An Evaluation of Dynamic Curve Warning Systems in the Sacramento River Canyon

Final Report

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DISCLAIMER

ABSTRACT

Five dynamic curve warning systems were installed by CALTRANS for advance notification to motorists of alignment changes and speed advisories in the Sacramento River Canyon. The individual sign systems included a Changeable Message Sign (CMS) to display both text and diagrammatic curve warnings. The CMS sign systems were also coupled with a radar measurement and display so that both the advisory speed and operating speed of the approaching vehicles would be identified.

Measures of effectiveness were utilized to evaluate these systems including frequency of crashes/erratic maneuvers, operating speeds, public acceptance and response, and maintenance requirements. Preliminary results indicate reductions in both accidents and operating speeds at selected sites based upon assessment of limited data available and evaluation time period. Motorist acceptance of these systems and desired response is favorable with few maintenance difficulties. It is recommended these systems continue to be monitored for more conclusive results.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

BACKGROUND

In 1994, there were approximately 6.5 million motor vehicular crashes in this country, which cost the United States over $150 billion in associated medical and legal expenses, insurance administration costs, lost productivity, and property damage (1). It is generally acknowledged that countermeasures must be developed and implemented by states to reduce the frequency and severity of vehicle crashes. One method of improving conditions at high crash locations involves alerting motorists of approaching conditions through the use of traffic control devices, including signs, signals, and pavement markings. Different types of signs can be installed, depending on the specific needs of the particular area. General sign types include regulatory, warning, guidance, recreational, and construction or maintenance. Specifically, warning signs are used to inform motorists of conditions to minimize crashes and reduce injuries and crash-related costs. Warning signs are commonly installed as permanent safety improvements, and can be accompanied by regulatory signs.

Because of cost considerations and geographic constraints, such as mountains, canyons, and waterways, some sections of highways are constructed with a lower design speed. Specifically, some horizontal curves may need to have a radius shorter than can be traversed safely at the operating speed for the rest of the highway. Additionally, heavy trucks may need to travel at lower speeds on long, steep downgrades to maintain safety. Where geometric features, such as curves of short radii and long and steep downgrades, cannot feasibly be eliminated from a highway, appropriate warning signs should be placed in advance of these features to warn the driver of a reduction in appropriate speed.

Static warning signs are usually installed at locations where an advisory speed differs from the design speed of the proceeding section of the roadway. Drivers can become desensitized to some common warning applications. In an attempt to increase effectiveness by catching the attention of motorists, changes can be made to the typical placement at the side of the roadway and the traditional static hardware by adding dynamic technologies. For example, to attract drivers' attention, warning signs can be mounted over travel lanes, or flashing beacons can be added to static signs. Intelligent Transportation System (ITS) advancements provide a number of new possibilities for warning motorists of approaching hazards. For instance, ITS technologies, such as changeable message signs (CMS), have proven to be effective in informing and warning drivers, resulting in reductions in crashes and related costs (2). These signs are used by Departments of Transportation to display dynamic information to drivers. CMS are still relatively new and have had limited use in rural areas. Some CMS can present only one of a few predetermined messages, while others can display any message at any time. CMS are useful in problem areas, such as areas with recurring congestion, adverse weather conditions, and frequent road closures or crashes.

Background of Dynamic Curve Warning System

There are strong correlations between the speed of a vehicle and the probability of the vehicle being involved in a crash. Moreover, speed is also related to the severity of a crash. In 1997, 30% of all fatal crashes in the United States had speed reported as a contributing factor. Crashes in which speed was found to be a contributing factor accounted for 13,000 deaths and 41,000 critical injuries. These figures represent the investigating officer's interpretation of "speeding" or traveling at a "speed too fast for conditions" as *one* of the contributing factors to the crash and should be interpreted with caution (3). However, the numbers clearly suggest that excessive speed is a major safety challenge.

Many traditional solutions exist to mitigate speed-related crashes, such as (1) adjusting the speed limit and increasing enforcement; (2) installing static warning signs in advance of changes in alignment, access, or road surface where high speeds could increase the likelihood of a crash; and (3) reconstructing alignments, cross-sections and clear zones to improve a driver's chances to recover from overdriving the highway (4). These solutions may not always be feasible and speed-related crashes may still exist regardless of the countermeasures put into effect.

There are many types of rural ITS applications that can complement the existing infrastructure to improve the safety and efficiency of the transportation system. Some rural ITS applications can provide information to the driver regarding unsafe traveling speeds, particularly in relation to an upcoming hill or curve. The primary purpose of these ITS applications is to reduce crashes by better informing the drivers of what lies ahead on their route and posting an appropriate advisory travel speed. The dynamic curve warning systems installed in the Sacramento River Canyon are examples of a rural ITS application used to enhance safety. The system utilizes CMS to display dynamic warnings in advance of sharp horizontal curves and steep downgrades. This report discusses the findings of the evaluation of the dynamic curve warning system installed in the Sacramento River Canyon.

Interstate 5 between Redding and Dunsmuir, the area known as the Sacramento River Canyon, was selected as the demonstration site for the dynamic curve warning system because of its high traffic volumes, mountainous terrain and the number of crashes specifically related to heavy trucks. In addition to safety costs, crashes involving heavy trucks in this corridor can close the Interstate to travel for several hours. Specific curves were selected for the dynamic curve warning system based on a potential cost-benefit procedure used by Caltrans. The procedure is based on a potential estimation of crash reduction for a five-year period. Table 1 lists the data used for the cost-benefit procedure. Crashes shown in Table 1 occurred between September 1, 1992 and August 31, 1997, and are separated into fatal, injury and property damage only (PDO) categories.

Table 1: Total Crashes for Proposed Sites (5)

Site	Total	Fatal		Injury		PDO	
		#	%	#	%	#	%
Sidehill Viaduct (PM 29.0-29.88 SB only)	30	1	3.3	13	43.3	16	53.3
O'Brien (PM 31.95-32.17 SB only)	21	0	0	6	28.6	15	71.4
Salt Creek (PM 36.7-37.3 SB only)	13	0	0	3	23.1	10	76.9
LaMoine (PM 48.8-49.1 SB only)	14	0	0	4	28.6	10	71.4
Sims Road (PM 58.1-58.2 NB only)	9	0	0	5	55.6	4	44.4

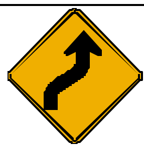
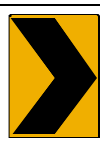
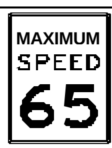
Existing Static Signing

To ensure that static signs will "(1) fulfill a need; (2) command attention; (3) convey a clear, simple meaning; (4) command respect of road users; and (5) give adequate time for proper response" they should comply with the Manual on Uniform Traffic Control Devices (MUTCD) and the Caltrans Traffic Manual for California (6, 7).

