	0.136	0.097
	55.01-60	0.090	0.036
	60.01-65	0.036	0.018
	65.01-70	0.199	0.119
	70.01-75	0.041	0.082
	75.01-80	0.114	0.023
	80.01-85	0.183	**0.251**
	85.01-90	0.253	0.115
	90.01-95	**0.412**	**0.229**
	95.01-100	0.112	0.067
	100.01-105	0.246	0.090
	105.01-110	0.000	0.069
	110.01-115	0.119	0.167
	115.01-120	0.139	0.186
	120.01-125	0.185	0.000
	125.01-130	0.158	0.090
	130.01-135	0.080	0.000
	135.01-140	0.225	0.000
	140.01-145	0.065	0.000
	145.01-150	0.033	0.163
	150.01-155	0.163	0.163
	155.01-160	0.064	0.095
	160.01-165	0.184	0.092
	165.01-170	0.178	0.148
	170.01-175	0.059	**0.206**
	175.01-180	0.062	0.062
	180.01-185	0.089	0.000
	185.01-190	0.147	**0.265**
	190.01-195	**0.425**	**0.227**
	195.01-200	**0.453**	0.198

Table A-1. Continued

	Milepost	Northbound	Southbound
Rural	200.01-205	0.113	0.057
	205.01-210	0.286	0.115
	210.01-215	0.086	0.058
	215.01-220	0.201	0.115
	220.01-225	0.133	0.133
	225.01-230	0.148	0.055
	230.01-235	0.030	0.076
	235.01-240	0.090	0.015
	240.01-245	0.044	0.015
	245.01-250	0.038	0.038
	250.01-255	0.026	0.044
Urban	255.01-260	0.018	**0.061**
	260.01-265	0.054	0.029
	265.01-270	0.037	0.048
	270.01-275	0.046	0.043
	275.01-280	0.034	0.040
	280.01-285	0.010	0.050
	285.01-290	0.033	0.030
	290.01-295	0.036	0.044
	295.01-300	0.034	0.020
	300.01-305	0.021	0.012
	305.01-310	0.018	0.016
	310.01-315	0.042	0.027
	315.01-320	0.034	0.019
	320.01-325	0.024	0.024
	325.01-330	0.056	0.016
	330.01-335	0.052	0.008
	335.01-340	0.056	0.007
	340.01-345	**0.088**	0.009
Rural	345.01-350	0.043	0.057
	350.01-355	0.042	0.042
	355.01-360	0.017	0.026
	360.01-365	0.087	0.011
	365.01-370	0.030	0.045
	370.01-375	0.031	0.062
	375.01-380	0.000	0.019
	380.01-385	0.027	0.082
	385.01-390	0.115	0.077
	390.01-395	0.040	0.119
	395.01-401	0.000	0.036

Table A-2. I-70 3-Year (2002-2004) Crash Rate Analysis

	Crash Rate per Million Vehicle-Miles Traveled		
	Milepost	**Eastbound**	**Westbound**
Rural	0-5	0.000	0.148
	5.01-10	0.000	0.000
	10.01-15	0.145	0.073
	15.01-20	0.430	0.072
	20.01-25	0.197	**0.393**
	25.01-30	0.481	0.267
	30.01-35	0.429	0.054
	35.01-40	0.182	0.122
	40.01-45	0.076	0.152
	45.01-50	0.397	0.072
	50.01-55	0.200	0.133
	55.01-60	0.108	0.072
	60.01-65	0.075	0.151
	65.01-70	0.076	0.076
	70.01-75	0.082	0.123
	75.01-80	0.057	0.057
	80.01-85	0.171	0.000
	85.01-90	0.181	0.302
	90.01-95	0.070	0.210
	95.01-100	0.000	**0.505**
	100.01-105	0.144	0.216
	105.01-110	0.216	0.072
	110.01-115	0.216	0.000
	115.01-120	0.144	0.000
	120.01-125	0.288	0.072
	125.01-130	0.216	**0.505**
	130.01-135	0.288	**0.360**
	135.01-140	**0.505**	0.072
	140.01-145	0.360	0.072
	145.01-150	0.146	0.219
	150.01-155	0.467	0.078
	155.01-160	**0.629**	0.063
	160.01-165	0.462	**0.528**
	165.01-170	0.057	0.057
	170.01-175	0.285	0.057
	175.01-180	0.171	0.114
	180.01-185	0.272	0.109
	185.01-190	0.054	0.107
	190.01-195	0.055	0.164
	195.01-200	0.000	0.109
	200.01-205	0.163	0.163
	205.01-210	0.163	0.163
	210.01-215	0.382	0.109
	215.01-220	0.281	0.056
	220.01-225	0.225	0.169
	225.01-232	**0.494**	0.000

Table A-3. I-80 3-Year (2002-2004) Crash Rate Analysis

	Crash Rate per Million Vehicle-Miles Traveled		
	Milepost	Eastbound	Westbound
Rural Area	0-5	0.000	0.000
	5.01-10	0.000	**0.191**
	10.01-15	0.143	0.143
	15.01-20	0.096	0.143
	20.01-25	0.048	**0.191**
	25.01-30	0.000	0.000
	30.01-35	0.239	**0.191**
	35.01-40	**0.383**	0.000
	40.01-45	0.288	0.096
	45.01-50	**0.335**	0.048
	50.01-55	0.233	0.047
	55.01-60	0.270	0.135
	60.01-65	**0.356**	0.089
	65.01-70	0.089	0.133
	70.01-75	0.266	**0.177**
	75.01-80	0.122	0.041
	80.01-85	0.037	0.150
	85.01-90	0.128	0.032
	90.01-95	0.028	0.000
	95.01-100	0.097	0.058
	100.01-105	0.102	0.073
	105.01-110	0.084	0.117
Urban Area	110.01-115	0.070	0.035
	115.01-120	0.000	0.013
	120.01-125	0.007	0.004
	125.01-130	0.021	0.034
Rural Area	130.01-135	0.042	0.025
	135.01-140	0.034	0.026
	140.01-145	0.045	0.009
	145.01-150	0.087	0.052
	150.01-155	0.125	0.025
	155.01-160	0.055	0.028
	160.01-165	0.057	0.057
	165.01-170	0.055	0.000
	170.01-175	0.027	0.027
	175.01-180	0.053	0.053
	180.01-185	0.134	0.080
	185.01-190	0.057	0.113
	190.01-197	0.283	0.057

Table A-4. I-84 3-Year (2002-2004) Crash Rate Analysis

	Crash Rate per Million Vehicle-Miles Traveled		
	Milepost	**Eastbound**	**Westbound**
Urban	0-5	0.000	0.056
	5.01-10	0.000	0.048
	10.01-15	0.178	0.133
	15.01-20	0.000	0.000
	20.01-25	0.042	0.085
	25.01-30	0.041	0.124
	30.01-35	0.000	0.000
	35.01-42	0.202	0.081
	81.04-85	0.000	0.026
	85.01-90	0.027	0.082
	90.01-95	0.196	0.028
	95.01-100	0.000	0.030
	100.01-105	0.135	0.000
	105.01-110	0.000	0.000
	110.01-115	**0.237**	**0.142**
	115.01-120	0.194	0.000

Table A-5. I-215 3-Year (2002-2004) Crash Rate Analysis

	Crash Rate per Million Vehicle-Miles Traveled		
	Milepost	**Inside Lanes**	**Outside Lanes**
Urban	0-5	0.047	0.047
	5.01-10	0.015	0.024
	10.01-15	0.029	0.015
	15.01-20	0.025	0.008
	20.01-25	0.032	0.052
	25.01-30	0.047	0.031

Table A-6. U.S. 89 3-Year (2002-2004) Crash Rate Analysis

	Crash Rate per Million Vehicle-Miles Traveled		
	Milepost	**Northbound**	**Southbound**
Rural	0-5	0.000	0.133
	5.01-10	**0.350**	0.350
	10.01-15	0.000	0.176
	15.01-20	0.176	0.176
	20.01-25	0.000	0.176
	25.01-30	0.176	0.176
	30.01-35	0.000	0.176
	35.01-40	0.176	0.000
	40.01-45	0.176	0.176
	45.01-50	0.000	0.176
	50.01-55	0.175	0.000
	55.01-60	**0.473**	0.158
	60.01-65	0.000	0.074
	65.01-70	0.000	0.098
	70.01-75	0.101	0.406
	75.01-80	0.000	0.101
	80.01-85	0.000	0.308
	85.01-90	0.173	0.000
	90.01-95	0.000	**0.854**
	95.01-100	0.285	0.285
	100.01-105	0.000	0.000
	105.01-110	**0.552**	0.000
	110.01-115	0.000	0.254
	115.01-120	0.000	**0.606**
	120.01-125	0.000	**0.523**
	125.01-130	0.000	0.000
	130.01-135	0.180	0.090
	135.01-140	0.000	0.151
	140.01-145	**0.485**	**0.485**
	145.01-150	0.000	0.000
	150.01-155	0.292	0.000
	155.01-160	0.000	0.000
	160.01-165	0.213	0.000
	165.01-170	0.000	0.000
	170.01-175	0.290	0.290
	175.01-180	0.000	0.000
	180.01-185	0.257	**0.515**
	185.01-191.74	0.257	0.000
	225.36-230	0.049	0.000
	230.01-235	0.000	0.093
	235.01-240	0.101	0.000
	240.01-245	0.000	0.000
	245.01-250	0.000	0.000

Table A-6. Continued

	Milepost	Northbound	Southbound
Rural	250.01-255	0.096	0.000
	255.01-260	0.060	0.000
	260.01-265	0.175	0.233
	265.01-270	0.085	0.085
	270.01-275	0.266	0.000
	275.01-280	0.084	0.084
	280.01-285	0.000	0.080
	285.01-290	0.000	0.405
	290.01-295	0.000	0.274
	295.01-300	0.000	0.151
	300.01-305	0.152	0.000
	305.01-312.8	0.304	0.304
	322.28-325	0.000	0.058
Urban	325.01-330	**0.116**	**0.116**
	330.01-335	0.068	0.068
	335.01-340	0.041	0.020
	340.01-345	0.047	0.028
	345.01-353	0.035	**0.088**
	362.01-370	0.044	0.058
	370.01-375	**0.104**	0.013
	375.01-380	0.014	0.068
	380.01-385	0.041	0.010
	385.01-389.5	0.013	0.039
	395.6-400	0.011	0.000
	400.01-405	0.046	0.011
	405.01-410	0.029	0.029
	410.01-415	0.013	0.052
	415.01-420	0.041	0.014
	420.01-425	0.031	0.031
	425.01-430	0.031	0.031
	430.01-435	0.041	0.021
	435.01-440	0.000	0.000
	440.01-445	0.000	0.000
	445.01-450	0.000	0.000
	450.01-455	0.000	0.000
	455.01-460	0.000	0.000
	460.01-465	0.029	0.059
	465.01-470	0.052	0.052
	470.01-475	0.069	0.000
	475.01-480	0.000	0.080
	480.01-485	0.000	0.000
Rural	485.01-490	0.000	0.000
	490.01-495	0.000	0.000
	495.01-500	0.160	0.000
	500.01-503	0.000	0.000

Table A-7. U.S. 91 3-Year (2002-2004) Crash Rate Analysis

	Crash Rate per Million Vehicle-Miles Traveled		
	Milepost	**Northbound**	**Southbound**
Rural	0-5	0.020	0.020
	5.01-10	0.047	0.023
	10.01-15	0.024	0.000
	15.01-20	0.140	0.047
	20.01-25	**0.284**	**0.122**
	25.01-30	0.076	0.022
	30.01-35	0.055	0.055
	35.01-40	0.056	0.056
	40.01-45	0.082	0.041

Table A-8. S.R. 36 3-Year (2002-2004) Crash Rate Analysis

	Crash Rate per Million Vehicle-Miles Traveled		
	Milepost	**Northbound**	**Southbound**
Rural	0-5	**2.100**	0.000
	5.01-10	0.000	0.000
	10.01-15	0.976	0.000
	15.01-20	0.000	0.000
	20.01-25	0.482	0.000
	25.01-30	0.000	**0.401**
	30.01-35	0.401	0.000
	35.01-40	0.000	0.000
	40.01-45	0.000	0.000
	45.01-50	0.000	0.000
	50.01-55	0.030	0.030
	55.01-60	0.013	0.039
	60.01-66	0.015	0.089

Table A-9. I-15 5-Year (2000-2004) Crash Rate Analysis

	Crash Rate per Million Vehicle-Miles Traveled		
	Milepost	**Northbound**	**Southbound**
Rural	0-5	**0.293**	0.076
	5.01-10	0.059	0.018
	10.01-15	0.052	0.111
	15.01-20	0.055	0.154
	20.01-25	0.103	0.103
	25.01-30	0.038	**0.214**
	30.01-35	0.147	0.147
	35.01-40	0.150	0.075
	40.01-45	0.063	0.100
	45.01-50	0.013	0.050
	50.01-55	0.133	0.073
	55.01-60	0.072	0.024
	60.01-65	0.048	0.036
	65.01-70	0.150	0.088
	70.01-75	0.039	0.065
	75.01-80	0.101	0.029
	80.01-85	0.129	**0.287**
	85.01-90	0.159	0.188
	90.01-95	**0.374**	**0.216**
	95.01-100	0.139	0.056
	100.01-105	0.194	0.069
	105.01-110	0.071	0.071
	110.01-115	0.150	0.150
	115.01-120	0.087	**0.204**
	120.01-125	0.130	0.043
	125.01-130	0.143	0.086
	130.01-135	0.168	0.000
	135.01-140	0.220	0.040
	140.01-145	0.100	0.020
	145.01-150	0.020	0.101
	150.01-155	0.143	0.123
	155.01-160	0.099	0.079
	160.01-165	0.190	0.133
	165.01-170	0.146	0.146
	170.01-175	0.036	0.181
	175.01-180	0.058	0.038
	180.01-185	0.075	0.000
	185.01-190	0.111	**0.203**
	190.01-195	**0.422**	**0.211**
	195.01-200	**0.281**	**0.193**

Table A-9. Continued

	Milepost	Northbound	Southbound
Rural	200.01-205	0.123	0.123
	205.01-210	**0.268**	0.071
	210.01-215	0.234	0.054
	215.01-220	0.252	0.108
	220.01-225	0.200	0.100
	225.01-230	0.128	0.082
	230.01-235	0.039	0.077
	235.01-240	0.077	0.019
	240.01-245	0.057	0.028
	245.01-250	0.080	0.064
	250.01-255	0.022	0.044
Urban	255.01-260	0.019	**0.065**
	260.01-265	0.050	0.029
	265.01-270	0.032	0.044
	270.01-275	0.040	0.050
	275.01-280	0.040	0.042
	280.01-285	0.013	0.051
	285.01-290	0.029	0.023
	290.01-295	0.032	0.048
	295.01-300	0.031	0.022
	300.01-305	0.019	0.012
	305.01-310	0.021	0.021
	310.01-315	0.037	0.029
	315.01-320	0.034	0.026
	320.01-325	0.034	0.022
	325.01-330	**0.076**	0.015
	330.01-335	0.058	0.025
	335.01-340	0.047	0.016
	340.01-345	**0.067**	0.006
Rural	345.01-350	0.047	0.089
	350.01-355	0.045	0.055
	355.01-360	0.031	0.031
	360.01-365	0.065	0.020
	365.01-370	0.036	0.054
	370.01-375	0.046	0.046
	375.01-380	0.012	0.035
	380.01-385	0.033	0.083
	385.01-390	0.094	0.047
	390.01-395	0.024	0.097
	395.01-401	0.022	0.044

