MIDWEST SMART WORK ZONE DEPLOYMENT INITIATIVE

MwSWZDI

FHWA POOLED FUND STUDY

Report Title	Report Date: 2000

CB Wizard Alert System

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Supplemental Funding Agency Name and Address (if applicable)

Supplemental Notes

Abstract

WIZARD CB ALERT SYSTEM

Objectives

The primary goal of this evaluation was to determine the effectiveness of the Wizard CB alert system (CB message) as located in the approach to a highway work zone. The CB message is intended for use both with stationary long-term work zones and with short-term moving projects. The specific research objectives were:

1. To test the effectiveness of the CB message in merging the traffic into one lane before the work zone starts;
2. To test and evaluate the effectiveness of the CB message in reducing the average speeds and speed variance approaching the work zone;
3. To determine the opinion of drivers traveling through the work zone about the CB message; and
4. To determine if the CB message changed the accident rate.

Measures Of Effectiveness

The CB message was expected to provide an advance warning of the lane closure, to encourage motorists to reduce vehicle speed, to reduce the speed variance, and to be safe for motorists. Table 4-47 shows the measures of effectiveness associated with each objective. Lane distribution and speed measurements were disaggregated by vehicle type (passenger vehicle vs. non-passenger vehicle) and by time of day (day, night, and dawn/dusk).

TABLE 4-47 Measures of effectiveness.

Objective	Measures
Provide advance warnings	Lane distribution
Reduce speed	Mean speed 85^{th} percentile speed Mean speed of fastest 15% of vehicles 10-mph pace
Reduce speed variance	Standard deviation of speed % of vehicles in 10-mph pace
Perform for life of project	Observed ease of installation Observed east of use
Provide for safety	Number of accidents related to CB message

Data Collection And Analysis Procedures

The field research was conducted at a stationary, long-term work zone on eastbound Interstate 70 (I-70) near Columbia, Missouri.

Site Description

The highway normally has a 70-mph speed limit, but the posted speed limit approaching the work zone was reduced first to 60-mph and then to 50-mph. The solar-powered, trailer-mounted CB wizard alert system broadcasts a work zone alert and information for advance warning about potentially hazardous conditions on a CB radio channel (Figure 4-36). The CB message was broadcast on Channel 19 from a location approximately 6 miles (9.67 km) upstream of the lane closure. The system transmitted the following message when the right lane was closed: "This is the Missouri Department of Transportation. The right lane of Eastbound I-70 is closed ahead. Watch for slow or stopped traffic." A similar message was transmitted when the left lane was closed.

The pavement-related work at this site included cold milling, pavement repair, and resurfacing. The average daily traffic was approximately 14,600 vehicles, with 25.6 % non-passenger vehicles (three or more axles) in the eastbound direction of travel. The right lane (driving lane) was closed during the study.

Data Collection

Data were collected at four locations along the approach to the work zone, as shown in Figure 4-37, before the CB message was broadcast (before case) and again while the message was broadcast (after case). Vehicle speeds, volumes, and vehicle classifications were collected in 15-minute intervals. Due to breaks in the pneumatic tubes, it was not always possible to collect data at all four sites during all time periods, but approximately 24 hours of data were collected for both the before and after cases. The CB message was initially broadcast on April 23, 1999. Data for the analysis were collected on April 6, 1999 for the before case and on April 27, 1999 for the after case.

Accident data were collected from one mile upstream of the first counter site through the end of the work zone. Drivers were surveyed to determine the availability and efficacy of the message.

FIGURE 4-36 Wizard CB alert system.

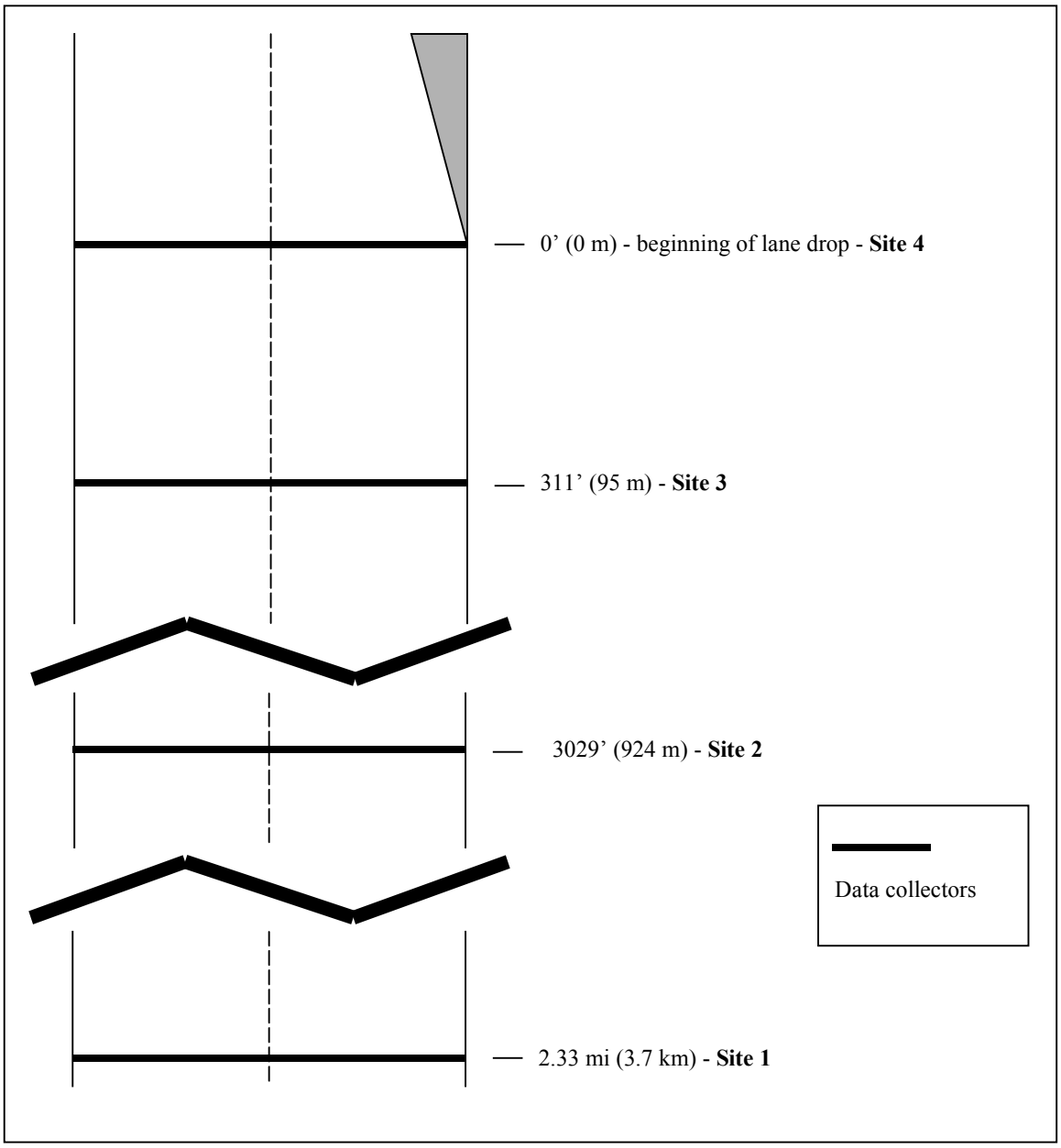

FIGURE 4-37 Schematic location of detectors approaching work zone.

Data Analysis

The primary measures of effectiveness used to analyze the data were mean speed, speed variance, and lane distribution upstream of the work zone. Along with these parameters, the percentage of vehicles below the speed limit, the 10-mph pace, the percentage of vehicles in the 10-mph pace, the 85th percentile speed**,** and the mean speed of the fastest 15% of vehicles were calculated to evaluate the traffic control devices in detail. The analysis examined the difference in the parameters before and after the device was installed. Significance testing of the parameters used a two-tailed Student's t-test with a level of significance $\alpha = 0.05$. An F-test was also conducted at the same level of significance to find any significant differences in the speed variance.