Static and dynamic curve warning signs are often used to notify drivers that their speed must be lowered to comfortably drive the curve. Such static signs can be accompanied by a speed advisory plate to further increase safety conditions.

The MUTCD has a designated code for each sign, while Caltrans uses a separate set of codes for identifying standard signs. Table 2 shows the different curve warning and speed signs present in the study area, their respective MUTCD symbol, the corresponding Caltrans symbol, a description of the sign, and its standard dimensions. Caltrans also has four signs not included in the MUTCD, as shown in Table 2.

Table 2: Existing Warning Sign Types (6, 7)

<table>
<tr><th>Graphic</th><th>MUTCD</th><th>Caltrans</th><th>Description</th><th>Standard Dimensions</th></tr>
<tr><td></td><td>W1-2R</td><td>W5 (RT)</td><td>Right Curve</td><td>30” X 30”</td></tr>
<tr><td>
</td><td>W13-1</td><td>W6 (speed)</td><td>Speed Advisory Plate</td><td>18” X 18”
24” X 24”</td></tr>
<tr><td>
</td><td>No MUTCD</td><td>W4 (RT)</td><td>Curve w/ Advisory Speed</td><td>72” X 72”</td></tr>
<tr><td></td><td>W1-4R</td><td>W1 (RT)</td><td>Reverse Curve</td><td>30” X 30”</td></tr>
<tr><td></td><td>W1-8</td><td>W81</td><td>Chevron Alignment</td><td>18” X 24”</td></tr>
<tr><td>
</td><td>No MUTCD</td><td>W4 (RT)</td><td>Curve w/ Advisory Speed</td><td>96” X 96”</td></tr>
<tr><td>
</td><td>No MUTCD</td><td>R48-1</td><td>Speed Limit Plate</td><td></td></tr>
<tr><td>
</td><td>R2-4</td><td>R6(65)</td><td>Speed Limit</td><td>24” X 30”</td></tr>
<tr><td>
</td><td>No MUTCD</td><td>R6-1</td><td>Speed Limit</td><td>24” X 30”</td></tr>
<tr><td>
</td><td></td><td></td><td>Trucks: Sharp Curves;
Steep Grades</td><td>96” X 96”</td></tr>
</table>

Other ITS Applications of Dynamic Warning Systems

Intelligent Transportation Systems (ITS) are the advanced technologies and management strategies used to enhance the safety and efficiency of current transportation systems. There are many different applications of ITS, including lateral collision warning devices, automated highway systems, and dynamic speed warning systems, to name a few.

Dynamic warning signs can be used to mitigate speed in areas where geometric features may make it more difficult for drivers to safely maintain a uniform speed. These warning signs, which may be accompanied by other signs or advisories, can be installed in advance of locations with steep downgrades, areas with weather conditions that can affect safety, construction work zones, and specific curves with high frequencies of crashes. Other states, such as Colorado, Oregon, and Washington, and some European countries have conducted studies and installed similar changeable message sign systems for speed warning and regulation. It should be noted that this area of study is relatively new in the transportation industry and few systems exist that are similar to the dynamic curve warning system installed in the Sacramento River Canyon. The dynamic curve warning system differs from the aforementioned systems because it is the first ITS application to use radar for speed measurement and to sign for a specific curve(s).

In the summer of 1998, a Downhill Truck Speed Warning System was installed in Colorado for commercial vehicles on Interstate 70. The system determines the weight and configuration of commercial vehicles weighing over 40,000 pounds as they pass a weigh-in-motion device. A CMS displays a safe speed for the drivers to travel down the steep grade. According to the evaluation conducted at the University of Colorado at

Denver, the Dynamic Truck Speed Warning System has significantly reduced commercial truck speeds through the steep descent from average speeds of 41 mph to 34 mph (8).

The Oregon Department of Transportation has installed a Downhill Warning System for commercial vehicles traveling on I-84 between Pendleton and La Grande, Oregon. This system utilizes existing infrastructure, including a Mainline Preclearance System used for weigh-in-motion purposes and a CMS, both located at the top of Emigrant Hill. The Downhill Warning System integrated these two existing elements to give a warning to trucks, based on the weight and configuration of each truck. When a vehicle is identified and weighed by the preclearance system, messages are posted on the CMS. The first line reads "TRUCK ADVISORY" and the second line reads "CAUTION". The third line reads "XX MPH DOWNHILL" if an accurate weight is obtained for the vehicle. The displayed advisory speed is dependent on the measured weight of the vehicle. If an accurate weight is not obtained by the preclearance system, the third line will read "STEEP DOWNGRADE". The shipping companies utilizing this system can choose to subscribe to the Green Light Mainline Preclearance Program, which would provide personalized messages to the drivers. When a driver from a subscribing company passes through the system area, the second line displays the company name of the specific truck. An evaluation is currently underway, but no results were available for inclusion in this document. A final evaluation report should be completed in July 2000 (9).

The Washington Department of Transportation installed 13 variable speed limit signs along a 40-mile segment of Interstate 90 over Snoqualmie Pass in December 1997.

Harsh weather conditions during the winter season can increase the risk of traveling this route through the Cascade Mountains. This ITS system includes loop detectors in three different locations throughout the section and the real-time traffic flows collected will help to determine safe speed limits. The CMS display safe, enforceable speed limits for current weather conditions and display messages to inform drivers of closures or the need for chains. Although the variable speed limit is enforceable, if weather conditions are severe enough to alter the speed limit, the Washington State Patrol agree they will most likely not stop anyone on the side of the roadway. A pre-installation evaluation was completed at the University of Washington through the use of simulation to determine if the traveler information conveyed externally (via the variable speed limit signs) and/or any information received in-vehicle were affecting driver behavior. This study concluded the variable speed limit signs had no statistically significant effect on a vehicle's mean speed over longer segments of the route. It was found, however, there was a statistically significant reduction in vehicle mean speed in sections immediately following a variable speed limit sign. A post-installation evaluation is in the process of being conducted and a December 2000 completion is planned (10).