Table A-10. I-70 5-Year (2000-2004) Crash Rate Analysis

	Crash Rate per Million Vehicle-Miles Traveled		
	Milepost	**Eastbound**	**Westbound**
Rural	0-5	0.000	0.091
	5.01-10	0.000	0.000
	10.01-15	0.132	0.088
	15.01-20	0.389	0.086
	20.01-25	0.233	0.272
	25.01-30	0.412	0.190
	30.01-35	0.325	0.065
	35.01-40	0.149	0.112
	40.01-45	0.093	0.163
	45.01-50	0.290	0.156
	50.01-55	0.166	0.125
	55.01-60	0.111	0.111
	60.01-65	0.070	0.093
	65.01-70	0.071	0.071
	70.01-75	0.051	0.152
	75.01-80	0.140	0.035
	80.01-85	0.105	0.070
	85.01-90	0.112	0.299
	90.01-95	0.087	0.219
	95.01-100	0.000	**0.407**
	100.01-105	0.136	0.136
	105.01-110	0.181	0.045
	110.01-115	0.136	0.045
	115.01-120	0.181	0.045
	120.01-125	0.271	0.181
	125.01-130	0.226	**0.452**
	130.01-135	0.362	0.271
	135.01-140	**0.543**	0.045
	140.01-145	**0.452**	0.090
	145.01-150	0.137	0.182
	150.01-155	0.425	0.047
	155.01-160	**0.533**	0.038
	160.01-165	0.330	**0.371**
	165.01-170	0.100	0.133
	170.01-175	0.266	0.033
	175.01-180	0.133	0.166
	180.01-185	0.162	0.194
	185.01-190	0.161	0.129
	190.01-195	0.098	0.131
	195.01-200	0.065	0.229
	200.01-205	0.229	0.131
	205.01-210	0.132	0.132
	210.01-215	0.331	0.132
	215.01-220	0.238	0.136
	220.01-225	0.204	0.102
	225.01-232	0.399	0.050

Table A-11. I-80 5-Year (2000-2004) Crash Rate Analysis

	Crash Rate per Million Vehicle-Miles Traveled		
	Milepost	**Eastbound**	**Westbound**
Rural Area	0-5	0.000	0.030
	5.01-10	0.000	0.115
	10.01-15	0.086	0.115
	15.01-20	0.086	0.143
	20.01-25	0.029	**0.258**
	25.01-30	0.000	0.057
	30.01-35	0.172	**0.172**
	35.01-40	0.258	0.029
	40.01-45	0.228	0.142
	45.01-50	**0.339**	0.057
	50.01-55	**0.278**	0.056
	55.01-60	0.243	0.108
	60.01-65	0.239	0.080
	65.01-70	0.079	0.079
	70.01-75	**0.290**	0.132
	75.01-80	0.197	0.025
	80.01-85	0.115	0.092
	85.01-90	0.119	0.040
	90.01-95	0.035	0.018
	95.01-100	0.119	0.036
	100.01-105	0.097	0.079
	105.01-110	0.081	0.081
Urban Area	110.01-115	0.058	0.029
	115.01-120	0.000	0.012
	120.01-125	0.008	0.005
	125.01-130	0.026	0.031
Rural Area	130.01-135	0.031	0.026
	135.01-140	0.032	0.021
	140.01-145	0.051	0.011
	145.01-150	0.054	0.065
	150.01-155	0.077	0.031
	155.01-160	0.069	0.052
	160.01-165	0.053	0.035
	165.01-170	0.034	0.000
	170.01-175	0.016	0.033
	175.01-180	0.033	0.082
	180.01-185	0.097	0.097
	185.01-190	0.102	0.153
	190.01-197	0.250	0.067

Table A-12. I-84 5-Year (2000-2004) Crash Rate Analysis

	Crash Rate per Million Vehicle-Miles Traveled		
	Milepost	**Eastbound**	**Westbound**
Rural	0-5	0.034	0.034
	5.01-10	0.028	0.028
	10.01-15	0.101	0.101
	15.01-20	0.025	0.025
	20.01-25	0.024	0.072
	25.01-30	0.023	**0.117**
	30.01-35	0.000	0.000
	35.01-42	**0.209**	0.093
	81.04-85	0.017	0.033
	85.01-90	0.034	0.051
	90.01-95	0.134	0.050
	95.01-100	0.000	0.018
	100.01-105	0.079	0.059
	105.01-110	0.048	0.024
	110.01-115	0.134	0.107
	115.01-120	0.152	0.000

Table A-13. I-215 5-Year (2000-2004) Crash Rate Analysis

	Crash Rate per Million Vehicle-Miles Traveled		
	Milepost	**Inside Lanes**	**Outside Lanes**
Urban	0-5	0.042	0.042
	5.01-10	0.009	0.031
	10.01-15	0.029	0.029
	15.01-20	0.030	0.016
	20.01-25	0.029	0.040
	25.01-30	0.041	0.029

Table A-14. U.S. 89 5-Year (2000-2004) Crash Rate Analysis

	Crash Rate per Million Vehicle-Miles Traveled		
	Milepost	**Northbound**	**Southbound**
Rural	0-5	0.082	0.164
	5.01-10	0.210	0.315
	10.01-15	0.000	0.106
	15.01-20	**0.423**	0.211
	20.01-25	0.000	0.211
	25.01-30	0.106	0.211
	30.01-35	0.000	0.106
	35.01-40	0.211	0.106
	40.01-45	0.317	0.317
	45.01-50	0.106	0.211
	50.01-55	0.210	0.105
	55.01-60	**0.386**	0.096
	60.01-65	0.000	0.045
	65.01-70	0.064	0.064
	70.01-75	0.132	0.264
	75.01-80	0.000	0.066
	80.01-85	0.000	0.191
	85.01-90	0.101	0.000
	90.01-95	0.178	**0.711**
	95.01-100	**0.534**	0.178
	100.01-105	0.000	0.351
	105.01-110	**0.486**	0.000
	110.01-115	0.000	0.311
	115.01-120	0.000	**0.472**
	120.01-125	0.103	0.308
	125.01-130	0.000	0.000
	130.01-135	0.110	0.055
	135.01-140	0.092	0.184
	140.01-145	0.295	**0.443**
	145.01-150	0.000	0.177
	150.01-155	0.177	0.000
	155.01-160	0.000	0.000
	160.01-165	0.122	0.000
	165.01-170	0.000	0.000
	170.01-175	0.170	0.170
	175.01-180	0.000	0.000
	180.01-185	0.311	0.311
	185.01-191.74	**0.466**	0.000
	225.36-230	0.057	0.000
	230.01-235	0.000	0.055
	235.01-240	0.059	0.029
	240.01-245	0.055	0.055
	245.01-250	0.070	0.000

Table A-14. Continued

	Milepost	Northbound	Southbound
Rural	250.01-255	0.118	0.000
	255.01-260	0.037	0.037
	260.01-265	0.108	0.144
	265.01-270	0.052	0.052
	270.01-275	0.166	0.083
	275.01-280	0.107	0.107
	280.01-285	0.000	0.050
	285.01-290	0.000	0.251
	290.01-295	0.000	**0.422**
	295.01-300	0.000	0.179
	300.01-305	0.090	0.000
	305.01-312.78	0.270	0.180
	322.28-325	0.000	0.036
Urban	325.01-330	0.071	**0.071**
	330.01-335	0.062	**0.083**
	335.01-340	0.029	0.033
	340.01-345	0.051	0.029
	345.01-350	0.026	0.026
	350.01-355	0.000	0.064
	355.01-360	0.000	0.000
	360.01-365	0.011	0.011
	365.01-370	0.022	0.029
	370.01-375	**0.100**	0.036
	375.01-380	0.022	0.067
	380.01-385	0.025	0.006
	385.01-389.53	0.031	0.031
	395.59-400	0.020	0.027
	400.01-405	0.055	0.028
	405.01-410	0.018	0.036
	410.01-415	0.023	0.039
	415.01-420	0.033	0.017
	420.01-425	0.055	0.018
	425.01-430	0.038	0.019
	430.01-435	0.038	0.013
	435.01-440	0.000	0.000
	440.01-445	0.000	0.000
	445.01-450	0.000	0.000
	450.01-455	0.000	0.000
	455.01-460	0.000	0.000
	460.01-465	0.018	**0.072**
	465.01-470	0.064	0.032
Rural	470.01-475	0.046	0.046
	475.01-480	0.000	0.112
	480.01-485	0.000	0.000
	485.01-490	0.094	0.000
	490.01-495	0.103	0.000
	495.01-500	0.096	0.000
	500.01-503	0.000	0.138

Table A-15. U.S. 91 5-Year (2000-2004) Crash Rate Analysis

	Crash Rate per Million Vehicle-Miles Traveled		
	Milepost	**Northbound**	**Southbound**
Rural	0-5	0.026	0.013
	5.01-10	0.028	0.028
	10.01-15	0.029	0.029
	15.01-20	0.155	0.070
	20.01-25	**0.323**	**0.087**
	25.01-30	0.073	0.033
	30.01-35	0.085	0.042
	35.01-40	0.103	0.034
	40.01-45	0.127	0.025

Table A-16. S.R. 36 5-Year (2000-2004) Crash Rate Analysis

	Crash Rate per Million Vehicle-Miles Traveled		
	Milepost	**Northbound**	**Southbound**
Rural	0-5	**1.287**	0.000
	5.01-10	0.598	0.000
	10.01-15	0.590	0.000
	15.01-20	0.000	0.000
	20.01-25	0.364	0.000
	25.01-30	0.000	**0.316**
	30.01-35	0.316	**0.316**
	35.01-40	0.000	0.000
	40.01-45	0.000	0.000
	45.01-50	0.000	0.000
	50.01-55	0.036	0.036
	55.01-60	0.018	0.055
	60.01-66	0.029	0.077

Table A-17. Northbound I-15 13-Year (1992-2004) Crash Rate Analysis

		Crash Rate per Million Vehicle-Miles Traveled												
	Milepost	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Rural	0-5	0.09	0.00	0.15	0.00	0.20	0.19	0.12	0.24	0.24	0.28	0.32	0.26	0.36
	5.01-10	0.00	0.00	0.04	0.04	0.00	0.11	0.07	0.00	0.07	0.03	0.09	0.09	0.03
	10.01-15	0.00	0.05	0.00	0.14	0.00	0.00	0.00	0.04	0.04	0.00	0.06	0.03	0.12
	15.01-20	0.00	0.09	0.08	0.08	0.07	0.00	0.00	0.13	0.06	0.06	0.05	0.05	0.05
	20.01-25	0.34	0.00	**0.59**	0.10	0.18	0.16	0.23	0.00	0.14	0.27	0.06	0.00	0.06
	25.01-30	**0.45**	0.21	0.10	0.09	0.09	0.16	0.30	0.00	0.00	0.07	0.06	0.00	0.06
	30.01-35	0.00	0.21	0.19	0.09	0.00	0.31	0.07	0.14	0.00	0.19	0.13	0.29	0.11
	35.01-40	0.11	0.00	0.00	0.28	0.17	0.08	0.15	0.28	0.14	0.07	0.25	0.23	0.06
	40.01-45	0.00	0.31	**0.48**	0.09	0.26	0.39	0.22	0.29	0.07	0.00	0.06	0.06	0.11
	45.01-50	0.00	0.21	0.10	0.09	0.09	0.16	0.07	0.21	0.00	0.00	0.00	0.06	0.00
	50.01-55	0.00	0.20	0.19	0.00	0.25	0.00	0.07	0.07	0.20	0.06	0.24	0.12	0.06
	55.01-60	0.00	0.00	0.21	0.00	0.00	0.00	0.16	0.15	0.00	0.07	0.16	0.05	0.05
	60.01-65	0.22	0.00	0.10	0.00	0.17	0.00	0.15	0.00	0.00	0.13	0.00	0.11	0.00
	65.01-70	0.00	0.33	0.00	0.00	0.09	0.00	0.07	0.21	0.07	0.07	0.28	0.19	0.12
	70.01-75	0.35	**0.43**	**0.71**	**0.58**	0.18	0.25	0.16	0.00	0.07	0.00	0.06	0.00	0.06
	75.01-80	0.38	0.23	0.11	0.10	0.20	**0.63**	0.17	0.00	0.00	0.15	0.00	0.20	0.14
	80.01-85	0.12	0.33	0.21	0.10	0.29	0.09	**0.42**	0.08	0.00	0.08	0.14	0.07	0.35
	85.01-90	**0.47**	0.00	0.21	0.10	0.10	0.37	0.17	0.24	0.00	0.00	0.14	**0.47**	0.14
	90.01-95	0.12	0.33	**0.42**	**0.40**	**0.49**	**0.92**	0.26	0.32	0.32	0.30	**0.49**	**0.47**	0.27
	95.01-100	**0.55**	0.10	0.10	0.19	0.00	0.09	0.24	**0.46**	0.30	0.07	0.07	0.20	0.07
	100.01-105	0.33	0.00	0.20	0.29	0.18	**0.69**	0.00	**0.76**	0.00	0.21	0.35	0.13	0.26
	105.01-110	0.11	0.11	**0.41**	**0.40**	0.10	0.00	0.25	0.16	0.23	0.15	0.00	0.00	0.00
	110.01-115	0.13	0.12	0.11	0.32	0.21	0.10	0.09	0.00	0.33	0.08	0.14	0.07	0.14
	115.01-120	0.12	0.11	0.11	0.10	0.00	0.09	0.00	0.25	0.00	0.00	0.00	0.07	0.34
	120.01-125	0.37	**0.46**	0.11	0.00	0.00	0.00	0.26	0.32	0.00	0.08	0.14	0.14	0.28
	125.01-130	0.00	0.11	0.32	0.21	0.20	0.00	0.09	0.16	0.08	0.15	0.20	0.14	0.14
	130.01-135	0.14	0.00	0.25	0.12	**0.68**	0.21	0.30	0.38	0.37	0.26	0.16	0.00	0.08
	135.01-140	0.16	**0.60**	0.00	**0.40**	**0.51**	**0.48**	0.11	0.32	0.11	0.31	0.28	0.29	0.10
	140.01-145	0.32	0.30	0.14	0.14	0.00	0.12	0.11	0.22	0.11	0.21	0.09	0.10	0.00
	145.01-150	0.00	0.15	0.14	0.14	0.13	0.00	0.34	0.22	0.00	0.00	0.00	0.10	0.00
	150.01-155	0.16	**0.45**	0.29	0.00	0.26	0.00	0.11	**0.54**	0.22	0.00	0.20	0.20	0.10
	155.01-160	0.00	0.14	0.13	0.00	0.36	0.34	**0.43**	0.00	0.22	0.10	0.09	0.00	0.10
	160.01-165	**0.56**	0.39	0.12	0.12	0.23	**0.64**	0.10	0.19	0.10	0.29	0.27	0.28	0.00
	165.01-170	0.30	0.14	0.00	0.13	0.12	0.11	0.11	0.10	0.20	0.00	0.00	0.27	0.26
	170.01-175	**0.61**	0.14	0.14	0.13	**0.49**	0.23	0.11	0.10	0.00	0.00	0.18	0.00	0.00
	175.01-180	**0.50**	0.16	0.15	0.14	0.27	0.00	0.00	0.11	0.00	0.10	0.19	0.00	0.00
	180.01-185	0.16	0.29	**0.55**	0.13	0.00	0.23	0.11	0.21	0.10	0.00	0.18	0.09	0.00
	185.01-190	0.30	0.00	0.27	0.00	0.36	0.34	0.21	0.00	0.00	0.10	0.09	0.27	0.09
	190.01-195	**0.43**	0.27	0.25	0.00	0.23	**0.53**	0.30	0.39	**0.47**	0.36	**0.52**	0.17	**0.58**
	195.01-200	**0.71**	**0.40**	**0.62**	0.24	**0.45**	**0.43**	0.00	0.29	0.00	0.00	0.35	**0.69**	0.33