Each "before and after" comparison is a test of the hypothesis that the characteristic under study is the same in the before and after cases (i.e., the characteristic did not change). The

level of significance (α) used was 0.05. This means that when there was no change, the test can be expected to reach that conclusion correctly (that there is no statistically significant difference) in 95% of the comparisons. However, in 5% of the cases in which there was no change, the test can be expected to indicate a statistically significant difference (this is called a Type I error).

The analysis methods, as well as classification procedures, were the same as those used to evaluate the removable orange rumble strips (refer to page 4-1).

Results

Results related to lane distribution, speed, speed variance, driver response to the CB message, and safety are presented below. All comparisons described are the after case compared to the before case, and after cells that show a statistically significant difference from the before case ($\alpha = 0.05$) are shaded in the tables. A blank cell indicates that there were no such conditions observed, and a dash (–) indicates that it was not possible to calculate the particular parameter. For example, if only one vehicle were observed in a 15-minute interval, it would not be possible to calculate a standard deviation of speed.

Due to problems with the data collection device at Site 4, data are only reported for Sites 1, 2, and 3. Data collection sites 1, 2, and 3 were 2.33 miles, 3029 feet, and 311 feet upstream from the beginning of the lane closure, respectively. Drivers at all three locations probably could have heard the CB message if they were listening to Channel 19.

Lane Distribution

The lane distribution is considered to be improved in the after case if a lower percentage of vehicles is in the closed lane.

Figures 4-38 to 4-40 present profiles of the percentage of traffic remaining in the lane closed downstream. In all cases at Data Collection Site 1, the majority of traffic is in the right-side driving lane (the lane closed downstream). At Sites 2 and 3, the majority of traffic is in the left-side passing lane (the lane open downstream). In general, the percentage of traffic in the closed lane was lower in the after case than in the before case. Non-passenger vehicles exhibited greater reductions than passenger vehicles.

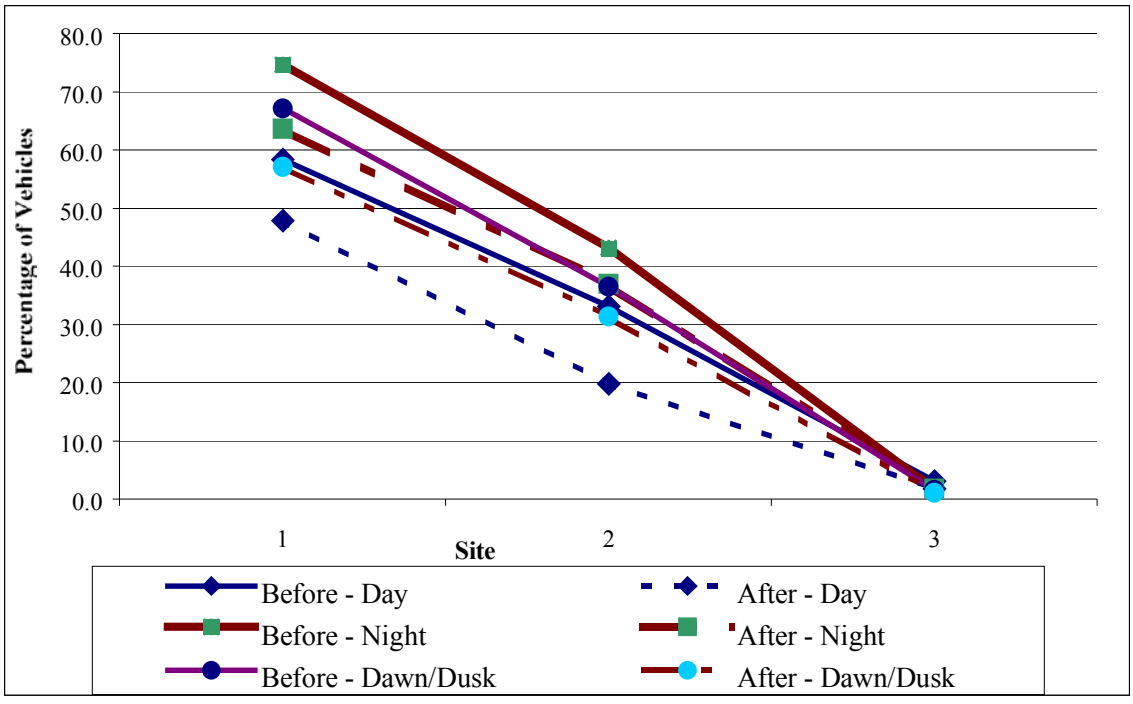

FIGURE 4-38 Profile of percentage of traffic in closed lane – all vehicles.

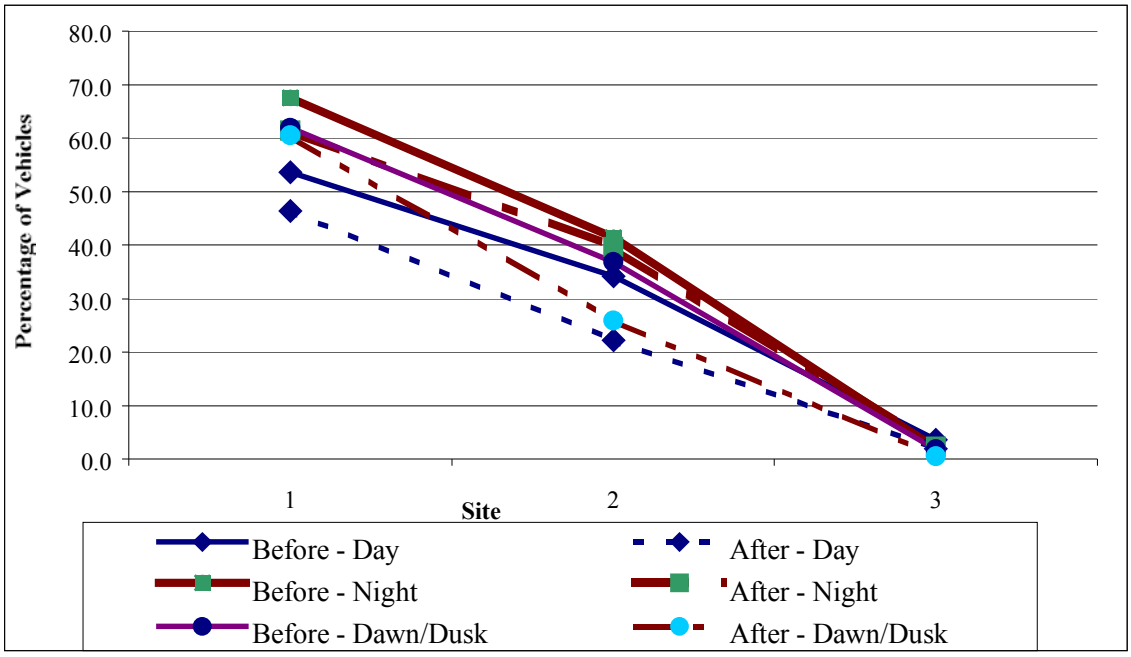

FIGURE 4-39 Profile of percentage of traffic in closed lane – *passenger vehicles.*