Several European communities have installed changeable message signs to display variable speed limits. Loop detectors have been positioned to maintain real-time traffic flows in order to measure if the traffic is slowing downstream of the CMS. Automated enforcement is used in many areas to ensure that vehicles are following the set limits. This automated procedure eliminates the confusion that standard enforcement officers might face with a constantly changing speed limit. Although these CMS display dynamic speed information, the main purpose of the application is to maintain an adequate level of service on congested freeways; improving safety is a secondary objective (11).

Europeans also have experimented with in-vehicle speed advisories and speed limiters. With such a system, a roadside beacon is placed at areas where lower speeds are desired. When an equipped vehicle passes the beacon, a warning is given to the driver and, if appropriate, the vehicle speed is reduced. Initial trials included small test fleets that did not yield sufficient data to statistically verify any safety benefits. Larger trials are currently underway (11).

Speed warning signs also are used in construction or maintenance work zones to display speeds to both motorists and workers. These signs can be attached to a trailer and displayed to inform drivers of their current traveling speeds. The intent is to slow the drivers to reduce the number of vehicle-pedestrian collisions. Although these systems are widely used around the United States, evaluations are currently unavailable.

SITE DESCRIPTIONS

The five study sites were selected by Caltrans staff, based on a cost-benefit analysis. Each site has unique characteristics that must be considered in the evaluation, as described below.

General Site Descriptions

Caltrans District 2 has installed five dynamic curve warning systems with radar-measured vehicle speed incorporated into the respective changeable warning messages. The five sites, all within Shasta County, include:

1. Sidehill Viaduct, Southbound, Postmile 30.00;
2. O'Brien, Southbound, Postmile 32.30;
3. Salt Creek, Southbound, Postmile 37.53;
4. La Moine, Southbound, Postmile 49.23; and
5. Sims Road, Northbound, Postmile 57.90.

The sight distance for each CMS met or exceeded the manufacturer's specifications. Specifically, for the minimum 18-inch lettering that is being displayed on each CMS, the sign manufacturer specifies a sight distance of 1,000 feet (12). Figure 1 shows the location of each site on Interstate 5.

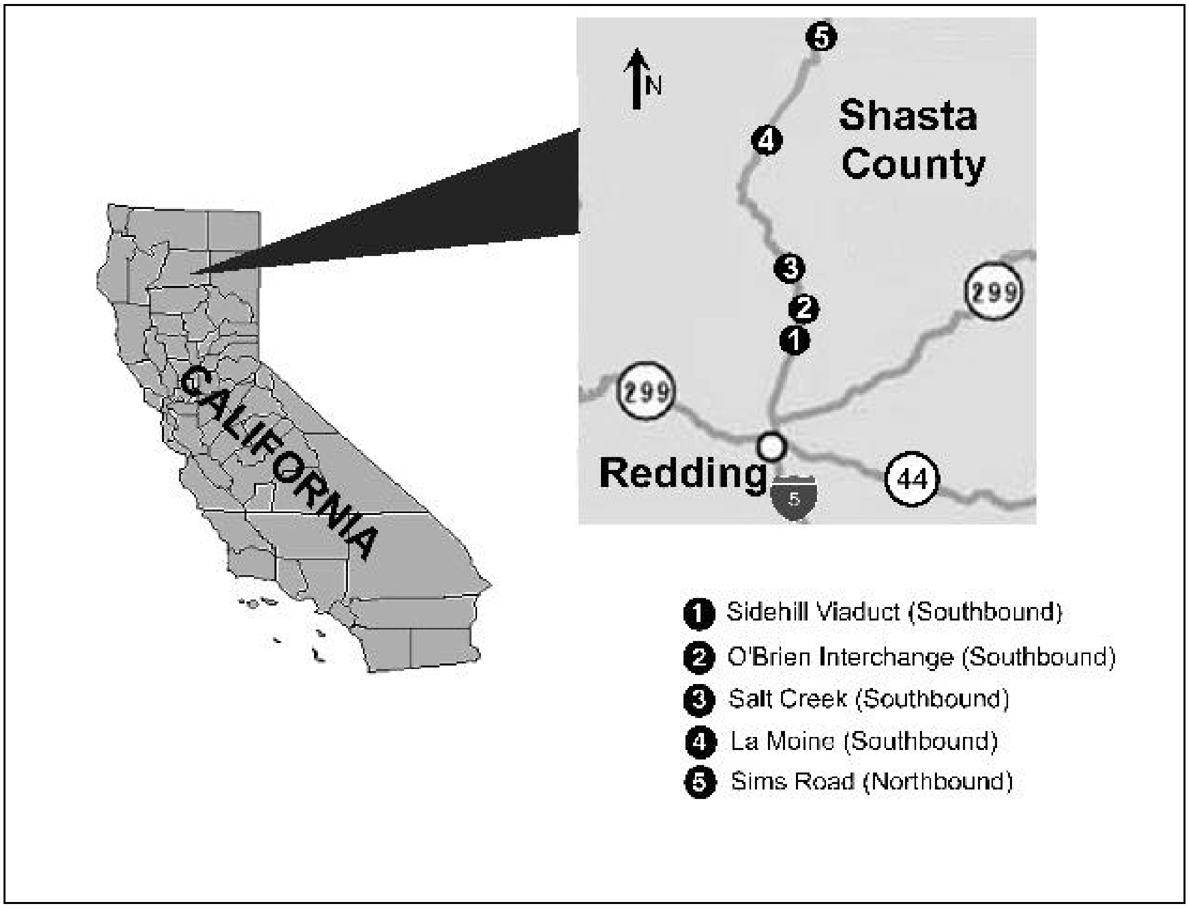


Figure 1: Site Locations in Shasta County

Sidehill Viaduct

Sidehill Viaduct is the southernmost site on Interstate 5. This is the only location where the CMS is on the left-hand side of approaching traffic, due to a steep cut slope on the right side of the road. The curve for which this system applies is approximately one-third of the way down a 6% downgrade on a southbound divided section of I-5 (13). Figure 2 shows the Sidehill Viaduct site and Figure 3 shows the layout of the curve at this site.