Table A-17. Continued

Rural	200.01-205	0.28	**0.40**	0.12	0.35	0.11	0.11	0.20	0.10	0.09	0.18	0.09	0.09	0.17
	205.01-210	0.15	**0.42**	0.13	0.12	0.00	0.11	0.10	**0.40**	0.10	0.37	0.17	**0.60**	0.09
	210.01-215	0.15	0.14	0.13	0.37	0.12	**0.78**	**0.42**	0.10	**0.59**	0.38	0.09	0.09	0.09
	215.01-220	0.00	**0.43**	0.39	0.12	0.35	**0.67**	0.11	0.31	0.20	**0.47**	0.09	0.09	**0.43**
	220.01-225	0.14	0.00	0.12	0.35	0.23	0.32	0.20	0.19	**0.66**	0.00	0.16	0.00	0.24
	225.01-230	**0.43**	0.00	0.09	0.00	0.00	0.08	**0.53**	0.15	0.07	0.12	0.11	0.22	0.11
	230.01-235	0.00	0.09	0.08	0.15	0.22	0.14	0.00	0.06	0.06	0.05	0.00	0.09	0.00
	235.01-240	0.09	0.18	0.00	0.30	0.14	0.07	0.13	0.06	0.06	0.05	0.00	0.18	0.09
	240.01-245	0.27	**0.43**	0.24	0.15	0.36	0.20	0.00	0.00	0.06	0.10	0.04	0.00	0.09
	245.01-250	0.08	0.07	0.13	0.18	0.17	0.05	0.00	0.09	0.17	0.12	0.00	0.12	0.00
	250.01-255	0.21	0.20	0.05	0.04	0.12	0.04	0.10	0.00	0.00	0.03	0.03	0.03	0.03
Urban	255.01-260	0.00	**0.17**	**0.12**	0.08	**0.11**	0.00	0.02	0.04	0.02	0.02	0.02	0.00	0.04
	260.01-265	0.02	0.02	0.02	0.06	**0.09**	0.02	0.05	0.03	0.03	0.06	0.05	0.05	0.06
	265.01-270	0.02	0.02	0.09	0.06	0.04	0.04	0.05	0.06	0.05	0.00	0.04	0.04	0.02
	270.01-275	0.09	0.08	0.03	0.04	0.08	0.04	0.04	0.01	0.02	0.04	0.07	0.03	0.04
	275.01-280	0.04	0.04	**0.10**	0.08	0.07	0.06	0.03	0.07	0.07	0.03	0.03	0.04	0.03
	280.01-285	**0.10**	0.00	0.08	0.00	0.07	0.04	0.06	0.03	0.02	0.01	0.00	0.02	0.01
	285.01-290	0.04	0.03	0.05	0.04	0.04	0.01	0.07	0.04	0.04	0.00	0.03	0.04	0.04
	290.01-295	0.01	0.04	0.04	0.07	0.08	**0.09**	0.04	0.07	0.01	0.04	0.02	0.04	0.05
	295.01-300	0.01	0.01	0.02	0.05	0.01	0.03	0.03	0.03	0.03	0.02	0.04	0.04	0.02
	300.01-305	0.00	0.04	0.01	0.04	0.02	0.03	0.05	0.05	0.02	0.01	0.05	0.01	0.01
	305.01-310	0.01	0.01	0.04	0.02	0.03	0.01	0.02	0.02	0.04	0.02	0.02	0.01	0.02
	310.01-315	0.02	0.04	0.04	0.01	0.01	0.06	0.01	0.03	0.03	0.03	0.04	0.06	0.03
	315.01-320	0.00	0.06	0.00	0.02	0.04	0.02	0.02	0.05	0.04	0.03	0.06	0.02	0.02
	320.01-325	0.06	0.01	0.01	0.04	0.06	0.00	0.01	0.01	0.04	0.06	0.02	0.04	0.02
	325.01-330	**0.12**	0.07	0.03	**0.11**	0.06	0.05	0.00	0.09	0.04	**0.18**	**0.09**	0.03	0.05
	330.01-335	0.08	0.05	0.08	0.02	0.06	0.08	0.04	0.00	0.08	0.05	0.04	0.08	0.03
	335.01-340	0.02	0.03	0.06	0.08	0.03	0.03	0.06	0.02	0.02	0.04	0.04	0.08	0.05
	340.01-345	0.00	0.06	0.07	0.05	0.05	0.02	0.05	0.03	0.04	0.03	0.06	**0.13**	0.07
Rural	345.01-350	0.13	0.09	0.08	0.12	0.00	0.00	0.09	0.02	0.04	0.06	0.02	0.04	0.07
	350.01-355	0.04	0.04	0.13	0.12	0.00	0.03	0.00	0.00	0.00	0.10	0.02	0.00	0.11
	355.01-360	0.00	0.04	0.07	0.03	0.09	0.09	0.06	0.05	0.08	0.03	0.02	0.03	0.00
	360.01-365	0.00	0.00	0.05	0.13	0.04	0.08	0.04	0.11	0.03	0.03	0.06	0.13	0.07
	365.01-370	0.00	0.00	0.06	0.06	0.11	0.00	0.00	0.05	0.00	0.09	0.04	0.00	0.05
	370.01-375	0.00	0.00	0.07	0.06	0.06	0.17	0.11	0.00	0.09	0.05	0.00	0.00	0.10
	375.01-380	0.09	0.09	0.08	0.07	0.07	0.21	0.00	0.00	0.06	0.00	0.00	0.00	0.00
	380.01-385	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.08	0.00	0.08	0.00
	385.01-390	0.00	0.00	0.00	0.29	0.00	0.13	0.13	0.00	0.00	0.12	0.12	0.23	0.00
	390.01-395	0.21	0.00	0.16	0.00	0.15	0.00	0.00	0.13	0.00	0.00	0.12	0.00	0.00
	395.01-400.59	0.00	0.00	0.29	0.00	0.13	0.00	0.12	0.00	0.00	0.11	0.00	0.00	0.00

Table A-18. Southbound I-15 13-Year (1992-2004) Crash Rate Analysis

		Crash Rate per Million Vehicle-Miles Traveled												
	Milepost	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Rural	0-5	0.00	0.00	0.15	0.00	0.00	0.26	0.12	0.06	0.00	0.11	0.21	0.00	0.05
	5.01-10	0.00	0.00	0.00	0.04	0.00	0.07	0.03	0.10	0.03	0.00	0.00	0.03	0.03
	10.01-15	0.05	0.10	0.15	0.28	0.22	0.04	0.12	0.04	0.08	0.20	0.06	0.12	0.09
	15.01-20	0.19	0.18	**0.42**	0.16	0.15	0.07	0.00	0.19	0.06	0.29	0.05	0.21	0.15
	20.01-25	0.11	**0.31**	**0.49**	**0.38**	**0.44**	0.08	0.15	0.15	0.00	0.20	0.19	0.12	0.00
	25.01-30	0.11	0.21	0.10	0.09	0.09	0.08	0.15	0.22	0.21	**0.33**	0.26	0.11	0.18
	30.01-35	0.11	0.00	**0.48**	0.18	0.00	0.00	0.15	0.14	0.00	0.13	0.13	0.23	0.22
	35.01-40	0.00	0.10	0.10	0.09	0.26	0.00	0.07	0.21	0.14	0.07	0.13	0.06	0.00
	40.01-45	0.00	0.21	0.19	0.00	0.09	0.16	0.07	**0.36**	0.07	0.20	0.00	0.12	0.11
	45.01-50	0.11	0.10	0.19	0.09	0.00	0.08	0.07	0.29	0.00	0.00	0.06	0.06	0.12
	50.01-55	0.11	0.00	0.00	0.00	0.08	0.00	0.14	0.00	0.00	0.06	0.12	0.06	0.11
	55.01-60	0.00	0.00	0.00	0.00	0.18	0.00	0.08	0.00	0.00	0.00	0.05	0.00	0.05
	60.01-65	0.11	0.22	0.10	0.19	0.26	0.00	0.08	0.07	0.07	0.07	0.00	0.06	0.00
	65.01-70	0.11	**0.44**	0.19	0.09	0.26	0.23	0.15	0.07	0.07	0.00	0.22	0.06	0.06
	70.01-75	**0.46**	**0.65**	0.10	0.10	**0.72**	**0.49**	0.23	0.15	0.00	0.07	0.06	0.12	0.06
	75.01-80	0.13	**0.47**	**0.44**	0.10	0.20	0.27	0.17	0.08	0.00	0.08	0.07	0.00	0.00
	80.01-85	0.24	**0.45**	**0.32**	0.20	**0.29**	**0.36**	**0.34**	0.08	**0.40**	**0.30**	**0.35**	0.20	0.21
	85.01-90	0.24	0.00	**0.64**	**0.51**	**0.29**	0.18	0.17	0.08	0.00	**0.61**	0.00	0.07	0.28
	90.01-95	0.12	0.22	0.21	0.20	**0.59**	0.09	0.17	**0.32**	0.16	0.23	0.21	0.20	0.27
	95.01-100	**0.33**	0.00	0.10	0.29	0.00	0.09	0.24	0.15	0.00	0.07	0.07	0.13	0.00
	100.01-105	0.22	0.00	0.00	0.00	0.00	0.09	0.00	0.15	0.00	0.07	0.00	0.20	0.07
	105.01-110	0.23	0.11	0.00	0.00	0.00	0.00	0.00	0.08	0.16	0.00	0.07	0.07	0.07
	110.01-115	0.00	**0.36**	0.00	0.00	0.00	0.10	0.09	0.26	0.08	0.16	0.29	0.15	0.07
	115.01-120	0.00	0.00	0.22	0.00	**0.40**	0.00	0.00	**0.33**	0.16	**0.30**	0.14	0.21	0.21
	120.01-125	0.00	0.00	0.00	0.20	0.10	0.09	0.26	0.24	0.08	0.15	0.00	0.00	0.00
	125.01-130	0.00	0.11	0.00	0.10	0.00	0.18	0.00	0.00	0.08	0.08	0.27	0.00	0.00
	130.01-135	0.14	0.26	0.00	0.12	0.23	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00
	135.01-140	**0.31**	0.00	0.00	0.13	0.00	0.24	**0.45**	0.11	0.11	0.10	0.00	0.00	0.00
	140.01-145	**0.32**	0.00	**0.43**	0.00	0.13	0.12	0.11	**0.32**	0.11	0.00	0.00	0.00	0.00
	145.01-150	0.00	0.00	0.14	0.00	0.13	0.00	0.11	**0.32**	0.00	0.00	**0.29**	0.10	0.10
	150.01-155	0.00	**0.30**	0.14	0.00	0.13	0.12	0.23	0.11	0.11	0.00	0.20	0.10	0.19
	155.01-160	0.15	0.00	0.13	0.00	0.12	0.00	0.11	0.10	0.00	0.10	0.09	0.00	0.19
	160.01-165	0.14	0.13	0.12	0.12	0.11	0.00	0.20	0.09	0.21	0.19	0.09	0.09	0.09
	165.01-170	0.15	0.00	0.27	0.25	0.00	0.11	0.21	0.00	0.00	0.28	0.09	0.18	0.17
	170.01-175	0.15	0.00	**0.41**	0.00	0.00	0.23	0.00	0.21	0.20	0.09	0.27	0.18	0.17
	175.01-180	**0.50**	0.16	0.15	0.00	0.13	0.13	0.00	**0.33**	0.00	0.00	0.09	0.00	0.09
	180.01-185	0.16	**0.29**	0.14	0.13	0.00	0.12	0.00	0.11	0.00	0.00	0.00	0.00	0.00
	185.01-190	0.15	0.00	0.00	0.00	**0.36**	0.00	0.11	0.00	0.10	0.10	**0.45**	0.18	0.17
	190.01-195	**0.86**	**0.40**	**0.37**	0.00	0.23	**0.43**	0.00	0.19	0.19	0.18	**0.35**	0.09	0.25
	195.01-200	0.14	**1.07**	0.12	0.24	**0.34**	0.21	0.10	0.19	**0.38**	0.00	0.17	0.00	**0.41**

Table A-18. Continued

Rural	200.01-205	0.00	0.13	**0.74**	0.12	**0.34**	**0.32**	0.00	0.29	**0.38**	0.09	0.09	0.00	0.08
	205.01-210	0.15	0.28	0.26	0.00	0.23	0.11	0.10	**0.30**	0.00	0.00	0.00	**0.34**	0.00
	210.01-215	0.15	**0.43**	0.13	0.00	0.00	0.00	0.11	**0.51**	0.10	0.00	0.00	0.09	0.09
	215.01-220	0.00	0.29	0.26	0.00	0.00	0.00	0.00	**0.61**	0.00	0.19	0.26	0.09	0.00
	220.01-225	0.14	0.27	0.00	0.12	0.11	0.00	**0.30**	0.00	0.00	0.08	0.08	0.24	0.08
	225.01-230	0.00	0.21	0.09	**0.35**	0.00	0.08	0.00	0.07	0.07	0.18	0.11	0.00	0.06
	230.01-235	0.09	0.18	0.00	0.00	0.07	0.07	0.19	**0.31**	0.06	0.10	0.05	0.14	0.05
	235.01-240	0.09	0.09	0.08	0.07	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.04
	240.01-245	0.00	0.09	0.16	0.22	0.07	0.20	0.06	0.06	0.00	0.10	0.00	0.04	0.00
	245.01-250	0.00	0.00	0.07	0.06	0.11	0.00	0.14	0.09	0.09	0.12	0.12	0.00	0.00
	250.01-255	0.05	0.00	0.00	0.13	0.00	0.11	0.10	0.06	0.06	0.03	0.06	0.05	0.03
Urban	255.01-260	0.00	0.03	**0.09**	0.06	0.00	0.02	0.05	0.02	0.04	**0.10**	0.06	0.04	**0.09**
	260.01-265	0.07	0.00	0.04	0.00	0.02	0.05	0.03	0.01	0.01	0.04	0.01	0.02	0.05
	265.01-270	0.06	**0.09**	0.09	**0.09**	**0.10**	**0.10**	**0.09**	0.04	0.06	0.01	0.04	**0.10**	0.00
	270.01-275	0.05	**0.10**	**0.11**	**0.11**	0.08	**0.14**	0.02	0.03	0.04	0.08	0.02	0.05	0.06
	275.01-280	**0.10**	**0.15**	0.08	0.03	0.06	0.06	0.07	0.07	0.04	0.06	0.05	0.01	0.06
	280.01-285	**0.10**	**0.22**	**0.13**	**0.12**	0.06	**0.15**	0.07	**0.10**	0.07	0.03	0.08	0.02	0.05
	285.01-290	0.04	0.03	0.05	0.01	0.04	0.01	0.00	0.02	0.02	0.00	0.04	0.04	0.02
	290.01-295	0.07	0.04	0.01	0.06	0.05	0.02	0.01	0.02	0.03	0.07	0.06	0.03	0.04
	295.01-300	0.01	0.04	0.02	0.04	0.01	0.03	0.05	0.00	0.02	0.03	0.02	0.00	0.04
	300.01-305	0.02	0.03	0.02	0.01	0.03	0.01	0.02	0.00	0.02	0.01	0.02	0.01	0.01
	305.01-310	0.02	0.02	0.04	0.01	0.04	0.02	0.00	0.00	0.07	0.02	0.01	0.01	0.03
	310.01-315	0.05	0.02	0.03	0.00	0.03	0.06	0.00	0.03	0.03	0.04	0.03	0.04	0.02
	315.01-320	0.03	0.05	0.04	0.02	0.01	0.06	0.01	0.03	0.05	0.02	0.00	0.03	0.03
	320.01-325	0.06	0.04	0.01	0.01	0.00	0.02	0.02	0.02	0.03	0.01	0.03	0.01	0.04
	325.01-330	0.02	0.02	0.03	0.02	0.05	0.05	0.04	0.01	0.01	0.01	0.01	0.01	0.02
	330.01-335	0.04	0.05	0.03	0.06	0.00	0.02	0.01	0.06	0.06	0.05	0.01	0.00	0.01
	335.01-340	0.03	0.05	0.03	0.00	0.00	0.01	0.00	0.00	0.03	0.02	0.00	0.01	0.01
	340.01-345	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.00	0.00	0.00	0.01	0.00	0.01
Rural	345.01-350	0.00	0.03	0.03	0.00	0.00	0.02	0.05	0.15	0.17	0.10	0.06	0.04	0.07
	350.01-355	0.04	0.00	0.00	0.03	0.15	0.06	0.06	0.16	0.05	0.10	0.07	0.05	0.00
	355.01-360	0.04	0.04	0.00	0.06	0.06	0.06	0.03	0.00	0.08	0.00	0.02	0.03	0.03
	360.01-365	0.00	0.00	0.14	0.13	0.04	0.00	0.04	0.00	0.07	0.00	0.00	0.00	0.03
	365.01-370	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.05	0.09	0.09	0.00	0.05
	370.01-375	0.00	0.00	0.07	0.00	0.11	0.11	0.11	0.05	0.05	0.00	0.09	0.05	0.05
	375.01-380	0.00	0.09	0.00	0.07	0.14	0.00	0.07	0.19	0.06	0.06	0.06	0.00	0.00
	380.01-385	0.13	0.00	0.00	0.00	0.10	0.10	0.10	0.09	0.17	0.00	0.16	0.08	0.00
	385.01-390	0.00	0.00	0.00	0.15	0.00	0.13	0.13	0.00	0.00	0.00	0.12	0.12	0.00
	390.01-395	0.00	0.18	0.00	0.15	0.15	0.14	0.00	0.00	0.00	0.12	0.00	0.24	0.12
	395.01-400.59	**0.36**	0.00	0.29	0.00	0.00	0.00	0.12	0.00	0.12	0.00	0.00	0.00	0.11