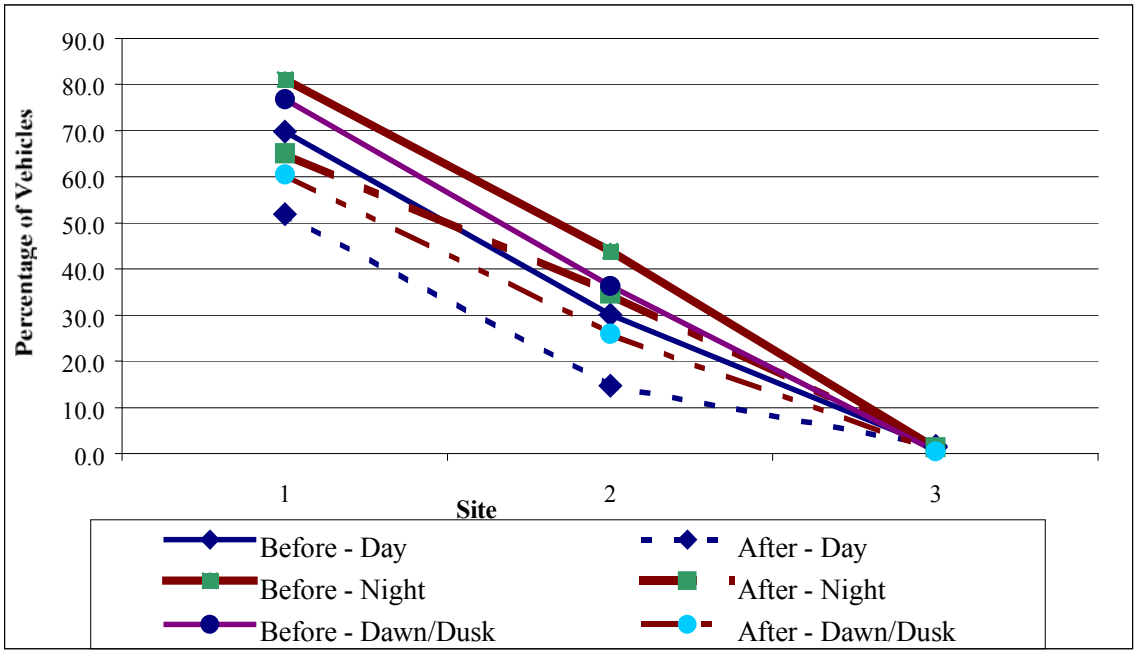

FIGURE 4-40 Profile of percentage of traffic in closed lane – *non-passenger vehicles.*

Tables 4-48 to 4-50 show the percentage of traffic remaining in the lane closed downstream during the day, night, and dawn/dusk in the before and after cases.

During the day (Table 4-48), lane distribution was better at all three sites under both uncongested and congested conditions. In several of the uncongested cases, the improvement was at a statistically significant level.

At night (Table 4-50), lane distribution improved at both Sites 1 and 2, with most of the improvements at a statistically significant level. Site 3 showed some small increases in the percentage of traffic in the closed lane, but the changes were not statistically significant.

During the dawn/dusk periods (Table 4-48), lane distribution improved at all sites in almost all cases.

TABLE 4-48 Percentage of traffic in the closed lane – day.

Vehicle type	Case	Uncongested Conditions at Site			Congested Conditions at Site		
		1	2	3	1*	2*	3
All vehicles	Before	58.3	33.1	3.0			5.1
	After	**47.8**	**19.7**	**1.8**			1.4
Passenger vehicles	Before	53.6	34.1	3.6			6.2
	After	**46.4**	**22.2**	**1.9**			1.7
Non-passenger vehicles	Before	69.8	30.1	1.4			1.8
	After	**51.9**	14.7	1.6			0.6
* No congested conditions were observed at Sites 1 and 2							

TABLE 4-49 Percentage of traffic in the closed lane – night.

Vehicle type	Case	Uncongested Conditions at Site*		
		1	2	3
All vehicles	Before	74.7	43.2	1.7
	After	**63.6**	**36.9**	1.8
Passenger vehicles	Before	67.5	41.5	2.0
	After	**61.4**	39.7	2.2
Non-passenger vehicles	Before	81.1	44.0	1.2
	After	**65.1**	**34.7**	1.4
* No congested conditions were observed				

TABLE 4-50 Percentage of traffic in the closed lane – dawn/dusk.

Vehicle type	Case	Uncongested Conditions at Site*		
		1	2	3
All vehicles	Before	67.19	36.50	1.48
	After	**57.07**	31.30	1.00
Passenger vehicles	Before	61.88	36.8	1.77
	After	54.27	34.4	1.25
Non-passenger vehicles	Before	76.87	36.4	0.47
	After	**60.50**	25.9	0.51
* No congested conditions were observed				

Mean Speed Characteristics

This section presents results for mean speed, percentage of vehicles below the speed limit, 10-mph pace, 85th percentile speed, and mean speed of the fastest 15% of vehicles during the day, night, and dawn/dusk. A lower mean speed, 10-mph pace, 85th percentile speed, and mean speed of the fastest 15% of vehicles are associated with improved conditions, as is an increase in the percentage of vehicles below the speed limit.

Mean Speeds

Figures 4-41 to 4-43 show the mean speed profiles for the open lane for the before and after cases. At Sites 2 and 3, mean speeds tended to be lower in the after case.

Tables 4-51 to 4-53 present the results for mean speeds in the before and after cases.

Under uncongested conditions during the day (Table 4-51), in the after cases, Site 1 speeds were higher while Site 2 and 3 speeds (closer to the merge point) were all lower. Site 3 speeds were also lower under congested conditions.

At night (Table 4-52), Site 1 again showed higher mean speeds in the after case, while Sites 2 and 3 showed lower mean speeds.

In the dawn/dusk periods (Table 4-53), mean speeds at Site 1 tended to be higher in the after case. Site 2 speeds were mostly lower, and Site 4 speeds were all lower in the after case.