Figure 2: Sidehill Viaduct Site Location

At the time of pre-installation data collection, this area had a speed limit of 55 mph. When the second set of data was collected, the speed limit had been increased to 65 mph for passenger cars; the speed limit for commercial trucks remains at 55mph. The advisory speed for the curve has remained at 50 mph.

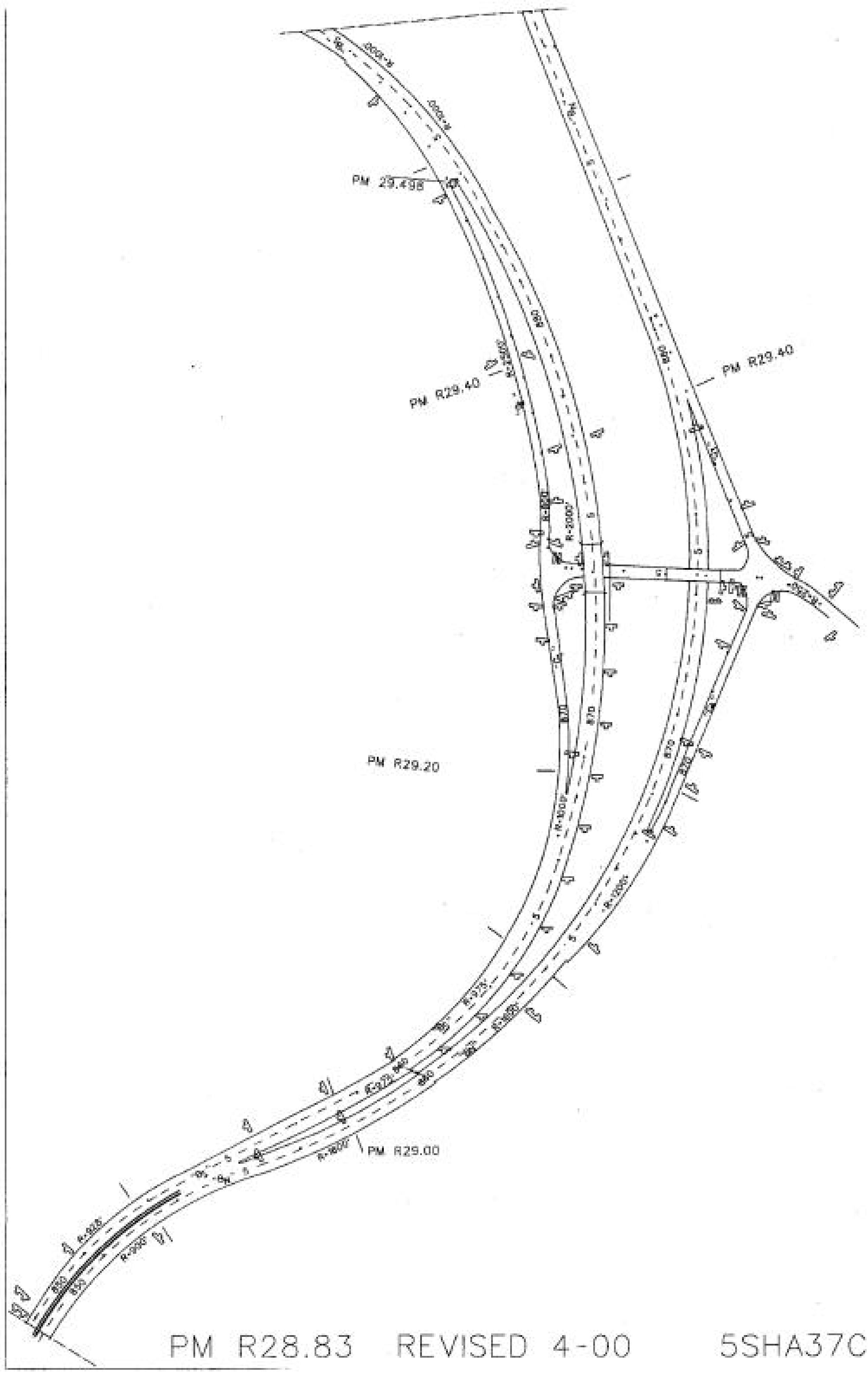


Figure 3: Sidehill Viaduct Curve Layout

O’Brien

The O’Brien site is located facing southbound traffic on Interstate 5. The signed right-hand curve is located preceding a diamond interchange. The photograph in Figure 4 is the O’Brien site, and the layout of the curve can be seen in Figure 5.

Figure 4: O’Brien Site Location

An advisory speed of 50 mph has been maintained throughout the course of the curves at the O’Brien Interchange. Although this area had a 55 mph speed limit at the time of the first data collection trip, it since has been raised to 65 mph for passenger cars. The truck speed limit remains at 55 mph.