Table A-19. Eastbound I-70 13-Year (1992-2004) Crash Rate Analysis

		Crash Rate per Million Vehicle-Miles Traveled												
	Milepost	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Rural	0-5	0.36	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5.01-10	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	10.01-15	0.34	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.44	0.00
	15.01-20	**0.65**	0.31	0.32	0.31	0.29	0.27	0.00	0.23	0.22	0.43	**0.64**	0.44	0.21
	20.01-25	**0.58**	**0.55**	0.27	0.00	0.25	0.00	0.21	0.41	0.39	0.19	0.19	0.40	0.00
	25.01-30	0.25	0.47	**0.66**	0.00	**0.60**	0.37	0.35	0.33	0.16	0.46	0.15	**0.64**	**0.67**
	30.01-35	0.00	0.00	0.42	0.00	0.43	0.40	0.37	0.00	0.34	0.00	0.31	0.50	0.48
	35.01-40	0.00	0.28	0.51	0.00	0.00	0.47	0.22	0.21	0.20	0.00	0.00	0.19	0.35
	40.01-45	0.21	**0.57**	0.18	0.34	0.00	0.15	0.14	0.00	0.12	0.12	0.23	0.00	0.00
	45.01-50	0.20	0.00	0.00	**0.65**	0.16	0.00	0.14	0.00	0.12	0.11	**0.54**	0.45	0.21
	50.01-55	0.19	0.17	0.00	0.15	0.00	0.14	0.26	0.24	0.11	0.11	0.20	0.10	0.29
	55.01-60	0.00	0.00	0.00	0.00	0.16	0.00	0.14	0.13	0.12	0.12	0.22	0.11	0.00
	60.01-65	0.21	0.19	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.11	0.00	0.11
	65.01-70	0.00	0.00	0.36	0.00	0.00	0.31	0.00	0.00	0.00	0.12	0.00	0.12	0.11
	70.01-75	0.23	0.00	0.39	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00
	75.01-80	0.32	0.29	**0.81**	0.26	0.49	0.23	0.21	0.00	0.37	0.18	0.00	0.17	0.00
	80.01-85	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.17	0.17	0.17
	85.01-90	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.38	0.17
	90.01-95	0.00	0.00	0.00	**0.66**	0.32	0.00	0.00	0.50	0.00	0.23	0.00	0.00	0.20
	95.01-100	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	100.01-105	0.00	0.00	0.00	0.00	0.33	0.31	0.00	0.26	0.00	0.24	0.22	0.22	0.00
	105.01-110	0.00	0.00	0.00	0.35	0.00	**0.92**	0.00	0.00	0.00	0.24	0.22	0.22	0.21
	110.01-115	0.00	0.00	0.35	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.42
	115.01-120	0.00	0.37	0.35	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.22	0.21
	120.01-125	0.00	0.00	0.35	0.00	0.33	0.00	0.00	0.00	0.25	0.24	0.22	0.44	0.21
	125.01-130	0.40	0.37	0.00	0.35	**1.31**	0.31	0.28	0.00	0.00	0.48	0.22	0.00	0.42
	130.01-135	0.40	0.37	0.00	0.00	0.00	0.00	**0.87**	0.26	0.25	**0.71**	0.00	0.22	**0.64**
	135.01-140	0.40	**0.74**	0.00	0.35	0.00	**0.63**	0.00	**0.80**	**0.74**	0.47	0.43	0.44	**0.64**
	140.01-145	0.00	0.00	0.35	**0.70**	**0.67**	0.31	0.29	0.53	0.25	**0.95**	0.22	0.00	**0.85**
	145.01-150	0.39	0.36	0.34	0.00	0.00	0.31	0.00	0.26	0.00	0.24	0.00	0.22	0.22
	150.01-155	0.34	0.30	0.31	**1.27**	0.31	0.29	0.27	0.00	0.25	0.47	0.45	0.23	**0.73**
	155.01-160	**0.54**	0.00	0.25	0.00	0.25	0.00	0.43	0.41	0.20	**0.56**	**0.55**	**0.76**	**0.58**
	160.01-165	0.00	0.00	0.28	0.29	0.00	0.00	0.50	0.23	0.00	0.21	**0.65**	0.37	0.39
	165.01-170	0.22	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.16	0.16	0.17	0.00	0.00
	170.01-175	0.00	0.00	0.40	0.00	0.41	0.00	0.00	0.00	0.33	0.16	0.34	0.17	0.35
	175.01-180	0.00	0.00	0.20	0.20	0.41	0.00	0.00	0.00	0.16	0.00	0.34	0.17	0.00
	180.01-185	0.23	0.21	0.00	0.40	0.20	0.00	0.18	0.00	0.00	0.00	0.48	0.16	0.17
	185.01-190	0.00	0.00	0.00	0.00	0.00	0.20	0.18	0.34	0.33	0.32	0.00	0.16	0.00
	190.01-195	0.24	0.45	0.21	0.00	0.00	0.40	0.37	0.00	0.00	0.32	0.00	0.17	0.00
	195.01-200	0.00	0.45	0.21	0.20	0.20	0.00	0.18	0.00	0.33	0.00	0.00	0.00	0.00
	200.01-205	0.00	0.45	0.21	**0.61**	0.20	0.20	0.18	0.17	0.33	0.32	0.30	0.17	0.00
	205.01-210	0.00	0.45	**0.86**	**0.61**	0.21	0.00	0.19	0.00	0.00	0.16	0.16	0.33	0.00
	210.01-215	0.48	0.00	0.43	0.00	0.00	0.00	0.00	0.17	0.34	0.17	**0.78**	0.17	0.17
	215.01-220	0.00	0.46	0.22	0.42	0.21	0.41	0.00	0.18	0.00	0.34	0.48	0.35	0.00
	220.01-225	0.48	0.23	0.22	0.21	0.43	0.41	0.00	0.35	0.18	0.17	0.00	0.35	0.35
	225.01-232	0.13	0.13	0.24	0.12	0.24	0.23	0.00	0.00	0.00	0.37	0.43	0.47	0.20

Table A-20. Westbound I-70 13-Year (1992-2004) Crash Rate Analysis

		Crash Rate per Million Vehicle-Miles Traveled												
	Milepost	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Rural	0-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.22
	5.01-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	10.01-15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.22
	15.01-20	0.00	0.31	0.00	**1.22**	0.00	0.00	0.00	0.00	0.00	0.21	0.21	0.00	0.00
	20.01-25	0.00	0.28	**0.55**	0.00	0.25	0.00	0.00	0.00	0.19	0.00	**0.58**	0.20	0.39
	25.01-30	**0.50**	0.00	0.22	**0.42**	0.40	**0.56**	0.00	0.17	0.16	0.00	0.31	**0.48**	0.00
	30.01-35	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.18	0.17	0.00	0.16	0.00	0.00
	35.01-40	0.00	0.28	0.00	0.25	0.00	0.00	**0.67**	0.21	0.20	0.00	0.18	0.00	0.18
	40.01-45	0.21	**0.95**	0.18	0.00	0.33	0.15	0.29	0.26	0.25	0.12	0.11	0.35	0.00
	45.01-50	0.00	0.00	0.00	0.32	0.32	0.15	0.00	0.00	0.36	0.23	0.22	0.00	0.00
	50.01-55	0.00	0.34	0.00	0.15	0.15	0.00	0.00	0.00	0.11	0.11	0.20	0.20	0.00
	55.01-60	0.39	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.35	0.00	0.11	0.11
	60.01-65	0.00	0.00	0.36	0.00	0.00	0.15	0.00	0.26	0.00	0.00	0.11	0.11	0.22
	65.01-70	0.00	0.00	0.00	0.34	0.17	0.31	0.00	0.00	0.13	0.00	0.12	0.12	0.00
	70.01-75	0.00	0.21	0.00	0.00	0.18	0.17	0.00	0.00	0.27	0.13	0.37	0.00	0.00
	75.01-80	0.32	**0.57**	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00
	80.01-85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.00	0.00	0.00
	85.01-90	0.34	0.31	0.29	**0.55**	0.00	0.00	0.23	0.00	0.40	0.19	0.38	0.38	0.17
	90.01-95	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.24	0.23	0.21	0.21	0.20
	95.01-100	0.40	0.37	0.00	0.00	0.00	0.31	0.00	0.26	0.00	**0.48**	**0.87**	0.00	**0.64**
	100.01-105	0.00	0.00	0.00	0.35	0.33	0.00	0.00	**0.52**	0.00	0.00	0.22	0.22	0.21
	105.01-110	0.00	0.37	0.00	**0.69**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21
	110.01-115	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0.00
	115.01-120	0.40	0.00	0.35	0.00	0.00	0.00	0.28	0.00	0.25	0.00	0.00	0.00	0.00
	120.01-125	0.00	0.00	0.00	0.00	0.00	**0.92**	0.00	0.26	**0.49**	0.24	0.00	0.00	0.21
	125.01-130	0.40	0.37	0.00	0.00	0.00	0.31	0.00	0.26	0.00	**0.72**	**0.44**	**0.87**	0.21
	130.01-135	0.00	0.00	0.00	0.00	0.33	**0.62**	0.00	0.00	0.00	0.24	**0.87**	0.22	0.00
	135.01-140	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.22	0.00
	140.01-145	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.22	0.00	0.00
	145.01-150	0.00	0.36	0.00	0.00	0.00	0.31	0.29	0.26	0.00	0.24	0.00	0.22	**0.43**
	150.01-155	0.00	0.00	**0.62**	0.00	0.00	0.00	0.00	**0.51**	0.00	0.00	0.00	0.00	0.24
	155.01-160	0.27	0.00	0.00	0.00	0.25	0.00	0.00	0.41	0.00	0.00	0.00	0.19	0.00
	160.01-165	0.00	0.00	0.28	0.29	**0.86**	0.00	0.25	0.23	0.23	0.00	**0.43**	0.37	**0.77**
	165.01-170	0.00	0.00	0.20	0.00	0.21	0.19	0.18	0.00	0.33	0.16	0.00	0.17	0.00
	170.01-175	0.00	0.20	0.00	0.00	0.21	0.00	0.00	0.17	0.00	0.00	0.17	0.00	0.00
	175.01-180	**0.66**	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.33	0.16	0.00	0.17	0.17
	180.01-185	0.00	0.21	0.20	0.00	0.00	0.19	0.18	0.00	0.16	**0.47**	0.16	0.16	0.00
	185.01-190	**0.48**	0.23	0.00	0.00	0.00	0.00	0.00	0.17	0.16	0.16	0.15	0.00	0.17
	190.01-195	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.17	0.00	0.00	0.17	0.35
	195.01-200	0.00	**0.67**	0.00	0.20	0.20	0.00	0.00	0.17	0.17	**0.64**	0.15	0.00	0.17
	200.01-205	0.24	0.22	0.21	0.00	0.00	0.00	0.18	0.00	0.00	0.16	0.15	0.33	0.00
	205.01-210	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.17	0.00	0.16	0.33	0.00
	210.01-215	0.00	0.00	**0.43**	0.00	0.00	0.20	0.19	0.00	0.17	0.17	0.16	0.00	0.17
	215.01-220	0.00	0.00	0.00	**0.42**	0.00	0.21	0.00	0.36	0.00	**0.51**	0.00	0.00	0.18
	220.01-225	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.35	0.00
	225.01-232	0.00	0.13	0.00	0.12	0.24	0.12	0.21	0.00	0.10	0.09	0.00	0.00	0.00

Table A-21. Eastbound I-80 13-Year (1992-2004) Crash Rate Analysis

		Crash Rate per Million Vehicle-Miles Traveled												
	Milepost	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Rural Area	0-5	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5.01-10	0.00	0.00	0.00	0.00	0.00	0.15	0.14	0.00	0.00	0.00	0.00	0.00	0.00
	10.01-15	0.17	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.28	0.00	0.14
	15.01-20	0.17	0.34	0.16	0.15	0.00	0.00	0.00	0.14	0.00	0.14	0.28	0.00	0.00
	20.01-25	0.17	0.00	0.00	0.15	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.14
	25.01-30	0.34	**0.50**	0.16	0.00	0.32	0.00	0.29	**0.42**	0.00	0.00	0.00	0.00	0.00
	30.01-35	0.34	0.00	**0.64**	0.15	0.00	0.29	**0.43**	0.14	0.00	0.14	0.28	0.29	0.14
	35.01-40	**0.85**	**0.67**	0.00	0.00	0.32	0.00	0.14	0.00	0.00	0.14	**0.84**	0.15	0.14
	40.01-45	0.17	0.33	0.16	0.30	0.31	**0.87**	0.00	0.14	0.28	0.00	**0.56**	0.15	0.14
	45.01-50	0.33	**0.66**	0.00	**0.45**	0.16	**0.58**	0.00	**0.41**	0.27	**0.42**	**0.42**	0.29	0.29
	50.01-55	0.17	0.00	0.31	**0.45**	0.31	0.14	0.28	0.27	0.14	**0.55**	0.00	**0.71**	0.00
	55.01-60	0.00	**0.49**	0.30	**0.72**	**0.45**	0.14	**0.69**	0.27	0.27	0.14	0.14	**0.68**	0.00
	60.01-65	0.00	0.00	0.30	0.28	0.15	0.14	0.14	0.13	0.13	0.00	**0.53**	**0.40**	0.13
	65.01-70	0.16	0.00	0.15	0.00	0.30	**0.41**	0.13	0.13	0.00	0.13	0.13	0.00	0.13
	70.01-75	0.16	0.31	0.00	0.00	0.15	**0.55**	0.13	0.39	0.26	**0.39**	0.13	0.27	**0.40**
	75.01-80	**0.44**	**0.44**	0.14	0.13	**0.55**	0.26	0.39	**0.62**	0.25	0.38	0.00	0.00	0.37
	80.01-85	0.14	0.00	0.27	0.00	0.26	0.25	0.37	0.24	**0.48**	0.00	0.11	0.00	0.00
	85.01-90	0.13	**0.40**	**0.40**	0.12	0.13	0.12	0.00	0.00	0.11	0.10	0.09	0.19	0.10
	90.01-95	0.12	0.12	0.13	0.00	0.25	0.00	0.00	0.00	0.00	0.09	0.00	0.09	0.00
	95.01-100	0.34	0.17	0.26	0.25	0.00	0.22	0.21	0.21	0.26	0.06	0.11	0.17	0.00
	100.01-105	0.27	0.13	0.00	0.12	0.06	0.00	0.05	0.05	0.09	0.09	0.08	0.13	0.09
	105.01-110	0.15	0.07	0.00	0.07	0.06	0.06	0.11	0.06	0.16	0.00	0.05	0.10	0.11
Urban Area	110.01-115	**0.12**	**0.16**	0.00	0.05	**0.14**	0.05	**0.13**	0.08	0.04	0.04	0.10	0.03	0.07
	115.01-120	0.03	0.00	0.00	0.02	0.02	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	120.01-125	0.00	0.00	0.00	0.01	0.00	0.03	0.00	0.00	0.00	0.01	0.02	0.00	0.00
	125.01-130	0.00	**0.13**	0.09	0.00	0.00	0.00	0.03	0.06	0.00	0.07	0.04	0.00	0.02
Rural Area	130.01-135	0.07	0.03	0.00	0.03	0.00	0.00	0.00	0.06	0.00	0.03	0.05	0.03	0.05
	135.01-140	0.00	0.07	0.06	0.03	0.00	0.08	0.03	0.03	0.06	0.00	0.08	0.03	0.00
	140.01-145	0.04	0.04	0.04	0.07	0.00	0.00	0.06	0.00	0.06	0.06	0.05	0.03	0.05
	145.01-150	0.08	0.16	0.14	0.00	0.00	0.06	0.06	0.06	0.00	0.00	0.05	0.11	0.10
	150.01-155	0.11	0.00	0.29	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.08	0.15
	155.01-160	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.10	0.10	0.09	0.08	0.08	0.00
	160.01-165	0.00	0.00	0.23	0.00	0.00	0.10	0.00	0.00	0.00	0.09	0.00	0.09	0.09
	165.01-170	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.00
	170.01-175	0.00	0.00	0.00	0.10	0.10	0.00	0.09	0.09	0.00	0.00	0.00	0.00	0.08
	175.01-180	0.00	0.00	0.00	0.00	0.10	0.00	0.09	0.00	0.00	0.00	0.16	0.00	0.00
	180.01-185	0.12	0.22	0.00	0.10	0.00	0.00	0.00	0.08	0.08	0.00	0.23	0.08	0.08
	185.01-190	0.12	0.33	0.11	0.10	0.20	0.19	0.28	0.09	0.17	0.17	0.00	0.09	0.09
	190.01-197	0.00	0.16	0.08	0.38	0.38	0.21	0.21	0.26	0.19	0.12	0.23	0.20	0.20