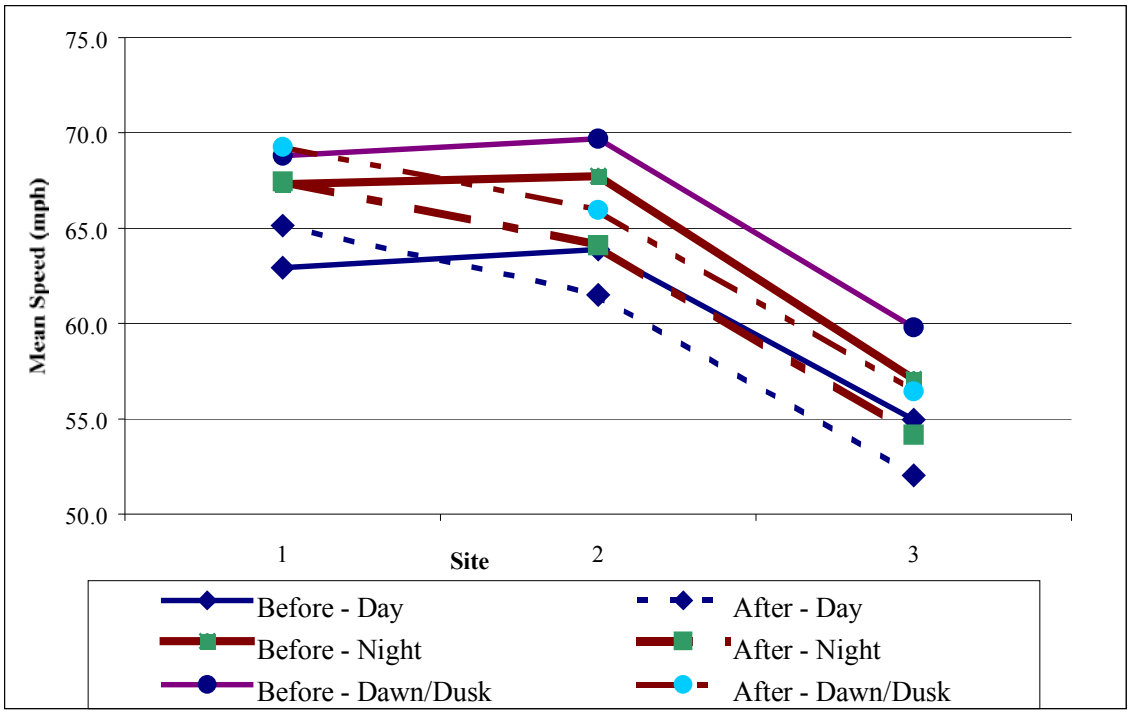

FIGURE 4-41 Mean speed profiles for open lane – *all vehicles.*

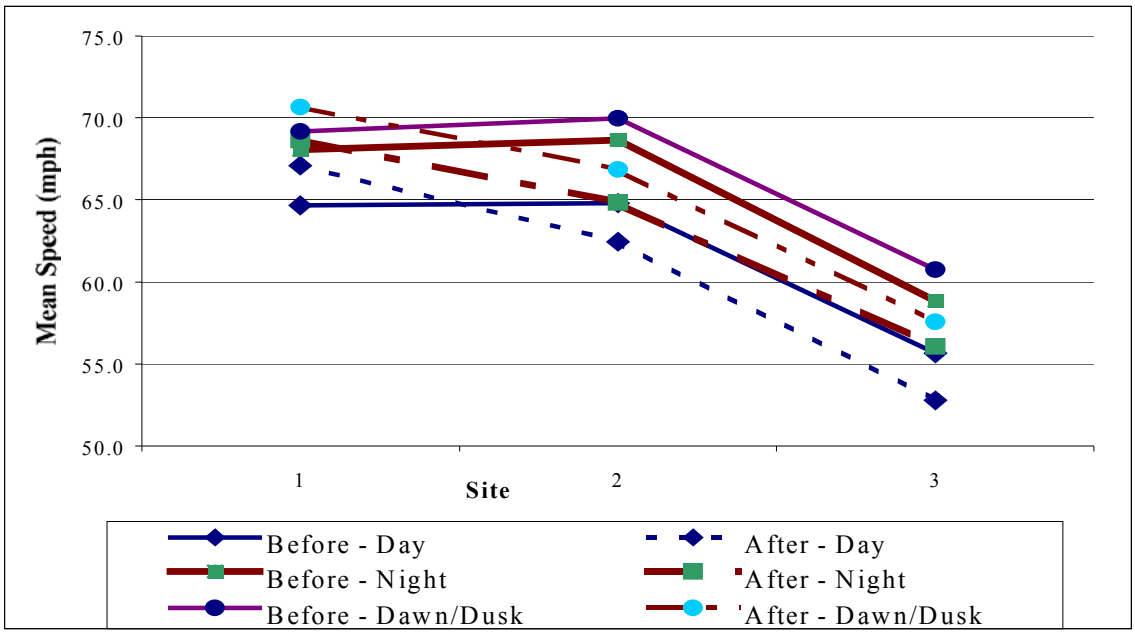

FIGURE 4-42 Mean speed profiles for open lane – *passenger vehicles.*

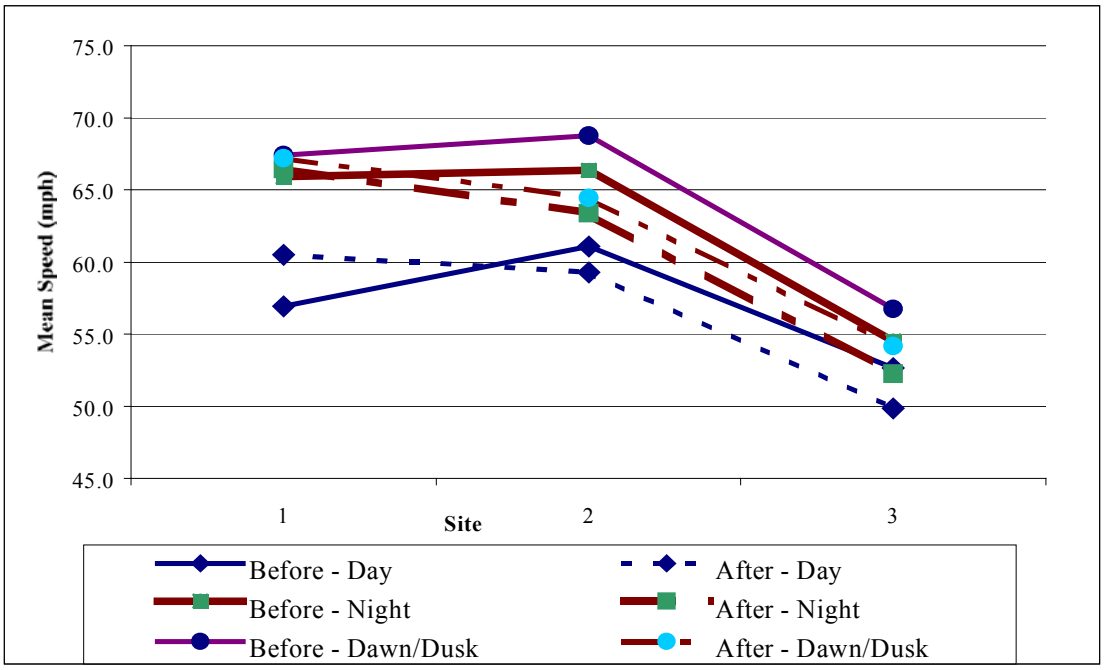

FIGURE 4-43 Mean speed profiles for open lane – *non-passenger vehicles.*

TABLE 4-51 Mean speeds – day.

Vehicle Type	Case	Lane	Uncongested Conditions at Site			Congested Conditions at Site		
			1	2	3	1*	2*	3
All vehicles	Before	Driving	64.0	66.8	56.4			33.3
		Passing	62.9	63.9	54.9			30.4
	After	Driving	**65.9**	**66.1**	54.7			32.6
		Passing	**65.1**	**61.5**	**52.0**			**27.8**
Passenger vehicles	Before	Driving	65.0	67.1	56.8			33.2
		Passing	64.7	64.8	55.7			31.1
	After	Driving	**66.6**	**66.6**	55.6			33.5
		Passing	**67.1**	**62.4**	**52.8**			**28.2**
Non-passenger vehicles	Before	Driving	62.2	65.3	52.9			34.0
		Passing	56.9	61.1	52.6			27.9
	After	Driving	**64.5**	**63.9**	**49.7**			31.2
		Passing	**60.5**	**59.3**	**49.9**			**26.4**
* No congested conditions were observed at Sites 1 and 2								

TABLE 4-52 Mean speeds – night.

Vehicle Type	Case	Lane	Uncongested Conditions at Site*		
			1	2	3
All vehicles	Before	Driving	63.85	66.3	57.0
		Passing	67.32	67.7	57.1
	After	Driving	**65.26**	**64.8**	**53.7**
		Passing	67.44	**64.1**	**54.2**
Passenger vehicles	Before	Driving	64.3	66.8	57.9
		Passing	68.1	68.7	58.9
	After	Driving	**66.4**	66.1	**54.9**
		Passing	68.7	**64.8**	**56.1**
Non-passenger vehicles	Before	Driving	63.5	65.7	55.1
		Passing	65.9	66.4	54.5
	After	Driving	**64.5**	**63.4**	**51.7**
		Passing	66.4	**63.4**	**52.3**
* No congested conditions were observed					

TABLE 4-53 Mean speeds – dawn/dusk.