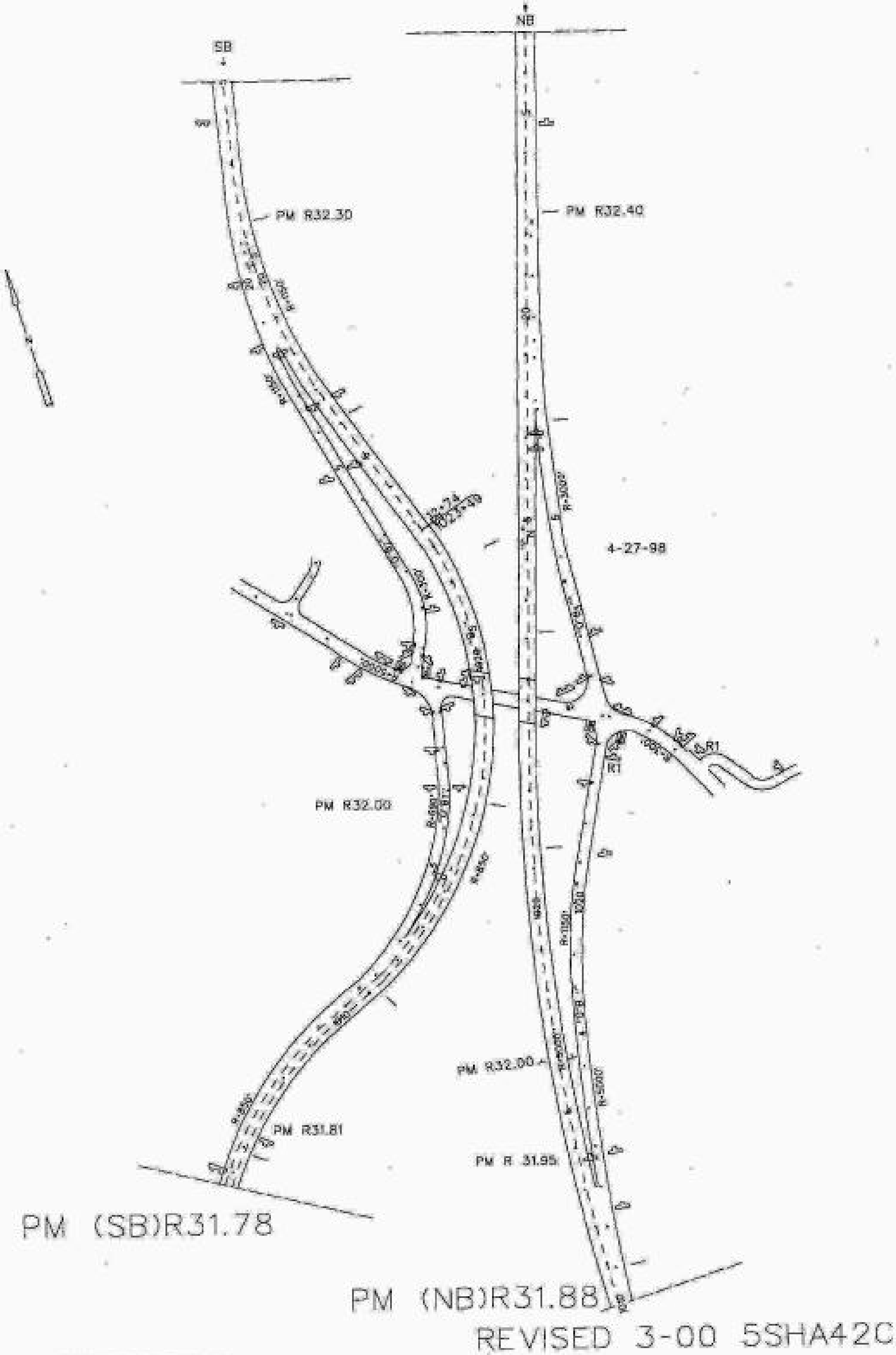


Figure 5: O'Brien Curve Layout

Salt Creek

This site is on Interstate 5 southbound, following the Salt Creek Interchange. Of the two curves following the dynamic curve warning system (shown on the right in Figure 6), the second curve is the principal reason for placing the dynamic curve warning sign in this area. Placing the dynamic curve warning system between the two curves would not have allowed adequate sight distance for motorists to respond prior to entering the second curve; therefore, the dynamic curve warning system was placed before the first curve. A fairly steep downgrade exists prior to and within the first curve. The second horizontal curve coincides with a vertical curve changing from a grade of –5% to +6% (13). The site location at Salt Creek is shown in Figure 6 and the horizontal drawing of the curve is in Figure 7.

Figure 6: Salt Creek Site Location

At the time of the first site visit, this area had a 55 mph speed limit that has been increased to 65 mph for passenger cars. The speed limit for trucks remains at 55 mph, and the curve advisory speed remains at 50 mph.