Table A-22. Westbound I-80 13-Year (1992-2004) Crash Rate Analysis

		Crash Rate per Million Vehicle-Miles Traveled												
	Milepost	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Rural Area	0-5	0.19	0.00	0.18	0.00	0.17	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00
	5.01-10	0.17	0.00	0.00	0.00	0.00	0.15	0.00	0.14	0.00	0.00	0.14	**0.44**	0.00
	10.01-15	0.00	0.00	0.00	0.15	0.00	0.00	0.00	**0.28**	0.00	0.14	0.14	0.15	0.14
	15.01-20	0.17	0.00	0.16	**0.30**	0.00	0.00	0.00	0.00	**0.29**	0.00	**0.28**	0.00	0.14
	20.01-25	0.00	0.00	0.16	**0.30**	0.00	0.00	0.00	0.00	**0.73**	0.00	0.00	**0.29**	**0.29**
	25.01-30	**0.51**	**0.84**	**0.32**	0.00	0.00	**0.29**	0.14	**0.28**	**0.29**	0.00	0.00	0.00	0.00
	30.01-35	0.17	0.00	0.16	0.15	0.16	0.00	0.00	0.14	0.15	0.14	**0.28**	0.15	0.14
	35.01-40	**0.34**	0.00	0.00	0.00	0.00	**0.29**	**0.29**	0.14	0.15	0.00	0.00	0.00	0.00
	40.01-45	0.17	0.00	0.00	0.15	0.16	0.00	0.14	0.14	0.14	**0.28**	0.14	0.15	0.00
	45.01-50	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.14	0.00	0.00	0.15	0.00
	50.01-55	0.17	0.16	0.16	0.15	0.00	0.00	0.00	0.14	0.00	0.14	0.00	0.14	0.00
	55.01-60	0.16	0.00	0.00	0.00	0.00	0.00	0.14	**0.27**	0.00	0.14	0.00	**0.27**	0.13
	60.01-65	0.00	0.00	0.00	0.00	0.15	0.00	0.14	0.00	0.00	0.13	0.13	0.00	0.13
	65.01-70	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.13	0.00	0.00	**0.26**	0.00	0.13
	70.01-75	0.00	0.00	0.00	0.00	0.15	0.14	0.13	0.00	0.13	0.00	**0.26**	0.14	0.13
	75.01-80	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12
	80.01-85	0.00	0.00	0.00	0.00	0.13	0.13	0.00	0.12	0.00	0.00	0.22	0.11	0.11
	85.01-90	0.00	0.00	0.13	0.00	0.13	0.12	0.00	0.00	0.00	0.10	0.09	0.00	0.00
	90.01-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00
	95.01-100	0.09	0.00	0.09	0.00	0.00	0.07	**0.28**	0.00	0.00	0.00	0.06	0.06	0.06
	100.01-105	0.00	0.00	0.12	0.00	0.06	0.11	0.05	0.09	0.09	0.09	0.00	0.13	0.09
	105.01-110	0.08	0.07	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.05	0.05	**0.24**	0.05
Urban Area	110.01-115	0.00	0.00	**0.10**	**0.15**	0.00	0.05	**0.08**	0.00	0.00	0.04	0.00	0.07	0.04
	115.01-120	0.03	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.03	0.00	0.00	0.04	0.00
	120.01-125	0.00	0.00	0.00	0.01	0.02	0.02	0.00	0.00	0.00	0.01	0.01	0.00	0.00
	125.01-130	0.05	0.00	0.00	0.00	0.05	**0.07**	0.00	0.03	0.05	0.00	0.06	0.00	0.04
Rural Area	130.01-135	0.04	0.03	0.03	0.03	0.00	0.00	0.03	0.06	0.00	0.05	0.07	0.00	0.00
	135.01-140	0.04	0.04	0.10	0.03	0.06	0.03	0.00	0.03	0.03	0.00	0.05	0.00	0.03
	140.01-145	0.00	0.04	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.03	0.00	0.00	0.03
	145.01-150	0.08	0.08	0.14	0.06	0.06	0.00	0.00	0.00	0.06	0.11	0.00	0.11	0.05
	150.01-155	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.08	0.07	0.00	0.00
	155.01-160	0.13	0.00	0.00	0.00	0.21	0.19	0.00	0.10	0.10	0.09	0.00	0.08	0.00
	160.01-165	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.09	0.00
	165.01-170	0.12	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	170.01-175	0.00	0.00	0.10	0.20	0.20	0.00	0.18	0.00	0.08	0.00	0.08	0.00	0.00
	175.01-180	0.12	0.11	0.00	0.00	0.00	0.19	0.18	0.00	0.08	0.17	0.08	0.08	0.00
	180.01-185	0.12	0.00	0.00	0.00	0.10	0.00	0.00	0.08	**0.25**	0.00	0.08	0.00	0.16
	185.01-190	0.12	0.00	0.00	**0.31**	0.00	**0.28**	0.09	0.09	0.08	**0.34**	0.08	0.18	0.09
	190.01-197	0.09	0.08	0.00	0.00	0.00	0.07	0.00	0.06	0.06	0.06	0.00	0.00	0.13

Table A-23. Eastbound I-84 13-Year (1992-2004) Crash Rate Analysis

		Crash Rate per Million Vehicle-Miles Traveled												
	Milepost	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Rural	0-5	**0.48**	0.00	**0.21**	0.00	**0.20**	0.00	0.19	0.18	0.18	0.00	0.00	0.00	0.00
	5.01-10	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.13	0.00	0.13	0.00	0.00	0.00
	10.01-15	0.00	0.00	0.00	0.00	**0.28**	0.00	0.00	0.12	0.00	0.00	**0.23**	0.15	0.15
	15.01-20	0.17	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.12	0.00	0.00	0.00	0.00
	20.01-25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.14
	25.01-30	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
	30.01-35	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	35.01-42	0.00	**0.22**	0.00	0.00	0.19	0.09	0.00	0.08	0.00	**0.31**	0.14	**0.20**	0.10
	81.04-85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00
	85.01-90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.09	0.00	0.00
	90.01-95	0.00	0.00	0.00	0.00	0.11	**0.21**	0.18	0.00	0.00	0.08	**0.25**	0.08	**0.25**
	95.01-100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	100.01-105	0.00	0.00	0.00	0.13	0.00	0.11	0.00	**0.20**	0.00	0.00	0.10	**0.21**	0.10
	105.01-110	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.11	0.00	**0.22**	0.00	0.00	0.00
	110.01-115	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	**0.24**	**0.31**	0.15
	115.01-120	0.00	0.00	0.00	**0.20**	0.19	0.00	0.00	0.17	0.17	0.00	**0.49**	0.00	0.15

Table A-24. Westbound I-84 13-Year (1992-2004) Crash Rate Analysis

		Crash Rate per Million Vehicle-Miles Traveled												
	Milepost	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Rural	0-5	0.00	0.00	**0.21**	0.00	0.00	**0.38**	0.00	0.00	0.00	0.00	0.00	0.17	0.00
	5.01-10	**0.39**	**0.37**	0.00	0.16	0.00	0.00	0.00	0.13	0.00	0.00	0.13	0.00	0.00
	10.01-15	0.18	0.00	**0.31**	**0.30**	0.14	0.00	0.00	0.12	0.00	0.12	**0.34**	0.00	0.00
	15.01-20	0.17	0.16	0.00	**0.29**	0.14	0.00	0.00	**0.24**	0.00	0.11	0.00	0.00	0.00
	20.01-25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.10	0.14	0.00
	25.01-30	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.22**	0.00	0.10	0.14	0.14
	30.01-35	0.00	0.00	0.14	0.13	0.13	0.00	0.11	0.11	0.00	0.00	0.00	0.00	0.00
	35.01-42	0.12	0.00	0.00	0.10	0.00	0.00	0.00	0.08	0.08	0.08	0.00	**0.20**	0.00
	81.04-85	0.00	0.00	0.00	0.15	0.00	0.14	0.00	0.12	0.00	0.11	0.09	0.00	0.00
	85.01-90	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.16
	90.01-95	0.00	0.00	0.00	0.00	0.11	0.00	0.09	0.00	0.00	0.17	0.08	0.00	0.00
	95.01-100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00
	100.01-105	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.10	**0.19**	0.00	0.00	0.00
	105.01-110	0.00	0.00	0.00	0.00	0.14	0.00	0.11	0.00	0.11	0.00	0.00	0.00	0.00
	110.01-115	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.12	0.16	0.15
	115.01-120	0.00	0.00	0.00	0.00	**0.19**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A-25. Inner Lanes I-215 13-Year (1992-2004) Crash Rate Analysis

		Crash Rate per Million Vehicle-Miles Traveled												
	Milepost	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Urban	0-5	0.03	0.02	0.02	0.00	**0.11**	0.02	0.05	0.07	0.07	0.00	**0.09**	0.04	0.02
	5.01-10	0.05	**0.09**	0.02	0.06	0.02	0.00	0.00	0.02	0.00	0.00	0.03	0.01	0.00
	10.01-15	0.06	0.05	0.06	0.01	0.02	0.02	0.03	0.03	0.00	0.06	0.04	0.02	0.02
	15.01-20	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.03	0.04	0.03	0.01	0.04	0.03
	20.01-25	0.00	0.03	0.02	0.02	0.00	0.00	0.00	0.03	0.05	0.00	0.06	0.04	0.00
	25.01-30	0.00	0.00	0.04	0.04	0.04	0.06	0.02	**0.08**	0.04	0.05	**0.13**	0.00	0.03

Table A-26. Outer Lanes I-215 13-Year (1992-2004) Crash Rate Analysis

		Crash Rate per Million Vehicle-Miles Traveled												
	Milepost	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Urban	0-5	0.03	0.02	0.00	0.02	0.02	0.04	**0.07**	0.00	0.02	0.05	**0.07**	0.06	0.02
	5.01-10	0.00	0.00	**0.10**	0.02	0.06	0.02	0.00	0.02	0.05	0.03	0.03	0.00	0.04
	10.01-15	0.04	0.03	0.01	0.02	0.05	0.04	0.04	0.02	**0.07**	0.03	0.01	0.02	0.01
	15.01-20	0.06	0.00	0.04	0.01	0.04	0.01	0.03	**0.07**	0.02	0.03	0.01	0.01	0.00
	20.01-25	0.03	0.05	0.00	0.02	0.02	0.00	0.00	0.00	0.05	0.00	0.06	0.04	0.06
	25.01-30	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.02	0.05	0.05	0.03	0.03

Table A-27. Northbound U.S. 89 13-Year (1992-2004) Crash Rate Analysis

		Crash Rate per Million Vehicle-Miles Traveled												
	Milepost	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Rural	0-5	0.00	0.00	**0.69**	0.00	0.00	0.00	0.61	0.58	0.42	0.00	0.00	0.00	0.00
	5.01-10	**0.70**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.54	0.00
	10.01-15	0.00	0.00	0.00	0.62	0.00	0.00	0.00	0.53	0.00	0.00	0.00	0.00	0.00
	15.01-20	0.00	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.52	**1.07**	0.00	0.54	0.00
	20.01-25	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	25.01-30	**0.70**	**0.66**	0.00	0.00	0.00	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.53
	30.01-35	0.00	**1.32**	0.63	0.00	0.00	0.00	0.56	0.53	0.00	0.00	0.00	0.00	0.00
	35.01-40	0.00	**1.32**	0.00	0.00	0.00	0.57	0.56	0.00	0.52	0.00	0.51	0.00	0.00
	40.01-45	0.00	**0.66**	**1.26**	**1.24**	0.00	**1.15**	0.00	0.53	0.52	0.53	0.00	0.54	0.00
	45.01-50	0.00	0.00	0.00	0.00	**1.20**	0.57	0.00	0.00	0.00	0.53	0.00	0.00	0.00
	50.01-55	**0.69**	0.00	0.62	**1.22**	**1.18**	0.57	0.56	**1.57**	0.00	0.53	0.00	0.00	0.53
	55.01-60	0.00	**1.12**	0.00	0.00	0.00	0.00	0.47	0.00	0.49	0.00	0.48	0.47	0.46
	60.01-65	0.00	0.00	0.00	0.26	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	65.01-70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.00	0.00	0.00
	70.01-75	0.46	0.00	0.00	0.00	0.00	0.38	0.00	0.00	0.38	0.00	0.00	0.31	0.00
	75.01-80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	80.01-85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00
	85.01-90	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51
	90.01-95	0.00	0.00	**1.65**	0.00	**0.75**	0.00	0.00	0.00	**0.95**	0.00	0.00	0.00	0.00
	95.01-100	0.00	0.00	0.00	**0.79**	0.00	0.00	**0.78**	0.00	**0.95**	**0.94**	0.00	**0.92**	0.00
	100.01-105	0.00	0.00	0.00	0.00	0.00	0.00	**1.58**	0.00	0.00	0.00	0.00	0.00	0.00
	105.01-110	**0.85**	0.00	0.00	**0.78**	**0.75**	0.00	0.00	**0.79**	0.00	**0.78**	0.00	**0.89**	**0.86**
	110.01-115	0.00	**0.77**	**1.65**	**0.78**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	115.01-120	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	120.01-125	0.00	0.00	0.00	0.00	0.47	0.00	0.47	0.00	0.00	0.55	0.00	0.00	0.00
	125.01-130	0.00	0.47	0.00	0.00	0.00	0.00	0.37	0.36	0.00	0.00	0.00	0.00	0.00
	130.01-135	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.54	0.00	0.00
	135.01-140	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00
	140.01-145	0.00	0.00	0.00	0.00	0.00	**0.79**	0.00	0.00	0.00	0.00	**1.47**	0.00	0.00
	145.01-150	**1.02**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	150.01-155	0.00	**0.96**	0.00	0.00	0.00	0.00	0.00	**0.89**	0.00	0.00	**0.89**	0.00	0.00
	155.01-160	**1.02**	0.00	0.00	0.00	0.00	**1.90**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	160.01-165	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.67**
	165.01-170	0.00	0.00	0.00	0.00	**0.78**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	170.01-175	0.00	0.00	0.00	**0.99**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.95**
	175.01-180	0.00	0.00	0.00	**1.75**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	180.01-185	0.00	0.00	**0.79**	**0.77**	0.00	0.00	0.00	0.00	0.00	**0.79**	0.00	0.00	**0.77**
	185.01-191.74	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.00	0.57	0.59	0.00	0.00	0.57
	225.36-230	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.16	0.00
	230.01-235	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	235.01-240	0.00	0.00	0.00	0.00	0.00	0.32	0.30	0.00	0.00	0.00	0.14	0.00	0.15
	240.01-245	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.21	0.21	0.00	0.00	0.00	0.00
	245.01-250	0.00	0.00	0.00	0.37	0.00	0.37	0.00	0.00	0.00	0.35	0.00	0.00	0.00