Vehicle Type	Case	Lane	Uncongested Conditions at Site*		
			1	2	3
All vehicles	**Before**	**Driving**	65.0	69.22	61.5
		Passing	68.8	69.69	59.8
	After	**Driving**	**67.2**	68.18	57.2
		Passing	69.3	**65.95**	**56.5**
Passenger vehicles	**Before**	**Driving**	65.1	65.1	61.3
		Passing	69.2	70.0	60.7
	After	**Driving**	**68.4**	**68.9**	58.0
		Passing	**70.7**	**66.8**	**57.6**
Non-passenger vehicles	**Before**	**Driving**	64.8	66.5	–
		Passing	67.4	68.8	56.7
	After	**Driving**	65.9	66.5	–
		Passing	67.2	**64.4**	**54.2**
* No congested conditions were observed					

Percentage of Vehicles Below Speed Limit

Tables 4-54 to 4-56 show the percentage of vehicles below the speed limit in the before and after cases. The speed limit at Site 1 was 60-mph, and the speed limit at Sites 2 and 3 was 50-mph.

During the day (Table 4-54), in uncongested conditions, the percentage of vehicles below the speed limit tended to be higher (improved) in the after case at Sites 1 and 3. Improvements in the passing lane at Site 3 were the only statistically significant changes. In congested conditions, Site 3 showed improvement in four of the five comparisons.

At night (Table 4-55), compliance with the speed limit was improved at all locations in the after case.

TABLE 4-54 Percentage of vehicles below speed limit – day.

Vehicle Type	Case	Lane	Uncongested Conditions at Site			Congested Conditions at Site		
			1	2	3	1*	2*	3
All vehicles	Before	Driving	18.2	7.5	24.8			88.7
		Passing	11.9	11.4	23.9			92.2
	After	Driving	19.0	4.5	32.7			82.3
		Passing	14.1	8.1	**35.6**			97.4
Passenger vehicles	Before	Driving	17.7	6.8	23.8			88.3
		Passing	11.1	10.5	22.4			91.2
	After	Driving	18.9	4.6	26.6			90.6
		Passing	12.8	7.7	**33.3**			97.0
Non-passenger vehicles	Before	Driving	18.7	12.2	33.7			–
		Passing	14.8	16.2	29.4			95.7
	After	Driving	19.0	4.4	48.2			–
		Passing	17.4	9.1	**42.3**			98.1
* No congested conditions were observed at Sites 1 and 2								

TABLE 4-55 Percentage of vehicles below speed limit – night.

Vehicle Type	Case	Lane	Uncongested Conditions at Site*		
			1	2	3
All vehicles	Before	Driving	16.12	0.2	11.1
		Passing	4.15	0.2	16.3
	After	Driving	**19.52**	**1.2**	18.8
		Passing	**12.40**	0.4	**26.1**
Passenger vehicles	Before	Driving	16.9	0.3	6.7
		Passing	2.5	0.3	11.4
	After	Driving	18.5	0.6	21.3
		Passing	**10.7**	0.7	**17.5**
Non-passenger vehicles	Before	Driving	16.0	0.1	17.9
		Passing	5.5	0.0	21.9
	After	Driving	19.5	**1.6**	29.2
		Passing	**12.4**	0.5	**32.8**
* No congested conditions were observed					

In the dawn/dusk periods (Table 4-56), compliance with the speed limit was generally improved at Site 3. Results at Site 1 were mixed, while few vehicles at Site 2 complied with the speed limit in either case.

10-mph Pace

The speed distributions (that is, the proportion of vehicles in each speed interval) were analyzed to determine whether a significant difference existed in the before and after distributions. Changes in the 10-mph pace are reported only when the changes in the distribution were significant. Actual distributions are shown in tables in the appendix.

TABLE 4-56 Percentage of vehicles below speed limit – dawn/dusk.

Vehicle Type	Case	Lane	Uncongested Conditions at Site*		
			1	2	3
All vehicles	Before	Driving	13.4	0.0	12.5
		Passing	1.7	0.0	6.2
	After	Driving	11.4	0.0	8.3
		Passing	6.7	0.0	**21.7**
Passenger vehicles	Before	Driving	16.1	16.1	12.5
		Passing	2.0	0.0	5.5
	After	Driving	11.4	**0.0**	11.1
		Passing	4.1	0.0	**19.7**
Non-passenger vehicles	Before	Driving	6.1	0.0	–
		Passing	0.0	0.0	8.4
	After	Driving	11.2	0.0	–
		Passing	10.2	0.0	**27.0**
* No congested conditions were observed					

Significant differences in the speed distributions occurred at Site 1 during the day for all vehicles and passenger vehicles, and the 10-mph pace increased. At Site 2, significant differences occurred during the day for all vehicles, passenger vehicles, and non-passenger vehicles, and the 10-mph pace decrease from 56-75 mph to 60-70 mph. During the night, at Site 2, the speed distributions for all vehicles and passenger vehicles were significantly different in the after case, with the 10-mph pace decreasing from 65-75 mph to 60-70 mph. At Site 3, significant differences in the speed distributions occurred during both the day and night for all vehicles and passenger vehicles. No other significant differences in the distributions occurred.

85th Percentile Speeds

Tables 4-57 to 4-59-show the 85th percentile speeds in the before and after cases.

During the day (Table 4-57), in uncongested conditions, Site 1 had higher 85th percentile speeds in the after case, while Site 3 had lower 85th percentile speeds. Results at Site 2 were mixed. Under congested conditions, Site 3 generally showed uniformly lower 85th percentile speeds in the after case.

At night (Table 4-58), Site 1 had higher 85th percentile speeds in the after case, while most 85th percentile speeds at Sites 2 and 3 were lower.

During the dawn/dusk periods (Table 4-59), Site 1 had higher 85th percentile speeds in the after case, while Site 4 had lower 85th percentile speeds. Results at Site 2 were mixed.

TABLE 4-57 85th percentile speeds – day.

Vehicle Type	Case	Lane	Uncongested Conditions at Site			Congested Conditions at Site		
			1	2	3	1*	2*	3
All vehicles	Before	Driving	67.7	73.1	66.0			45.2
		Passing	69.9	72.8	64.9			44.0
	After	Driving	71.5	73.5	64.5			41.6
		Passing	72.1	70.5	61.6			38.1
Passenger vehicles	Before	Driving	68.4	73.8	66.2			44.0
		Passing	70.3	73.5	65.9			44.7
	After	Driving	72.4	74.1	64.2			38.4
		Passing	74.4	71.4	**62.7**			38.5
Non-passenger vehicles	Before	Driving	65.8	69.7	61.8			–
		Passing	67.4	69.8	61.4			32.3
	After	Driving	69.0	69.7	56.2			–
		Passing	69.4	68.0	**58.4**			31.9
* No congested conditions were observed at Sites 1 and 2								

TABLE 4-58 85th percentile speeds – night.

Vehicle Type	Case	Lane	Uncongested Conditions at Site*		
			1	2	3
All vehicles	Before	Driving	69.15	72.5	64.1
		Passing	72.45	74.6	65.4
	After	Driving	**72.14**	71.4	**58.0**
		Passing	**73.82**	**70.4**	**62.0**
Passenger vehicles	Before	Driving	70.2	73.5	63.8
		Passing	73.6	76.1	68.1
	After	Driving	**73.9**	73.1	57.9
		Passing	74.6	**72.1**	**65.7**
Non-passenger vehicles	Before	Driving	68.1	70.9	62.2
		Passing	70.5	72.0	61.0
	After	Driving	**70.6**	**69.4**	54.5
		Passing	**72.4**	**69.5**	**58.9**
* No congested conditions were observed					

TABLE 4-59 85th percentile speeds – dawn/dusk.