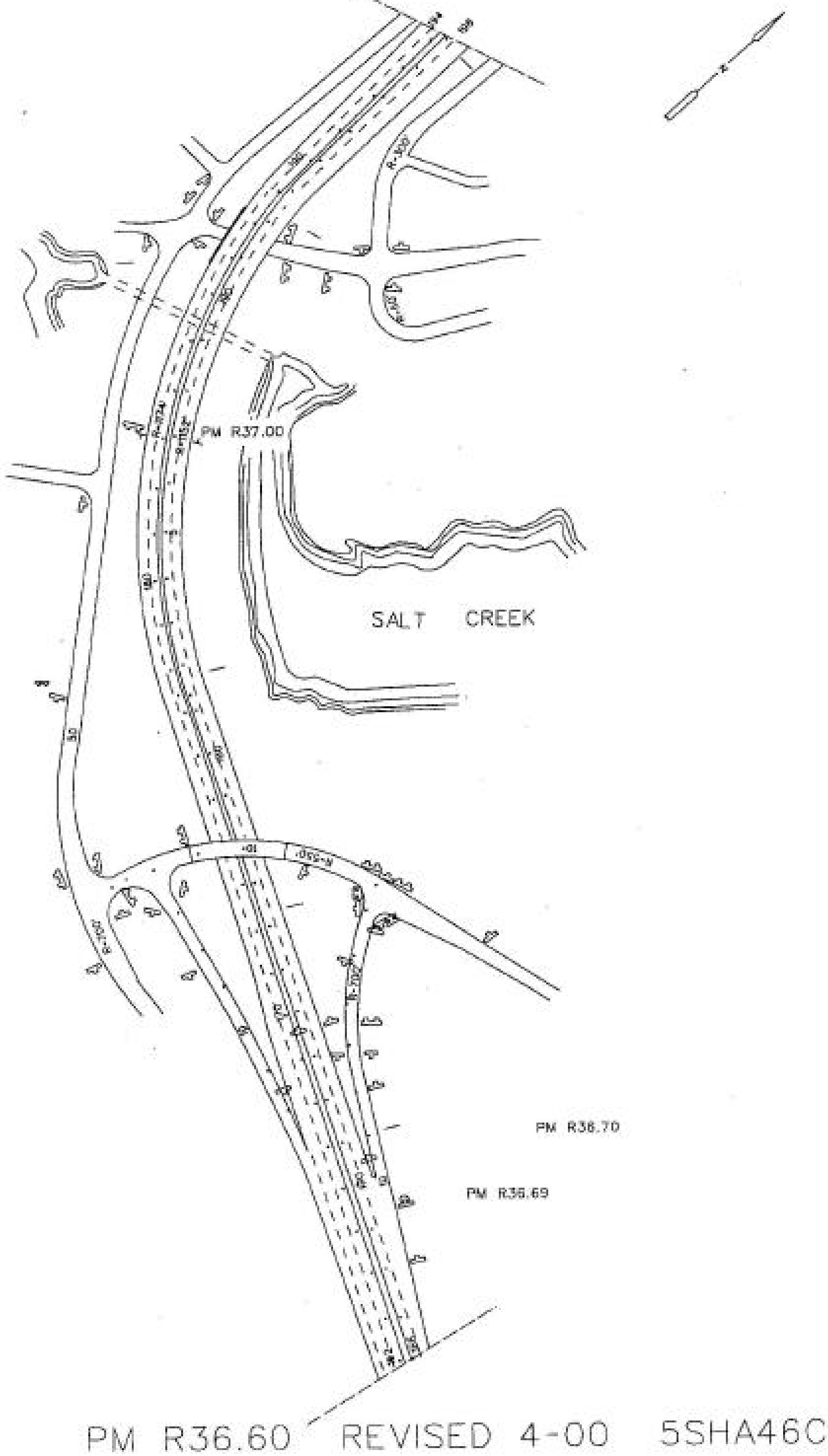


Figure 7: Salt Creek Curve Layout

La Moine

This dynamic curve warning system is located on the southbound side of Interstate 5, near the La Moine Interchange. Following the interchange, the freeway enters an S-Curve (left then right). Although both curves are being signed for, it was assumed that the first curve would better show the direct impact from the dynamic curve warning system message. Speeds at the following curve(s) may be influenced by the vehicle traveling speeds in the previous curve(s). Therefore, data were collected only for the first curve. Figure 8 depicts the La Moine site and curves, and Figure 9 shows the layout of the curve.

Figure 8: La Moine Site Location

Since the study began, this area has maintained a 65 mph speed limit for passenger cars and 55 mph speed limit for trucks. This is the only curve among the five study sites with an advisory speed of 60 mph.

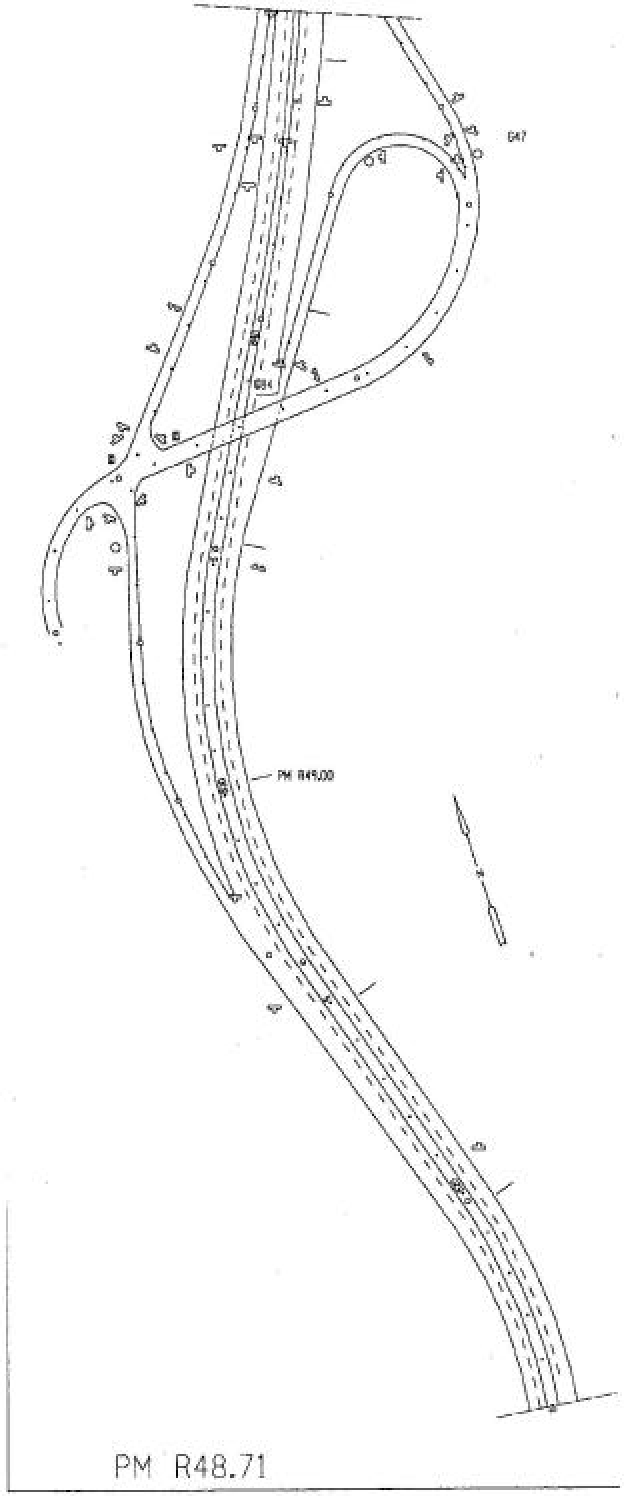


Figure 9: La Moine Curve Layout

Sims Road

The Sims Road dynamic curve warning system is the only northbound study site on Interstate 5. The signed curve is a right hand curve, which is pictured in Figure 10 and drawn in Figure 11.

Figure 10: Sims Road Site Location

This area also has had a 65 mph speed limit for passenger cars and a 55 mph speed limit for commercial trucks throughout the study period. An advisory speed of 50 mph exists for the curve.