Table A-27. Continued

Rural	250.01-255	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.30	0.00	0.00	0.29
	255.01-260	0.00	0.00	0.00	0.00	0.19	0.00	0.18	0.00	0.00	0.00	0.00	0.16	0.00
	260.01-265	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.19	0.17	0.16
	265.01-270	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00
	270.01-275	0.57	0.00	**0.95**	0.00	0.46	0.00	0.00	0.00	0.00	0.00	**0.77**	0.00	0.00
	275.01-280	0.00	0.00	0.38	0.00	0.00	0.00	0.00	0.30	0.00	0.28	0.00	0.27	0.00
	280.01-285	0.00	0.00	0.38	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	285.01-290	0.00	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	290.01-295	0.00	**0.69**	**1.22**	0.00	0.53	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	295.01-300	0.00	**0.69**	0.00	0.55	0.00	0.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00
	300.01-305	0.00	0.00	0.00	0.00	**1.07**	0.00	0.00	**0.82**	0.00	0.00	0.46	0.00	0.00
	305.01-312.78	0.00	**0.88**	0.39	0.00	**1.03**	0.00	0.29	0.26	0.00	0.29	0.00	0.29	0.30
	322.28-325	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Urban	325.01-330	0.00	**0.18**	0.09	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.07	**0.21**	0.07
	330.01-335	0.00	0.00	0.00	0.06	0.00	0.00	**0.17**	0.05	0.11	0.00	**0.15**	0.00	0.05
	335.01-340	0.08	0.03	0.02	0.02	0.00	0.02	0.07	0.02	0.02	0.00	0.08	0.02	0.02
	340.01-345	0.00	**0.13**	0.04	0.04	**0.15**	0.04	0.09	0.03	0.09	0.03	0.03	0.08	0.03
	345.01-350	0.00	0.00	0.00	**0.17**	0.06	0.05	**0.15**	0.05	0.05	0.00	0.04	0.00	0.04
	350.01-355	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00
	355.01-360	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	360.01-365	0.00	0.06	0.00	0.00	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.07	0.00
	365.01-370	0.00	0.04	0.04	0.04	0.00	0.03	0.06	0.00	0.03	0.00	0.00	0.08	0.00
	370.01-375	0.00	0.10	0.06	0.07	0.07	0.09	0.05	0.03	0.09	0.11	**0.16**	0.08	0.08
	375.01-380	0.04	0.00	0.07	0.07	0.10	0.06	0.05	0.09	0.06	0.00	0.00	0.00	0.04
	380.01-385	0.05	0.00	0.00	0.04	0.00	0.10	0.06	**0.13**	0.00	0.00	0.00	0.06	0.06
	385.01-389.53	0.00	0.00	0.10	0.00	0.00	**0.14**	0.09	0.04	0.00	**0.13**	0.04	0.00	0.00
	395.59-400	0.00	0.00	0.09	0.05	0.09	0.04	0.08	0.00	0.04	0.04	0.00	0.04	0.00
	400.01-405	0.04	0.04	0.04	0.00	**0.16**	0.00	0.07	0.00	0.04	0.10	0.00	0.04	0.11
	405.01-410	0.04	0.00	0.07	0.00	0.07	0.00	0.03	0.09	0.00	0.00	0.06	0.00	0.03
	410.01-415	0.10	0.00	0.09	0.05	0.09	0.04	0.00	0.00	0.08	0.00	0.00	0.00	0.04
	415.01-420	0.06	0.00	0.00	0.00	0.00	0.00	0.09	0.08	0.04	0.00	0.04	0.08	0.00
	420.01-425	0.00	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.09	0.09	0.00	0.09	0.00
	425.01-430	**0.13**	**0.12**	**0.23**	0.00	0.00	0.00	0.10	0.00	0.00	0.10	0.09	0.00	0.00
	430.01-435	0.00	0.00	**0.15**	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.06	0.06
	435.01-440	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	440.01-445	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	445.01-450	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	450.01-455	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	455.01-460	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	460.01-465	**0.14**	0.00	0.00	**0.12**	**0.12**	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00
	465.01-470	0.00	**0.33**	0.00	**0.30**	0.00	0.00	0.00	0.00	0.00	**0.17**	**0.16**	0.00	0.00
Rural	470.01-475	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.19
	475.01-480	0.00	0.00	0.00	0.00	0.44	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00
	480.01-485	0.00	0.00	0.50	0.00	0.00	0.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00
	485.01-490	0.00	0.62	0.00	0.00	0.00	0.53	0.00	0.00	0.00	0.47	0.00	0.00	0.00
	490.01-495	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00
	495.01-500	0.00	0.00	0.00	0.00	0.00	**0.65**	0.57	0.00	0.00	0.00	0.00	0.47	0.00
	500.01-503	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A-28. Southbound U.S. 89 13-Year (1992-2004) Crash Rate Analysis

		Crash Rate per Million Vehicle-Miles Traveled												
	Milepost	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Rural	0-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58	0.00	0.43	0.00	0.00	0.35
	5.01-10	**0.70**	**0.66**	0.00	0.00	0.60	0.58	0.00	0.53	0.52	0.00	0.00	0.54	0.53
	10.01-15	**0.70**	0.00	0.00	0.00	**1.20**	**1.15**	0.56	**1.58**	0.00	0.00	0.51	0.00	0.00
	15.01-20	0.00	**0.66**	0.00	0.00	**1.20**	0.00	0.00	0.53	0.52	0.00	0.00	0.54	0.00
	20.01-25	0.00	0.00	0.00	0.00	0.00	0.57	0.00	**1.58**	0.52	0.00	0.00	0.00	0.53
	25.01-30	**0.70**	**0.66**	0.00	0.00	0.00	0.00	0.00	0.53	0.52	0.00	0.51	0.00	0.00
	30.01-35	**0.70**	0.00	0.00	0.00	**1.20**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53
	35.01-40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1.06**	0.52	0.00	0.00	0.00	0.00
	40.01-45	0.00	0.00	**0.63**	0.00	0.00	0.00	0.00	0.00	**1.05**	0.00	0.51	0.00	0.00
	45.01-50	0.00	**0.66**	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0.53	0.00	0.54	0.00
	50.01-55	0.00	0.00	**0.62**	0.00	0.00	0.00	0.00	0.52	0.00	0.53	0.00	0.00	0.00
	55.01-60	0.00	0.00	0.00	0.00	0.00	0.48	0.00	0.00	0.00	0.00	0.48	0.00	0.00
	60.01-65	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00
	65.01-70	0.00	0.00	0.00	0.00	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29
	70.01-75	0.00	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.61**	0.31	0.30
	75.01-80	0.00	0.00	**0.82**	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00
	80.01-85	0.00	0.54	0.00	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.00	0.45
	85.01-90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	90.01-95	0.00	**0.77**	**0.82**	0.00	0.00	**0.80**	0.00	**0.75**	**0.95**	0.00	**0.91**	**1.83**	0.00
	95.01-100	0.00	**0.77**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.76**
	100.01-105	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.76**	0.00	**1.78**	0.00	0.00	0.00
	105.01-110	0.00	**0.77**	**0.83**	**0.78**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	110.01-115	0.00	0.00	**2.48**	0.00	0.00	0.00	0.00	0.00	0.00	**0.80**	**0.77**	0.00	0.00
	115.01-120	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.63**	**1.21**	0.00	0.60
	120.01-125	0.00	0.00	0.00	0.00	**0.94**	0.48	0.00	0.00	0.00	0.00	0.00	**1.07**	0.51
	125.01-130	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	130.01-135	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.28	0.00
	135.01-140	0.00	0.00	0.50	0.00	0.50	0.00	0.00	0.47	0.00	0.47	0.45	0.00	0.00
	140.01-145	0.00	**0.83**	0.00	0.00	0.00	**0.79**	0.00	0.00	0.00	**0.76**	0.00	**0.70**	**0.75**
	145.01-150	0.00	0.00	0.00	0.00	0.00	0.00	**0.93**	0.00	0.00	**0.92**	0.00	0.00	0.00
	150.01-155	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	155.01-160	0.00	**0.96**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	160.01-165	0.00	**0.67**	0.00	**0.64**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	165.01-170	0.00	**1.03**	0.00	0.00	**0.78**	0.00	0.00	**0.80**	0.00	0.00	0.00	0.00	0.00
	170.01-175	0.00	0.00	**0.99**	0.00	0.00	**0.80**	0.00	**0.82**	0.00	0.00	0.00	**0.85**	0.00
	175.01-180	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	180.01-185	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1.58**	0.00
	185.01-191.74	0.00	0.00	0.00	0.00	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	225.36-230	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	230.01-235	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.14	0.00
	235.01-240	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.14	0.00	0.00	0.00
	240.01-245	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00
	245.01-250	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.00

Table A-28. Continued

Rural	250.01-255	0.34	0.00	0.00	0.28	0.27	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00
	255.01-260	0.00	0.00	0.00	0.00	0.19	0.18	0.00	0.00	0.19	0.00	0.00	0.00	0.00
	260.01-265	0.00	0.00	0.39	0.39	0.20	0.38	0.00	0.00	0.00	0.00	0.19	0.51	0.00
	265.01-270	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25
	270.01-275	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00
	275.01-280	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.31	0.00	0.00	0.00	0.23
	280.01-285	**0.86**	0.00	0.00	0.00	0.00	0.30	0.00	0.27	0.00	0.00	0.00	0.26	0.00
	285.01-290	0.00	**0.69**	0.00	0.55	0.53	0.00	0.45	0.00	0.00	0.00	**0.91**	0.00	0.33
	290.01-295	0.00	**0.69**	0.00	0.00	0.00	0.51	0.45	0.00	0.43	**0.89**	**0.91**	0.00	0.00
	295.01-300	0.00	0.00	0.00	0.55	0.53	0.00	0.00	0.41	0.00	0.44	0.46	0.00	0.00
	300.01-305	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	305.01-312.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.30
	322.28-325	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00
Urban	325.01-330	0.09	0.09	0.09	0.00	**0.27**	0.00	**0.17**	0.08	0.00	0.00	**0.13**	0.07	**0.14**
	330.01-335	0.00	0.00	0.00	0.00	**0.19**	0.00	0.06	0.11	0.11	0.11	0.10	0.05	0.05
	335.01-340	0.00	0.10	0.02	0.07	0.00	0.00	0.05	0.04	0.04	0.06	0.00	0.06	0.00
	340.01-345	0.00	0.00	0.08	0.04	0.00	0.07	0.06	0.03	0.06	0.00	0.00	0.00	0.09
	345.01-350	0.00	0.00	0.06	**0.17**	0.06	0.00	0.00	0.00	0.05	0.05	0.00	0.00	0.04
	350.01-355	0.09	**0.17**	0.08	0.00	0.08	**0.15**	0.00	0.00	0.00	0.00	0.07	**0.20**	0.10
	355.01-360	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	360.01-365	0.06	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.05	0.00	0.00
	365.01-370	0.04	**0.20**	0.08	**0.12**	0.11	0.03	0.06	0.00	0.00	0.04	0.00	0.08	0.04
	370.01-375	0.00	0.06	0.00	0.07	0.00	0.00	0.03	0.03	0.11	0.00	0.00	0.04	0.00
	375.01-380	0.04	0.00	0.03	0.00	0.03	0.06	0.05	0.00	0.06	0.07	0.08	0.00	**0.12**
	380.01-385	0.05	0.00	0.04	0.04	0.04	0.00	0.00	0.03	0.00	0.00	0.00	0.03	0.00
	385.01-389.53	0.00	0.00	0.05	0.00	0.05	0.05	0.00	0.04	0.04	0.00	0.00	0.09	0.04
	395.59-400	**0.14**	0.05	0.05	0.05	0.04	0.00	0.04	0.00	0.08	0.08	0.00	0.00	0.00
	400.01-405	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.04	0.04	0.07	0.03	0.00	0.00
	405.01-410	0.00	0.00	0.00	0.04	0.00	0.07	0.00	0.03	0.06	0.03	0.06	0.03	0.00
	410.01-415	0.00	0.00	0.04	0.05	0.04	0.08	0.08	0.00	0.00	0.04	0.03	0.04	0.09
	415.01-420	**0.12**	0.00	0.00	0.05	0.00	0.09	0.05	0.00	0.04	0.00	0.00	0.04	0.00
	420.01-425	0.00	0.00	0.00	0.10	0.00	0.10	0.00	0.09	0.00	0.00	0.00	0.09	0.00
	425.01-430	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00
	430.01-435	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
	435.01-440	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	440.01-445	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	445.01-450	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	450.01-455	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	455.01-460	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00
	460.01-465	**0.14**	**0.26**	0.00	**0.12**	**0.12**	**0.35**	**0.23**	0.00	0.00	**0.19**	0.09	0.09	0.00
	465.01-470	0.00	**0.33**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.16**	0.00	0.00
Rural	470.01-475	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.28	0.00	0.00	0.00	0.00
	475.01-480	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.00	0.37	0.00	0.21	0.00
	480.01-485	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	485.01-490	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	490.01-495	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.00	0.00
	495.01-500	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	500.01-503	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.69**	0.00	0.00	0.00	0.00

Table A-29. Northbound U.S. 91 13-Year (1992-2004) Crash Rate Analysis

		Crash Rate per Million Vehicle-Miles Traveled												
	Milepost	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Rural	0-5	0.00	0.09	0.08	0.00	0.00	0.00	0.07	0.07	0.00	0.07	0.00	0.00	0.06
	5.01-10	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.14
	10.01-15	0.00	0.10	0.00	0.16	0.17	0.00	0.08	0.07	0.07	0.00	0.00	0.00	0.07
	15.01-20	0.00	0.30	0.00	0.00	0.17	0.16	0.07	0.07	0.21	0.14	0.07	0.14	0.21
	20.01-25	0.22	0.30	**0.44**	**0.41**	**0.38**	**0.35**	**0.34**	0.19	**0.39**	**0.39**	**0.31**	0.18	**0.36**
	25.01-30	0.18	0.00	0.15	0.04	0.12	0.27	0.19	0.18	0.07	0.07	0.13	0.07	0.03
	30.01-35	0.06	0.17	0.05	0.20	0.00	0.19	0.05	0.00	0.09	0.18	0.00	0.04	0.13
	35.01-40	0.21	0.00	0.11	**0.33**	**0.32**	0.20	0.00	0.10	0.27	0.09	0.00	0.00	0.16
	40.01-45	0.14	0.14	0.00	0.12	0.12	0.22	0.11	**0.32**	**0.36**	0.00	0.00	0.11	0.11