Vehicle Type	Case	Lane	Uncongested Conditions at Site*		
			1	2	3
All vehicles	Before	Driving	70.3	75.96	67.9
		Passing	74.1	76.37	67.7
	After	Driving	**74.6**	75.21	–
		Passing	75.9	**73.64**	64.7
Passenger vehicles	Before	Driving	70.8	70.8	67.0
		Passing	74.6	77.0	68.6
	After	Driving	**76.1**	**75.8**	–
		Passing	**77.5**	75.2	66.0
Non-passenger vehicles	Before	Driving	69.0	72.5	–
		Passing	72.4	74.3	62.9
	After	Driving	**71.0**	72.5	–
		Passing	73.5	**69.8**	**60.7**
* No congested conditions were observed					

Mean Speeds of the Fastest 15% of Vehicles

During the day (Table 4-60), in the after case for uncongested conditions, Site 1 had higher mean speeds for the fastest 15% of vehicles, while Site 3 had uniformly lower speeds. Results at Site 2 were mixed. Under congested conditions, Site 3 had consistently lower speeds for the fastest 15% of vehicles.

At night (Table 4-61), Site 1 had higher mean speeds for the fastest 15% of vehicles in the after case, while Sites 2 and 3 had lower speeds. Most of these changes were at statistically significant levels.

During the dawn/dusk periods (Table 4-62), Site 1 had uniformly higher mean speeds for the fastest 15% of vehicles in the after case. However, Site 2 had mostly lower speeds, and Site 3 had uniformly lower speeds. Few of these changes were at statistically significant levels.

TABLE 4-60 Mean speeds of fastest 15% of vehicles – day.

Vehicle Type	Case	Lane	Uncongested Conditions at Site			Congested Conditions at Site		
			1	2	3	1*	2*	3
All vehicles	Before	Driving	70.2	75.5	69.2			48.4
		Passing	72.3	75.3	68.5			48.9
	After	Driving	74.2	76.1	66.0			44.4
		Passing	75.4	73.5	65.3			40.8
Passenger vehicles	Before	Driving	70.9	76.1	69.5			48.1
		Passing	72.8	75.9	69.4			49.6
	After	Driving	**75.1**	76.6	**65.7**			42.4
		Passing	**76.7**	74.3	**66.3**			41.4
Non-passenger vehicles	Before	Driving	67.9	71.1	62.0			–
		Passing	69.3	71.7	63.7			44.0
	After	Driving	70.9	71.2	56.4			–
		Passing	71.9	70.4	**60.8**			38.9
* No congested conditions were observed at Sites 1 and 2								

TABLE 4-61 Mean speeds of fastest 15% of vehicles – night.

Vehicle Type	Case	Lane	Uncongested Conditions at Site*		
			1	2	3
All vehicles	Before	Driving	70.76	74.8	64.4
		Passing	74.11	76.7	69.0
	After	Driving	**74.42**	74.1	**58.2**
		Passing	**76.03**	**73.6**	**65.9**
Passenger vehicles	Before	Driving	71.8	75.8	64.1
		Passing	74.8	77.9	71.2
	After	Driving	**75.5**	75.1	58.1
		Passing	75.9	**74.6**	**68.7**
Non-passenger vehicles	Before	Driving	69.4	72.4	62.3
		Passing	71.1	73.5	63.1
	After	Driving	**72.5**	**70.9**	54.8
		Passing	**74.0**	**71.6**	**60.9**
* No congested conditions were observed					

TABLE 4-62 Mean speeds of fastest 15% of vehicles – dawn/dusk.

Vehicle Type	Case	Lane	Uncongested Conditions at Site*		
			1	2	3
All vehicles	Before	Driving	72.8	78.66	68.3
		Passing	76.3	78.49	70.3
	After	Driving	76.9	76.97	–
		Passing	78.2	76.27	68.7
Passenger vehicles	Before	Driving	73.1	73.1	67.3
		Passing	76.8	78.9	71.0
	After	Driving	**78.3**	**77.6**	–
		Passing	**79.4**	77.2	70.0
Non-passenger vehicles	Before	Driving	71.3	74.1	–
		Passing	73.1	76.0	65.5
	After	Driving	73.7	73.7	–
		Passing	74.8	72.7	63.6
* No congested conditions were observed					

Speed Variance Characteristics

This section presents the results for standard deviation of speed and percentage of vehicles traveling within the 10-mph pace during the day, night, and dawn/dusk. A decreased standard deviation of speed and an increased percentage of vehicles traveling within the 10-mph pace indicate an improvement from the before to the after case.

Standard Deviation of Speed

Figures 4-44 to 4-46 show changes in standard deviation by site for the before and after cases. At Site 1, all three categories had higher speed variation in the after case. At Sites 2 and 3, results were mixed.

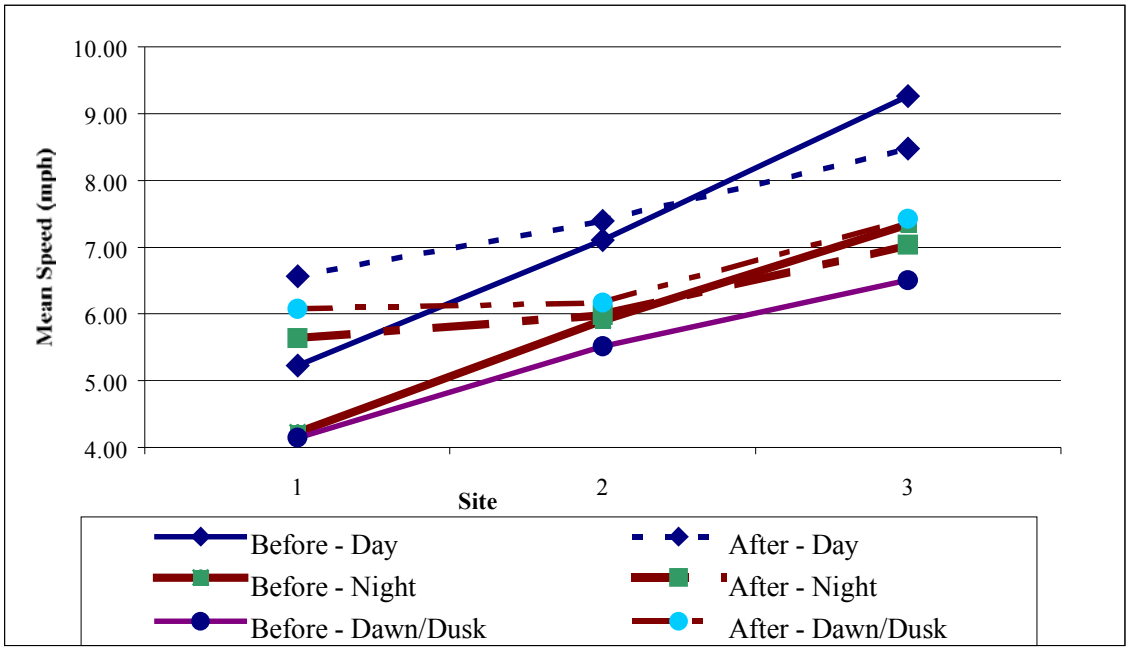

FIGURE 4-44 Standard deviation of mean speed profiles for open lane – *all vehicles.*