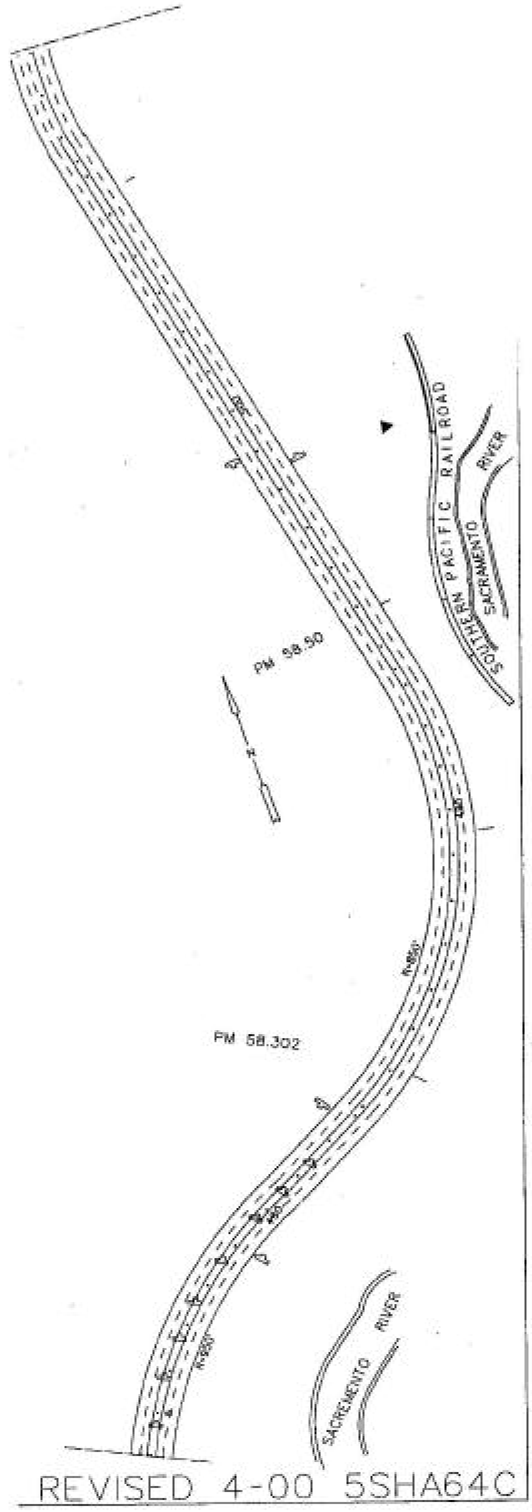


Figure 11: Sims Road Curve Layout

Geometric Features

Some important existing geometric features are included in Table 3 for each of the five sites. The radius of the curve is used to describe the sharpness of the curve (i.e., the smaller the radius, the sharper the turn).

Table 3: Existing Geometric Features by Site (13)

Site: NB/SB	CMS (PM)	Curve	Radius (ft)	Length (ft)	Grade (%)	Posted Advisory Speed (mph)
Sidehill Viaduct: SB	30.00	Left	850	1007.96	-6.0	50
O'Brien : SB	32.30	Right	850	1137.85	+2.7 to +6.0	50
Salt Creek: SB	37.53	Right	1150	855.80	-5.0	50
		Left	1174	1274.92	-5.0 to +6.0	50
La Moine: SB	49.23	Left	1150	928.14	-4.4 to +3.0	60
		Right	1150	1126.50	+3.9	60
Sims Road: NB	57.90	Right	950	1023.08	+1.3	50

Average Annual Daily Traffic (AADT) Figures and Composition

Table 4 includes the 1998 average annual daily traffic (AADT) figures for the appropriate direction of travel at each study site, which is to equal 50% of the total ADT. Two traffic monitoring stations in the area measure directional volumes. During the week of January 3, 2000, the northbound traffic passing the Sims Road site accounted for 50.4% of the total (leaving 49.6% in the southbound direction). The northbound traffic at Fawndale, approximately 3.7 miles south of the Sidehill Viaduct location, accounted for 50.3% (49.7% in the southbound direction) of the total AADT (15). Worth noting is the high percentage of commercial vehicles traveling this route.

Table 4: Average Annual Daily Traffic and Composition of Traffic by Site (16)

Site	Directional AADT	%Truck
Sidehill Viaduct	9300	32.1
O'Brien	9300	34.0
Salt Creek	8600	34.2
La Moine	7900	38.4
Sims Road	7650	37.4

Traffic Control/Warning Signs at the Study Sites

In addition to the dynamic curve warning system, there are other static warning signs located at each site. Table 5 shows the type of static sign, the quantity present, and the location. The sign type is listed by the California sign code (See Table 2 on page 6 for the corresponding MUTCD codes).

Table 5: Existing Features: Warning Signs (7)

Site	CA Code	Description	Qty.	Side: Left (L) or Right (R)	Date Installed or Replaced (I) or Removed (R)
Sidehill Viaduct	W5(LT)	Left Curve	2	L & R	(R) after 8/97
	W6(50)	Advisory Plate	2	L & R	(R) after 8/97
	W4(LT) 60"	Left Curve w/ Advisory Speed	2	L & R	(I) 12/93
	W4(LT) 96"	Left Curve w/ Advisory Speed	1	R	(I) 11/98
	W81	Chevron Alignment	6	R	(I) 3/97
		Trucks: Steep Grades and Sharp Curves	1	L	(I) 8/98
O'Brien	W1 (LT)	Reverse Curve	2	L & R	(I) 6/95
	W6 (50)	Advisory Plate	2	L & R	(I) 6/95
	W5 (RT)	Right Curve	2	L & R	(I) 6/21/95
	W6 (50)	Advisory Plate	2	L & R	(I) 6/21/95
Salt Creek	W5 (RT)	Right Curve	2	L & R	(I) prior to 9/93
	W6 (55)	Advisory Plate	2	L & R	(I) prior to 9/93
La Moine	W5 (LT)	Left Curve	2	L & R	(I) 3/15/99
	W6 (60)	Advisory Plate	2	L & R	(I) 3/15/99
Sims Road	R 6(65)	Speed Limit	1	R	(I) 7/6/97
	R48-1	Radar Enforced Plate	1	R	(I) 10/1/97
	R 6-1	Speed Limit	1	R	(I) 7/6/97
	R48-1	Radar Enforced Plate	1	R	(I) 10/1/97
	W4(RT)	Right Curve w/ Advisory Speed	1	R	(I) 7/16/97
	W5(RT)	Right Curve	1	R	(R) 7/6/97
	W6(50)	Advisory Plate	1	R	(R) 7/6/97
	W81	Chevron Alignment	15	L	(I) 8/28/97

Recent Changes

In order to adequately determine if changes in crashes or driving behavior can be attributed to the dynamic curve warning sign system, it is important to identify any other safety improvements that have been made within the designated stretch of Interstate 5.

This section lists any improvements documented since 1994, in addition to the signing changes noted in Table 5 on page 25.