Table A-30. Southbound U.S. 91 13-Year (1992-2004) Crash Rate Analysis

		Crash Rate per Million Vehicle-Miles Traveled												
	Milepost	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Rural	0-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00
	5.01-10	**0.29**	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.07	0.00	0.07	0.00	0.00
	10.01-15	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.15**	0.00	0.00	0.00
	15.01-20	0.00	0.00	0.00	0.00	0.00	0.08	0.07	0.00	0.14	0.07	0.07	0.07	0.00
	20.01-25	0.00	**0.20**	0.00	0.08	0.08	0.00	0.00	0.13	0.06	0.00	0.12	0.06	**0.18**
	25.01-30	0.00	0.08	0.08	0.12	0.04	0.08	0.04	0.04	0.07	0.03	0.03	0.03	0.00
	30.01-35	0.12	0.06	**0.15**	0.10	0.10	0.05	0.10	0.00	0.00	0.04	0.04	0.12	0.00
	35.01-40	**0.21**	0.00	0.00	0.11	0.00	0.00	0.10	0.00	0.00	0.00	0.08	0.00	0.08
	40.01-45	0.00	0.00	0.00	0.12	**0.24**	0.00	0.00	**0.21**	0.00	0.00	0.12	0.00	0.00

Table A-31. Northbound S.R. 36 13-Year (1992-2004) Crash Rate Analysis

		Crash Rate per Million Vehicle-Miles Traveled												
	Milepost	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Rural	0-5	0.00	0.00	0.00	0.00	0.00	**3.61**	0.00	0.00	0.00	0.00	**2.97**	**3.01**	0.00
	5.01-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**3.01**	0.00	0.00	0.00	0.00
	10.01-15	0.00	0.00	0.00	**3.38**	**3.38**	0.00	0.00	0.00	0.00	0.00	0.00	**2.85**	0.00
	15.01-20	0.00	**3.05**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	20.01-25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**2.82**	0.00	0.00
	25.01-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	30.01-35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**2.85**	0.00
	35.01-40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	40.01-45	0.00	0.00	0.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	45.01-50	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	50.01-55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.09	0.00	0.09	0.00	0.00
	55.01-60	0.00	0.00	0.00	0.10	0.00	0.07	0.07	0.00	0.06	0.00	0.04	0.00	0.00
	60.01-66	0.09	0.10	0.36	0.00	0.00	0.11	0.05	0.10	0.09	0.00	0.04	0.00	0.00

Table A-32. Southbound S.R. 36 13-Year (1992-2004) Crash Rate Analysis

		Crash Rate per Million Vehicle-Miles Traveled												
	Milepost	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Rural	0-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**3.35**	0.00	0.00	0.00	0.00	0.00
	5.01-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	10.01-15	0.00	0.00	0.00	0.00	0.00	0.00	**3.14**	0.00	0.00	0.00	0.00	0.00	0.00
	15.01-20	0.00	**3.05**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	20.01-25	0.00	0.00	**3.43**	0.00	0.00	0.00	**3.14**	0.00	0.00	0.00	0.00	0.00	0.00
	25.01-30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**2.82**	0.00	0.00
	30.01-35	0.00	**3.05**	0.00	0.00	0.00	**3.23**	0.00	0.00	**3.01**	0.00	0.00	0.00	0.00
	35.01-40	0.00	0.00	0.00	0.00	0.00	**1.61**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	40.01-45	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	45.01-50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	50.01-55	0.00	0.00	0.11	0.11	0.00	0.10	0.00	0.09	0.09	0.00	0.00	0.00	0.09
	55.01-60	0.11	0.12	0.42	0.10	0.00	0.14	0.00	0.06	0.18	0.00	0.04	0.00	0.08
	60.01-66	0.09	0.10	0.18	0.34	0.06	0.05	0.10	0.15	0.09	0.00	0.07	0.04	0.11

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APPENDIX B: BEFORE-AFTER ANALYSES

Table B-1. Number of Drowsy Driving Crashes on Eastbound I-80 from M.P. 27-37 and from M.P. 50-60 for Modified Traditional Before-After Analysis

	Time Period	Number of Crashes	
		EB M.P. 27-37	EB M.P. 50-60
Before	8/21/92 - 12/31/93	3	3
	8/21/94 - 12/31/95	3	8
	8/21/96 - 12/31/97	2	4
	8/21/98 - 12/31/99	2	9
	8/21/00 - 12/31/01	1	7
	8/21/02 - 12/31/03	3	10
After	8/21/04 - 12/31/05	4	1

Table B-2. Predicted Number of "After" Crashes Calculations for Eastbound I-80 for Modified Traditional Before-After Analysis

Direction and M.P.	Number of Before Time Periods	Number of After Time Periods	Accidents Before (K)	Accidents After (L)	r_d	r_d*K	r_d^2*K
EB M.P. 27-37	6	1	14	4	0.17	2.33	0.39
EB M.P. 50-60	6	1	41	1	0.17	6.83	1.14
Sums				5		9.2	1.5

Table B-3. Number of Drowsy Driving Crashes on westbound I-80 from M.P. 37-47 and from M.P. 85-95 for Modified Traditional Before-After Analysis

	Time Period	Number of Crashes	
		WB M.P. 37-47	WB M.P. 85-95
Before	8/21/92 - 12/31/93	1	0
	8/21/94 - 12/31/95	1	1
	8/21/96 - 12/31/97	2	2
	8/21/98 - 12/31/99	2	0
	8/21/00 - 12/31/01	3	2
	8/21/02 - 12/31/03	3	1
After	8/21/04 - 12/31/05	2	1

Table B-4. Predicted Number of "After" Crashes Calculations for Westbound I-80 for Modified Traditional Before-After Analysis

Direction and M.P.	Number of Before Time Periods	Number of After Time Periods	Accidents Before (K)	Accidents After (L)	r_d	r_d*K	r_d^2*K
WB M.P. 85-95	6	1	6	1	0.17	1.00	0.17
WB M.P. 37-47	6	1	12	2	0.17	2.00	0.33
Sums				3		3.0	0.5

Table B-5. Eastbound I-80 with Comparison Group of EB I-70 M.P. 130-150

Group	Number of Crashes		Odds Ratio (*o*)
	Treatment Group	Comparison Group	
Time Periods	**EB I-80 M.P. 27-37 & 50-60**	**EB I-70 M.P. 130-150**	
8/21/92 - 12/31/93	6	5	
8/21/94 - 12/31/95	11	4	0.338
8/21/96 - 12/31/97	6	5	1.618
8/21/98 - 12/31/99	11	8	0.676
8/21/00 - 12/31/01	8	13	1.788
8/21/02 - 12/31/03	13	5	0.205
8/21/04 - 12/31/05	5	10	3.714
Mean of Odds Ratios			0.925
Sample Variance			0.537
K	55	M	40
L	5	N	10
VAR(ω)			0.19

Table B-6. Eastbound I-80 with Comparison Group of SB I-15 M.P. 0-20

Group	Number of Crashes		Odds Ratio (*o*)
	Treatment Group	Comparison Group	
Time Periods	**EB I-80 M.P. 27-37 & 50-60**	**SB I-15 M.P. 0-20**	
8/21/92 - 12/31/93	6	6	
8/21/94 - 12/31/95	11	10	0.723
8/21/96 - 12/31/97	6	14	2.026
8/21/98 - 12/31/99	11	10	0.335
8/21/00 - 12/31/01	8	16	1.796
8/21/02 - 12/31/03	13	11	0.371
8/21/04 - 12/31/05	5	13	2.380
Mean of Odds Ratios			1.05
Sample Variance			0.647
K	55	M	67
L	5	N	13
VAR(ω)			0.34

Table B-7. Eastbound I-80 with Comparison Group of SB I-15 M.P. 168-188

Group	Number of Crashes		Odds Ratio (*o*)
	Treatment Group	Comparison Group	
Time Periods	**EB I-80 M.P. 27-37 & 50-60**	**SB I-15 M.P. 168-188**	
8/21/92 - 12/31/93	6	6	
8/21/94 - 12/31/95	11	3	0.217
8/21/96 - 12/31/97	6	6	2.444
8/21/98 - 12/31/99	11	6	0.434
8/21/00 - 12/31/01	8	3	0.532
8/21/02 - 12/31/03	13	4	0.582
8/21/04 - 12/31/05	5	5	2.241
Mean of Odds Ratios			0.842
Sample Variance			0.822
K	55	M	28
L	5	N	5
VAR(ω)			0.37

Table B-8. Eastbound I-80 with Comparison Group of WB I-80 M.P. 0-20

Group	Number of Crashes		Odds Ratio (*o*)
	Treatment Group	Comparison Group	
Time Periods	**EB I-80 M.P. 27-37 & 50-60**	**WB I-80 M.P. 0-20**	
8/21/92 - 12/31/93	6	2	
8/21/94 - 12/31/95	11	4	0.686
8/21/96 - 12/31/97	6	1	0.324
8/21/98 - 12/31/99	11	3	0.783
8/21/00 - 12/31/01	8	2	0.629
8/21/02 - 12/31/03	13	5	0.976
8/21/04 - 12/31/05	5	2	0.743
Mean of Odds Ratios			0.679
Sample Variance			0.057
K	55	M	17
L	5	N	2
VAR(ω)			0.00

Table B-9. Eastbound I-80 with Composite Comparison Group of Groups 1-4

Group	Number of Crashes		Odds Ratio (*o*)
	Treatment Group	Comparison Group	
Time Periods	**EB I-80 M.P. 27-37 & 50-60**	**Sum of Groups 1-4**	
8/21/92 - 12/31/93	6	19	
8/21/94 - 12/31/95	11	21	0.527
8/21/96 - 12/31/97	6	26	1.869
8/21/98 - 12/31/99	11	27	0.502
8/21/00 - 12/31/01	8	34	1.490
8/21/02 - 12/31/03	13	25	0.409
8/21/04 - 12/31/05	5	30	2.516
Mean of Odds Ratios			0.959
Sample Variance			0.452
K	55	M	152
L	5	N	30
Overall Odds Ratio			1.799
VAR(ω)			0.19

Table B-10. Eastbound I-80 Comparison Group Results with Data from Table C-9

INPUT:		
	Treatment	Comparison
Accident Count "Before" =	55	152
Accident Count "After" =	5	30
Variance of odds ratio =	0.19	
OUTPUT:		
Step 1:	Lambda-hat=	5
	$r_T = r_C =$	0.20
	pi-hat=	10.8
Step 2:	Var{lambda-hat}=	5.0
	Var{pi-hat}=	28.85
Step 3:	Delta-hat=	5.8
	Theta-hat=	0.371
Step 4:	Sigma{Delta-hat}=	5.82
	Sigma{Theta-hat}=	0.199

Table B-11. Westbound I-80 with Comparison Group of EB I-70 M.P. 130-150

Group	Number of Crashes		Odds Ratio (*o*)
	Treatment Group	Comparison Group	
Time Periods	WB I-80 M.P. 37-47 & 85-95	EB I-70 M.P. 130-150	
8/21/92 - 12/31/93	1	5	
8/21/94 - 12/31/95	2	4	0.235
8/21/96 - 12/31/97	4	5	0.417
8/21/98 - 12/31/99	2	8	1.882
8/21/00 - 12/31/01	5	13	0.491
8/21/02 - 12/31/03	4	5	0.362
8/21/04 - 12/31/05	3	10	1.739
Mean of Odds Ratios			0.677
Sample Variance			0.462
K	18	M	40
L	3	N	10
VAR(ω)			0.00

Table B-12. Westbound I-80 with Comparison Group of SB I-15 M.P. 0-20

Group	Number of Crashes		Odds Ratio (*o*)
	Treatment Group	Comparison Group	
Time Periods	WB I-80 M.P. 37-47 & 85-95	SB I-15 M.P. 0-20	
8/21/92 - 12/31/93	1	6	
8/21/94 - 12/31/95	2	10	0.500
8/21/96 - 12/31/97	4	14	0.519
8/21/98 - 12/31/99	2	10	0.909
8/21/00 - 12/31/01	5	16	0.492
8/21/02 - 12/31/03	4	11	0.655
8/21/04 - 12/31/05	3	13	1.106
Mean of Odds Ratios			0.615
Sample Variance			0.031
K	18	M	67
L	3	N	13
VAR(ω)			0.00

Table B-13. Westbound I-80 with Comparison Group of SB I-15 M.P. 168-188

Group	Number of Crashes		Odds Ratio (*o*)
	Treatment Group	Comparison Group	
Time Periods	**WB I-80 M.P. 37-47 & 85-95**	**SB I-15 M.P. 168-188**	
8/21/92 - 12/31/93	1	6	
8/21/94 - 12/31/95	2	3	0.150
8/21/96 - 12/31/97	4	6	0.632
8/21/98 - 12/31/99	2	6	1.200
8/21/00 - 12/31/01	5	3	0.146
8/21/02 - 12/31/03	4	4	1.053
8/21/04 - 12/31/05	3	5	1.053
Mean of Odds Ratios			0.636
Sample Variance			0.242
K	18	M	28
L	3	N	5
VAR(ω)			0.00

Table B-14. Westbound I-80 with Comparison Group of WB I-80 M.P. 0-20

Group	Number of Crashes		Odds Ratio (*o*)
	Treatment Group	Comparison Group	
Time Periods	**WB I-80 M.P. 37-47 & 85-95**	**WB I-80 M.P. 0-20**	
8/21/92 - 12/31/93	1	2	
8/21/94 - 12/31/95	2	4	0.500
8/21/96 - 12/31/97	4	1	0.083
8/21/98 - 12/31/99	2	3	2.400
8/21/00 - 12/31/01	5	2	0.174
8/21/02 - 12/31/03	4	5	1.786
8/21/04 - 12/31/05	3	2	0.348
Mean of Odds Ratios			0.989
Sample Variance			1.087
K	18	M	17
L	3	N	2
VAR(ω)			0.14

Table B-15. Westbound I-80 with Composite Comparison Group of Groups 1-4

Group	Number of Crashes		Odds Ratio (o)
	Treatment Group	Comparison Group	
Time Periods	**WB I-80 M.P. 37-47 & 85-95**	**Sum of Groups 1-4**	
8/21/92 - 12/31/93	1	19	
8/21/94 - 12/31/95	2	21	0.356
8/21/96 - 12/31/97	4	26	0.477
8/21/98 - 12/31/99	2	27	1.350
8/21/00 - 12/31/01	5	34	0.407
8/21/02 - 12/31/03	4	25	0.718
8/21/04 - 12/31/05	3	30	1.165
Mean of Odds Ratios			0.662
Sample Variance			0.167
K	18	M	152
L	3	N	30
Overall Odds Ratio			0.884
VAR(ω)			0.00

Table B-16. Westbound I-80 Comparison Group Results with Data from Table C-15

INPUT:		
	Treatment	Comparison
Accident Count "Before" =	4	25
Accident Count "After" =	3	30
Variance of odds ratio =	0.00	
OUTPUT:		
Step 1:	Lambda-hat=	3
	$r_T = r_C =$	0.20
	pi-hat=	3.5
Step 2:	Var{lambda-hat}=	3.0
	Var{pi-hat}=	1.19
Step 3:	Delta-hat=	0.5
	Theta-hat=	0.776
Step 4:	Sigma{Delta-hat}=	2.05
	Sigma{Theta-hat}=	0.464

APPENDIX C: CHI-SQUARE TESTS RESULTS

Table C-1. Gender vs. Seeing the Drowsy Driving Signs

Gender (question 1) *Frequency* *Percent* *Row Percent* *Column Percent*	**Did you see the drowsy driving signs? (question 6)**		
	Yes	**No**	**Total**
Female	73 18.02 98.65 18.86	1 0.25 1.35 5.56	74 18.27
Male	314 77.53 94.86 81.14	17 4.2 5.14 94.44	331 81.73
Total	387 95.56	18 4.44	405 100.0