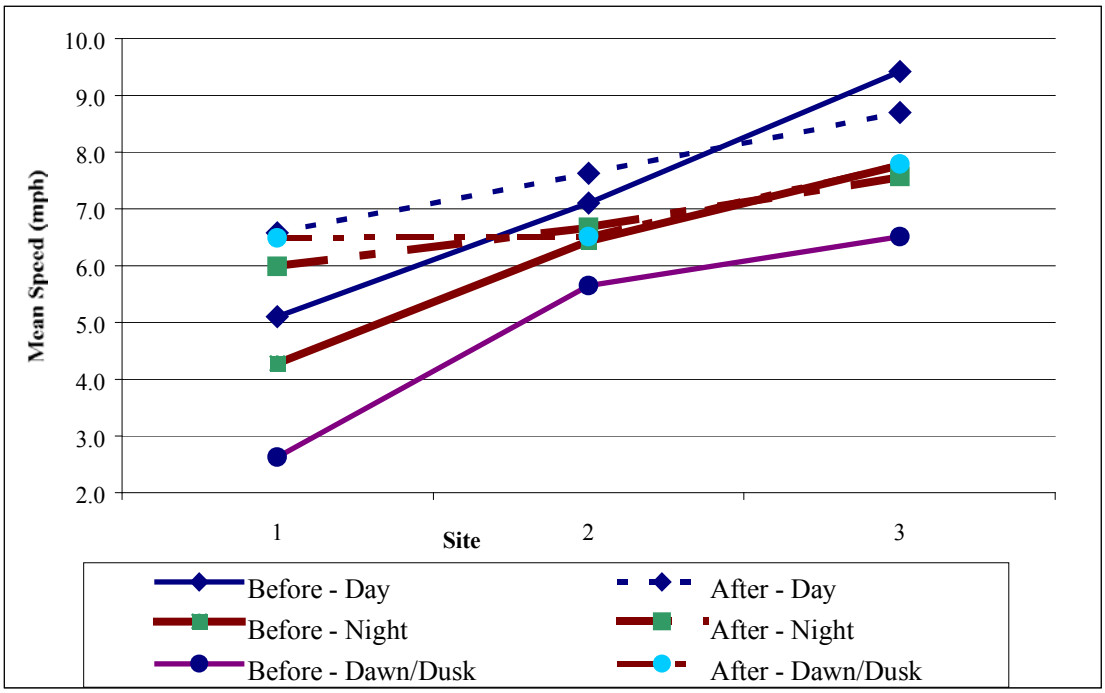

FIGURE 4-45 Standard deviation of mean speed profiles for open lane – *passenger* *vehicles.*

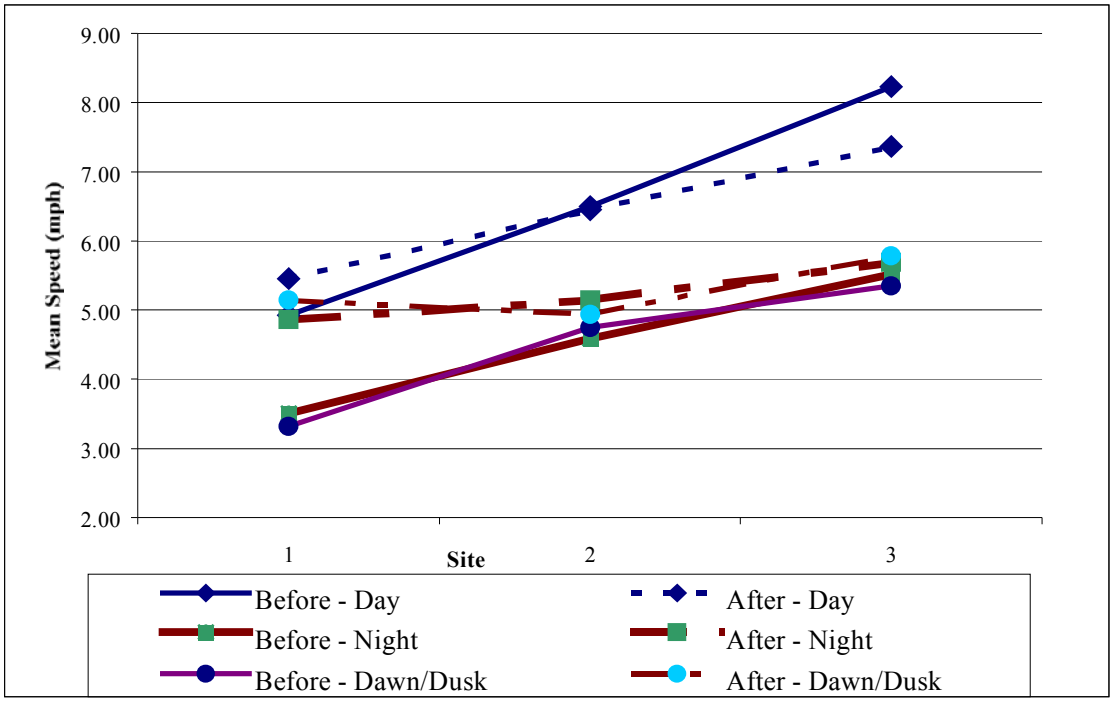

FIGURE 4-46 Standard deviation of mean speed profiles for open lane – *non-passenger* *vehicles.*

Tables 4-63 to 4-65 show the standard deviation of speed at each of the four sites for the before and after cases.

During the day (Table 4-63) in the after case with uncongested conditions, Sites 1 and 2 had uniformly higher (worse) standard deviations of speed. Site 3, under both uncongested and congested conditions, had lower (better) standard deviations of speed. However, none of the differences were at a statistically significant level.

At night (Table 4-64) Sites 1 and 2 had uniformly higher (worse) standard deviations of speed. Site 3, on the other hand, had generally lower (better) standard deviations of speed. However, none of the differences were at a statistically significant level.

During the dawn/dusk periods (Table 4-65), all three sites tended to have higher speed variation in the after case, but the differences were not statistically significant.

TABLE 63 Standard deviation of speed – day.

Vehicle Type	Case	Lane	Uncongested Conditions at Site			Congested Conditions at Site		
			1	2	3	1*	2*	3
All vehicles	Before	Driving	5.09	6.14	10.07			12.88
		Passing	5.22	7.10	9.27			11.37
	After	Driving	6.13	7.02	9.45			10.27
		Passing	6.57	7.40	8.47			8.31
Passenger vehicles	Before	Driving	5.3	6.3	10.11			11.44
		Passing	5.1	7.1	9.42			11.66
	After	Driving	6.4	7.1	8.53			8.54
		Passing	6.6	7.6	8.70			8.40
Non-passenger vehicles	Before	Driving	4.33	4.93	4.79			12.12
		Passing	4.92	6.50	8.23			9.83
	After	Driving	5.04	5.81	4.40			10.46
		Passing	5.45	6.45	7.36			7.72
* No congested conditions were observed at Sites 1 and 2								

TABLE 4-64 Standard deviation of speed – night.

Vehicle Type	Case	Lane	Uncongested Conditions at Site*		
			1	2	3
All vehicles	Before	Driving	4.29	5.62	5.51
		Passing	4.22	5.90	7.34
	After	Driving	6.25	6.40	3.38
		Passing	5.63	5.98	7.04
Passenger vehicles	Before	Driving	4.88	6.22	4.94
		Passing	4.28	6.43	7.77
	After	Driving	7.07	7.03	2.79
		Passing	5.99	6.67	7.58
Non-passenger vehicles	Before	Driving	3.52	4.48	2.17
		Passing	3.51	4.59	5.52
	After	Driving	5.42	5.26	1.89
		Passing	4.86	5.14	5.69
* No congested conditions were observed					

TABLE 4-65 Standard deviation of speed – dawn/dusk.

Vehicle Type	Case	Lane	Uncongested Conditions at Site*		
			1	2	3
All vehicles	Before	Driving	4.86	6.36	6.13
		Passing	4.14	5.51	6.50
	After	Driving	5.97	5.97	6.09
		Passing	6.07	6.17	7.42
Passenger vehicles	Before	Driving	2.31	5.20	5.85
		Passing	2.63	5.66	6.51
	After	Driving	6.29	6.03	6.24
		Passing	6.49	6.51	7.80
Non-passenger vehicles	Before	Driving	4.09	4.90	–
		Passing	3.32	4.75	5.35
	After	Driving	4.87	5.46	–
		Passing	5.14	4.93	5.79
* No congested conditions were observed					

Percentage of Vehicles Traveling within the 10-mph Pace

Tables 4-66 to 4-68 show the percentage of vehicles traveling within the 10-mph pace in the before and after cases.