Statistic	**DF**	**Value**	**Probability**
Chi-Square	1	2.0397	0.1532
Likelihood Ratio Chi-Square	1	2.6256	0.1052
Continuity Adj. Chi-Square	1	1.2459	0.2643
Mantel-Haenszel Chi-Square	1	2.0347	0.1537
Phi Coefficient		-0.071	
Contingency Coefficient		0.0708	
Cramer's V		-0.071	

Table C-2. Age vs. Seeing the Drowsy Driving Signs

Age (question 1) *Frequency* *Percent* *Row Percent* *Column Percent*	**Did you see the drowsy driving signs? (question 6)**		
	Yes	**No**	**Total**
18 - 25	23 5.68 92 5.94	2 0.49 8 11.11	25 6.17
26 - 35	55 13.58 96.49 14.21	2 0.49 3.51 11.11	57 14.07
36 - 50	105 25.93 92.11 27.13	9 2.22 7.89 50	114 28.15
> 50	204 50.37 97.61 52.71	5 1.23 2.39 27.78	209 51.6
Total	387 95.56	18 4.44	405 100.0

Statistic	**DF**	**Value**	**Probability**
Chi-Square	3	6.1296	0.1055
Likelihood Ratio Chi-Square	3	5.8274	0.1203
Mantel-Haenszel Chi-Square	1	2.1132	0.146
Phi Coefficient		0.123	
Contingency Coefficient		0.1221	
Cramer's V		0.123	

Table C-3. Gender vs. the Most Prominent Drowsy Driving Sign

Gender (question 1) *Frequency* *Percent* *Row Percent* *Column Percent*	**Which drowsy driving sign was most prominent to you? (question 7)**				**Total**
	Drowsy Drivers Next Exit 5 Miles	**Drowsy Drivers Pull Over If Necessary**	**Drowsy Driving Causes Crashes**	**No Preference**	
Female	8 2.07 10.96 19.05	17 4.39 23.29 19.32	36 9.3 49.32 21.82	12 3.1 16.44 13.04	73 18.86
Male	34 8.79 10.83 80.95	71 18.35 22.61 80.68	129 33.33 41.08 78.18	80 20.67 25.48 86.96	314 81.14
Total	42 10.85	88 22.74	165 42.64	92 23.77	387 100
Frequency Missing = 18					

Statistic	**DF**	**Value**	**Probability**
Chi-Square	3	2.9901	0.3931
Likelihood Ratio Chi-Square	3	3.1486	0.3693
Mantel-Haenszel Chi-Square	1	0.6866	0.4073
Phi Coefficient		0.0879	
Contingency Coefficient		0.0876	
Cramer's V		0.0879	

Table C-4. Age vs. the Most Prominent Drowsy Driving Sign

Age (question 1) *Frequency* *Percent* *Row Percent* *Column Percent*	**Which drowsy driving sign was most prominent to you? (question 7)**				
	Drowsy Drivers Next Exit 5 Miles	**Drowsy Drivers Pull Over If Necessary**	**Drowsy Driving Causes Crashes**	**No Preference**	**Total**
18 - 25	5 1.29 21.74 11.9	9 2.33 39.13 10.23	8 2.07 34.78 4.85	1 0.26 4.35 1.09	23 5.94
26 - 35	3 0.78 5.45 7.14	17 4.39 30.91 19.32	30 7.75 54.55 18.18	5 1.29 9.09 5.43	55 14.21
36 - 50	12 3.1 11.43 28.57	23 5.94 21.9 26.14	43 11.11 40.95 26.06	27 6.98 25.71 29.35	105 27.13
> 50	22 5.68 10.78 52.38	39 10.08 19.12 44.32	84 21.71 41.18 50.91	59 15.25 28.92 64.13	204 52.71
Total	42 10.85	88 22.74	165 42.64	92 23.77	387 100.0
Frequency Missing = 18					

Statistic	**DF**	**Value**	**Probability**
Chi-Square	9	22.976	0.0063
Likelihood Ratio Chi-Square	9	25.312	0.0026
Mantel-Haenszel Chi-Square	1	9.4681	0.0021
Phi Coefficient		0.2437	
Contingency Coefficient		0.2367	
Cramer's V		0.1407	

Table C-5. Gender vs. How the Drowsy Driving Signs Contribute to Drivers' Decisions to Stop

Gender (question 1) *Frequency* *Percent* *Row Percent* *Column Percent*	**Did the drowsy driving signs contribute to your decision to stop? (question 8)**			
	Definitely	**Somewhat**	**Not at all**	**Total**
Female	11 2.84 15.07 33.33	13 3.36 17.81 13.4	49 12.66 67.12 19.07	73 18.86
Male	22 5.68 7.01 66.67	84 21.71 26.75 86.6	208 53.75 66.24 80.93	314 81.14
Total	33 8.53	97 25.06	257 66.41	387 100.0
Frequency Missing = 18				

Statistic	**DF**	**Value**	**Probability**
Chi-Square	2	6.4118	0.0405
Likelihood Ratio Chi-Square	2	5.946	0.0511
Mantel-Haenszel Chi-Square	1	5.5366	0.0186
Phi Coefficient		0.1287	
Contingency Coefficient		0.1277	
Cramer's V		0.1287	

Table C-6. Age vs. How the Drowsy Driving Signs Contributed to Drivers' Decisions to Stop

Age (question 1) *Frequency* *Percent* *Row Percent* *Column Percent*	**Did the drowsy driving signs contribute to your decision to stop? (question 8)**			
	Definitely	**Somewhat**	**Not at all**	**Total**
18 - 25	2 0.52 8.7 6.06	6 1.55 26.09 6.19	15 3.88 65.22 5.84	23 5.94
26 - 35	5 1.29 9.09 15.15	13 3.36 23.64 13.4	37 9.56 67.27 14.4	55 14.21
36 - 50	11 2.84 10.48 33.33	26 6.72 24.76 26.8	68 17.57 64.76 26.46	105 27.13
> 50	15 3.88 7.35 45.45	52 13.44 25.49 53.61	137 35.4 67.16 53.31	204 52.71
Total	33 8.53	97 25.06	257 66.41	387 100.0
Frequency Missing = 18				

Statistic	**DF**	**Value**	**Probability**
Chi-Square	6	0.963	0.987
Likelihood Ratio Chi-Square	6	0.9477	0.9875
Mantel-Haenszel Chi-Square	1	0.1572	0.6918
Phi Coefficient		0.0499	
Contingency Coefficient		0.0498	
Cramer's V		0.0353	

Table C-7. Gender vs. Number of Hours Driven between Stops

Gender (question 1) *Frequency* *Percent* *Row Percent* *Column Percent*	**On average, how many hours do you drive between stops? (question 12)**					**Total**
	0.5	**1**	**2**	**3**	**> 3**	
Female	1 0.25 1.35 50	5 1.23 6.76 17.24	29 7.16 39.19 21.32	22 5.43 29.73 19.64	17 4.2 22.97 13.49	74 18.27
Male	1 0.25 0.3 50	24 5.93 7.25 82.76	107 26.42 32.33 78.68	90 22.22 27.19 80.36	109 26.91 32.93 86.51	331 81.73
Total	2 0.49	29 7.16	136 33.58	112 27.65	126 31.11	405 100.0

Statistic	**DF**	**Value**	**Probability**
Chi-Square	4	4.2857	0.3687
Likelihood Ratio Chi-Square	4	4.0841	0.3947
Mantel-Haenszel Chi-Square	1	2.3013	0.1293
Phi Coefficient		0.1029	
Contingency Coefficient		0.1023	
Cramer's V		0.1029	

Table C-8. Age vs. Number of Hours Driven between Stops

Age (question 1) *Frequency* *Percent* *Row Percent* *Column Percent*	**On average, how many hours do you drive between stops? (question 12)**					**Total**
	0.5	**1**	**2**	**3**	**> 3**	
18 - 25	0 0 0 0	4 0.99 16 13.79	5 1.23 20 3.68	7 1.73 28 6.25	9 2.22 36 7.14	25 6.17
26 - 35	0 0 0 0	0 0 0 0	15 3.7 26.32 11.03	18 4.44 31.58 16.07	24 5.93 42.11 19.05	57 14.07
36 - 50	1 0.25 0.88 50	9 2.22 7.89 31.03	29 7.16 25.44 21.32	34 8.4 29.82 30.36	41 10.12 35.96 32.54	114 28.15
> 50	1 0.25 0.48 50	16 3.95 7.66 55.17	87 21.48 41.63 63.97	53 13.09 25.36 47.32	52 12.84 24.88 41.27	209 51.6
Total	2 0.49	29 7.16	136 33.58	112 27.65	126 31.11	405 100.0

Statistic	**DF**	**Value**	**Probability**
Chi-Square	12	23.05	0.0273
Likelihood Ratio Chi-Square	12	26.892	0.008
Mantel-Haenszel Chi-Square	1	8.5103	0.0035
Phi Coefficient		0.2386	
Contingency Coefficient		0.2321	
Cramer's V		0.1377	

Table C-9. Gender vs. Number of Hours Slept before Drivers' Current Trips

Gender (question 1) *Frequency* *Percent* *Row Percent* *Column Percent*	**How many hours did you sleep the night before your current trip? (question 13)**					**Total**
	< 3	**3 - 5**	**5 - 7**	**7 - 9**	**> 9**	
Female	1 0.25 1.35 11.11	5 1.23 6.76 15.15	32 7.9 43.24 25.4	28 6.91 37.84 15.82	8 1.98 10.81 13.33	74 18.27
Male	8 1.98 2.42 88.89	28 6.91 8.46 84.85	94 23.21 28.4 74.6	149 36.79 45.02 84.18	52 12.84 15.71 86.67	331 81.73
Total	9 2.22	33 8.15	126 31.11	177 43.7	60 14.81	405 100.0

Statistic	**DF**	**Value**	**Probability**
Chi-Square	4	6.5005	0.1648
Likelihood Ratio Chi-Square	4	6.2989	0.1779
Mantel-Haenszel Chi-Square	1	2.4445	0.1179
Phi Coefficient		0.1267	
Contingency Coefficient		0.1257	
Cramer's V		0.1267	

Table C-10. Age vs. Number of Hours Slept before Drivers' Current Trips

Age (question 1) *Frequency* *Percent* *Row Percent* *Column Percent*	**How many hours did you sleep the night before your current trip? (question 13)**					
	< 3	**3 - 5**	**5 - 7**	**7 - 9**	**> 9**	**Total**
18 - 25	3 0.74 12 33.33	1 0.25 4 3.03	9 2.22 36 7.14	11 2.72 44 6.21	1 0.25 4 1.67	25 6.17
26 - 35	2 0.49 3.51 22.22	8 1.98 14.04 24.24	15 3.7 26.32 11.9	22 5.43 38.6 12.43	10 2.47 17.54 16.67	57 14.07
36 - 50	3 0.74 2.63 33.33	11 2.72 9.65 33.33	37 9.14 32.46 29.37	41 10.12 35.96 23.16	22 5.43 19.3 36.67	114 28.15
> 50	1 0.25 0.48 11.11	13 3.21 6.22 39.39	65 16.05 31.1 51.59	103 25.43 49.28 58.19	27 6.67 12.92 45	209 51.6
Total	9 2.22	33 8.15	126 31.11	177 43.7	60 14.81	405 100.0

Statistic	**DF**	**Value**	**Probability**
Chi-Square	12	26.732	0.0084
Likelihood Ratio Chi-Square	12	23.006	0.0277
Mantel-Haenszel Chi-Square	1	0.0018	0.9662
Phi Coefficient		0.2569	
Contingency Coefficient		0.2488	
Cramer's V		0.1483	

Table C-11. Gender vs. Number of Hours of Sleep Drivers Receive on an Average Night

Gender (question 1) *Frequency* *Percent* *Row Percent* *Column Percent*	**On average, how many hours do you sleep each night? (question 14)**					**Total**
	< 3	**3 - 5**	**5 - 7**	**7 - 9**	**> 9**	
Female	0 0 0 0	0 0 0 0	34 8.4 45.95 24.82	33 8.15 44.59 15.64	7 1.73 9.46 17.5	74 18.27
Male	2 0.49 0.6 100	15 3.7 4.53 100	103 25.43 31.12 75.18	178 43.95 53.78 84.36	33 8.15 9.97 82.5	331 81.73
Total	2 0.49	15 3.7	137 33.83	211 52.1	40 9.88	405 100.0

Statistic	**DF**	**Value**	**Probability**
Chi-Square	4	8.7263	0.0683
Likelihood Ratio Chi-Square	4	11.519	0.0213
Mantel-Haenszel Chi-Square	1	0.3911	0.5317
Phi Coefficient		0.1468	
Contingency Coefficient		0.1452	
Cramer's V		0.1468	

Table C-12. Age vs. Number of Hours of Sleep Drivers Receive on an Average Night

Age (question 1) *Frequency* *Percent* *Row Percent* *Column Percent*	**On average, how many hours do you sleep each night? (question 14)**					**Total**
	< 3	**3 - 5**	**5 - 7**	**7 - 9**	**> 9**	
18 - 25	0 0 0 0	1 0.25 4 6.67	8 1.98 32 5.84	14 3.46 56 6.64	2 0.49 8 5	25 6.17
26 - 35	1 0.25 1.75 50	3 0.74 5.26 20	22 5.43 38.6 16.06	24 5.93 42.11 11.37	7 1.73 12.28 17.5	57 14.07
36 - 50	0 0 0 0	7 1.73 6.14 46.67	42 10.37 36.84 30.66	48 11.85 42.11 22.75	17 4.2 14.91 42.5	114 28.15
> 50	1 0.25 0.48 50	4 0.99 1.91 26.67	65 16.05 31.1 47.45	125 30.86 59.81 59.24	14 3.46 6.7 35	209 51.6
Total	2 0.49	15 3.7	137 33.83	211 52.1	40 9.88	405 100.0

Statistic	**DF**	**Value**	**Probability**
Chi-Square	12	18.933	0.0902
Likelihood Ratio Chi-Square	12	18.893	0.0911
Mantel-Haenszel Chi-Square	1	0.0202	0.8871
Phi Coefficient		0.2162	
Contingency Coefficient		0.2113	
Cramer's V		0.1248	

Table C-13. Gender vs. Driving while Drowsy

Gender (question 1) *Frequency* *Percent* *Row Percent* *Column Percent*	**Have you ever driven while drowsy? (question 15)** **Yes**	**No**	**Total**
Female	57 14.07 77.03 18.75	17 4.2 22.97 16.83	74 18.27
Male	247 60.99 74.62 81.25	84 20.74 25.38 83.17	331 81.73
Total	304 75.06	101 24.94	405 100.0

Statistic	**DF**	**Value**	**Probability**
Chi-Square	1	0.1868	0.6656
Likelihood Ratio Chi-Square	1	0.1895	0.6633
Continuity Adj. Chi-Square	1	0.0804	0.7767
Mantel-Haenszel Chi-Square	1	0.1864	0.666
Phi Coefficient		-0.0215	
Contingency Coefficient		0.0215	
Cramer's V		-0.0215	

Table C-14. Age vs. Driving while Drowsy

Age (question 1) *Frequency* *Percent* *Row Percent* *Column Percent*	**Have you ever driven while drowsy? (question 15)** **Yes**	 **No**	**Total**
18 - 25	13 3.21 52 4.28	12 2.96 48 11.88	25 6.17
26 - 35	48 11.85 84.21 15.79	9 2.22 15.79 8.91	57 14.07
36 - 50	92 22.72 80.7 30.26	22 5.43 19.3 21.78	114 28.15
> 50	151 37.28 72.25 49.67	58 14.32 27.75 57.43	209 51.6
Total	304 75.06	101 24.94	405 100.0

Statistic	**DF**	**Value**	**Probability**
Chi-Square	3	12.472	0.0059
Likelihood Ratio Chi-Square	3	11.897	0.0077
Mantel-Haenszel Chi-Square	1	0.003	0.9564
Phi Coefficient		0.1755	
Contingency Coefficient		0.1728	
Cramer's V		0.1755	