During the day (Table 4-66), the percentage of vehicles in the 10-mph pace was mostly lower (worse) at Sites 1 and 2, but the results were mixed (some better, some worse) at Site 3. For congested conditions, the plurality of vehicle speeds fell below 30-mph (i.e. in the 1-30 mph interval); therefore, it was impossible to calculate a 10-mph pace.

At night (Table 4-67), the percentage of vehicles in the 10-mph pace was mostly lower (worse) at Site 1 and 2 but higher (better) at Site 3.

During the dawn/dusk periods (Table 4-68) at all sites, the percentage of vehicles in the 10-mph pace was mostly lower (worse).

TABLE 4-66 Percentage of vehicles within 10-mph pace – day.

Vehicle Type	Case	Lane	Uncongested Conditions at Site		
			1	2	3
All vehicles	Before	Driving	73.7	59.9	53.3
		Passing	76.0	58.6	47.1
	After	Driving	**61.0**	**55.7**	47.8
		Passing	**62.1**	57.0	50.2
Passenger vehicles	Before	Driving	70.6	58.8	54.5
		Passing	76.3	57.9	46.3
	After	Driving	**58.5**	**53.6**	53.9
		Passing	**64.1**	**53.7**	48.5
Non-passenger vehicles	Before	Driving	81.3	71.9	52.8
		Passing	84.6	64.7	54.5
	After	Driving	**73.4**	71.0	66.7
		Passing	**68.4**	64.5	59.6

TABLE 4-67 Percentage of vehicles within 10-mph pace – night.

Vehicle Type	Case	Lane	Uncongested Conditions at Site		
			1	2	3
All vehicles	Before	Driving	79.78	68.3	72.3
		Passing	79.48	63.5	54.7
	After	Driving	**62.30**	**62.5**	84.6
		Passing	**66.35**	64.2	**58.9**
Passenger vehicles	Before	Driving	75.7	62.2	74.0
		Passing	79.5	61.1	51.8
	After	Driving	**62.5**	59.4	80.6
		Passing	**67.8**	61.3	56.0
Non-passenger vehicles	Before	Driving	85.3	78.2	50.0
		Passing	87.6	75.4	65.9
	After	Driving	**69.5**	**71.6**	83.3
		Passing	**74.8**	**70.0**	66.2

TABLE 4-68 Percentage of vehicles within 10-mph pace – dawn/dusk.

Vehicle Type	Case	Lane	Uncongested Conditions at Site		
			1	2	3
All vehicles	Before	Driving	76.4	60.74	66.7
		Passing	77.2	63.99	55.9
	After	Driving	**59.7**	62.51	–
		Passing	64.9	56.46	50.0
Passenger vehicles	Before	Driving	71.2	71.2	66.7
		Passing	77.5	63.1	56.4
	After	Driving	**56.8**	61.1	–
		Passing	**61.8**	**49.1**	48.8
Non-passenger vehicles	Before	Driving	89.4	72.7	–
		Passing	89.2	75.5	70.4
	After	Driving	74.7	70.7	–
		Passing	72.3	75.2	62.8

Driver Response and Ease of Use

The responses to the driver survey questions are summarized in Figure 4-47. The CB wizard alert system was installed a few miles in advance of the work zone; therefore, people driving into the work zone were more likely to hear the message than were people driving in the opposite (westbound) direction. Drivers were interviewed between the transmitter and the lane closure. Most of the drivers learned of the work zone from a CB conversation or from the recorded CB message. The majority of the drivers understood all or part of the message, and 97.3% of the drivers felt the information they received was at least somewhat useful. A plurality wanted to be warned about three to five miles before the work zone. The drivers surveyed were enthusiastic about using the CB radios to give warnings about work zones and lane closures.

The CB message exhibited no great difficulty in set-up or use (figures 4-48 and 4-49). Roughly one-half hour was required to become familiar with the equipment, with instruction by a company representative. As part of this process, three individuals recorded trial messages. Particular effort was required to produce a succinct, clear script. One individual required several attempts to record a clear message, free of verbal mistakes. Once a successful message was recorded, the recording equipment, mounted on its trailer, was then towed to its deployment site, near a MoDOT maintenance shed.

Safety

The time periods when the CB message was in place were too short to indicate a statistically significant reduction in accidents. However, a sharp rise in accidents could indicate that the devices are hazardous. No accidents were found to have occurred because of the CB message. The CB message was expected to increase the driver awareness of the work zone well in advance and prepare drivers for the conditions ahead. Drivers would be expected to slow

down and change to the open lane well in advance of the lane closure. If the CB message were to cause an accident, it would be expected to be of the changing lane type. No changing lane accidents occurred when the CB message was tested.

Items	**Proportion**			
What type of vehicle?	Heavy truck or trailer (87.8%)	Light truck/Van (8.1%)	Bus (1.6%)	Passenger car (2.4%)
Which direction of travel?	Eastbound (62.7%)	Westbound (37.3%)	—	—
How many years driving this type of vehicle?	< 1 year (2.4%)	1-2 years (6.5%)	2-5 years (35.0%)	> 5 years (56.1%)
How far in advance of a work zone are warnings needed?	< 1 mile (32.5%)	1-2 miles (14.6%)	3-5 miles (41.5%)	≥ 6 miles (38.2%)
Did you know about the lane closure before starting your trip?	Yes (41.5%)	Yes, but forgot (0.8%)	No (57.7%)	—
How did you find out about the lane closure?	Radio (4.3%)	CB radio conversation (47.1%)	CB radio recorded message (41.4%)	Word of mouth (5.7%)
Did you hear the message in the vehicle you are driving?	Yes (60.2%)	No (39.8%)	—	—
Did you understand the message?	Yes (64.8%)	Yes, but message not clear (31.1%)	No (4.0%)	No opinion (0.0%)
Do you find the information useful?	Very useful (39.5%)	Useful (57.9%)	Not useful (1.3%)	No opinion (1.3%)
Did you drive through a work zone with a recorded CB radio warning before?	Yes (36.1%)	No (63.8%)	—	—
How hazardous are interstate work zones compared to normal highway segments?	More hazardous (55.3%)	About the same (34.1%)	Less hazardous (7.3%)	No opinion (3.2%)

FIGURE 4-47 Frequencies of responses to driver survey questions.

FIGURE 4-48 Inside of CB Wizard alert system.

FIGURE 4-49 Recording CB message.

Conclusions

This study examined the effect of the CB message on vehicle speeds, lane distributions, and vehicle conflicts at a long-term work zone in Missouri. The CB message was primarily

intended to reduce traffic speeds, speed variability, and the percentage of vehicles in the closed lane. The data analysis examined the difference in the parameters before and after the devices were installed. The primary measures of effectiveness were lane distributions, speed mean, and speed variance; however, other parameters were also studied for significance in the evaluation of the traffic control devices. For the before and after studies, the analysis took into consideration the effects of time of day and class of vehicle.

The CB message was associated with improved lane distributions in most cases, for all vehicles, passenger vehicles, and non-passenger vehicles. The improvement was strongest for non-passenger vehicles. In general, the CB message was associated with higher speeds upstream from the lane closure but lower speeds near the lane closure. In general, the CB message was associated with higher standard deviations of speed upstream from the lane closure but lower standard deviations of speed near the lane closure.

Recommendations

Based on the results of this study, a recorded CB message near the beginning of a lane closure on an interstate highway work zone can be expected to be heard and understood by a high proportion of truck drivers. There is strong evidence that truck drivers appreciate the warning and will adjust their lane choice based on the warning. The effect of the warning on speed and speed variance is less certain. There may be some beneficial effect on speed and speed variance near the beginning of the lane closure, but the results are inconclusive.

The primary costs of the CB Wizard Alert System include the system itself and staff time for installation, recording the message, and removal. No lane closures are required as the system is installed, operated, and removed without traffic disruption.