Table 6: Recent Changes at Study Sites

Site	Change	Date
Sidehill Viaduct	Speed Limit Change	1998
O'Brien	Speed Limit Change	1998
	Asphalt Concrete Resurfacing	After August 1999
Salt Creek	Speed Limit Change	1998
	Asphalt Concrete Resurfacing	1996
	Median Barrier Wall Installation	May 1999
La Moine	Median Barrier Wall Installation	May 1999
Sims Road	None	

The speed limit for trucks and autos with trailers has been 55 mph for all study sites throughout the analysis period. For passenger cars, the speed limit was 65 mph for the La Moine and Sims Road sites throughout the study period. At the other sites, the speed limit for passenger cars was 55 mph during the first data collection trip, but was subsequently increased to 65 mph before the second data collection trip.

The 55 mph speed limit for passenger cars was not immediately changed following the repeal of the national Maximum Speed Limit of 55 mph by Congress in 1995. Since 1995, many states have conducted speed studies and, as a result, increased their speed limits on highways and most of the Interstates. A section in the Sacramento River Canyon, including the Sidehill Viaduct, O'Brien, and Salt Creek sites, was one of the last sections on Interstate 5 in California to be evaluated and the speed limit adjusted accordingly (15). In terms of this evaluation, the speed limit for passenger cars was raised to 65 mph between the first and second data collection trips. It should be noted that this change might have had an effect on the differences in speeds collected prior to, and following, the dynamic curve warning sign system installation. Specific changes by site location are discussed below.

<u>DYNAMIC CURVE WARNING SYSTEM DESCRIPTIONS</u>

The dynamic curve warning system includes the following elements at each site: a changeable message sign (CMS), a radar speed-measuring device, two cameras, video detection software for one of the cameras, and control/communications equipment. This report includes the evaluation conducted on the effectiveness of the CMS and radar unit on driver behavior, and does not include an evaluation of the camera and software functions. The CMS at each location is a 10-foot by 7-foot full matrix light-emitting diode (LED) sign supplied by American Signal Company that allows for 50 columns and 28 rows of lights (<u>12</u>). Each CMS has specific messages and graphics that can be displayed and rotated every three to four seconds. Some of the standard messages are shown in Figure 12.

Figure 12: Some Standard Sign Messages

The Decautor Radar Unit measures speeds accurately between 15 mph and 120 mph on vehicles up to 2500 feet away, depending on the size of the vehicle. Smaller passenger cars can be read from approximately 1250 feet; larger commercial vehicles can be recognized at approximately 2500 feet. The radar unit is mounted on top of the CMS; the radar has a cone of detection of 18° and operates at a frequency of 10.525 GHz ± 5 MHz. The speed measured by the radar unit is used by the controller to determine the appropriate message on the CMS (12). The radar unit does not distinguish between direction of travel and, therefore, it may display the speeds of vehicles traveling in the opposite direction. To eliminate confusion resulting form this phenomenon or doubt on the part of the drivers with regard to the accuracy of the dynamic curve warning sign systems, the radar unit should be angled, if possible, so the cone of vision includes only the relevant travel lanes and does not include lanes traveling in the opposite direction. This is an issue only at the Salt Creek, La Moine, and Sims Road sites. Enough space exists between the two directions of traffic at the Sidehill Viaduct and O'Brien sites that the opposite lane of traffic does not intrude into the cone of vision and, therefore, does not affect the radar readings.

Two fixed-view, closed-circuit television cameras are mounted at each site with one camera pointing in each direction. The camera viewing upstream (facing the traffic approaching the dynamic curve warning system) utilizes the Autoscope Video Vehicle Detection System to detect vehicles and measure their speeds. The video vehicle detection system also is capable of collecting data relating to vehicle headway, vehicle classification, occupancy and volume. The speeds measured by the vehicle detection system are used to provide possible incident warning. If five or more vehicles are traveling at speeds less than 35 mph, a warning message is sent via pager to several key Caltrans personnel. In such an event, the second camera viewing downstream traffic is used for monitoring the roadway, weather, and traffic conditions from the Caltrans District 2 Office in Redding. In the future, these images may be accessible by the public via the Internet (12).

The video elements of each site are controlled by an Adpro controller accessible via telephone line. The systems operate as stand-alone units, but may be controlled and monitored from a personal computer at the Caltrans Redding District Office or a laptop computer at remote locations (12).

Initial costs of the dynamic curve warning system installation are comprised of hardware and construction expenses. The initial costs for the entire system, encompassing all five sites, totaled $565,222. However, this does not mean that a single sign system at each site cost exactly one-fifth of the total cost because there were expenses related to integration between the five individual systems and the setup of the workstation at the District office (12). Operational costs are described in a later section of this report.

METHODOLOGY

According to the *ITS Handbook 2000*, when evaluating ITS applications, there are standard steps to follow in order to demonstrate effectiveness correctly. Measures of effectiveness must be chosen and then site visits must occur during various stages of the evaluation process. Studies must be done before and after the installation of the application to collect both the baseline data and the characteristics after implementation (17). Table 7 shows the measures of effectiveness and data collected based on the goals of the project.

Table 7: Measures of Effectiveness

Goal	Measure of Effectiveness	Data Source
Improved Truck Safety	Change in Frequency of Truck Crashes	TASAS Crash Database
	Change in Frequency of Truck Erratic Maneuvers	Manual Erratic Maneuver Counts
	Change in Truck Operating Speeds	Manual Speed Measurements
	Reported Change in Truck Driver Behavior	Motorist Survey
Improved Passenger Car Safety	Change in Frequency of Passenger Car Crashes	TASAS Crash Database
	Change in Frequency of Passenger Car Erratic Maneuvers	Manual Erratic Maneuver Counts
	Change in Passenger Car Operating Speeds	Manual Speed Measurements
	Reported Change in Passenger Car Driver Behavior	Motorist Survey
Positive Public Acceptance	Reported Public Acceptance	Motorist Survey
Minimal Required Maintenance	Reported Maintenance Requirements	Maintenance Personnel Interviews

The main goal of the dynamic curve warning systems is to reduce crashes involving trucks by increasing truck safety. The same data collected for trucks was also collected for passenger cars because their improved safety may be a secondary benefit. The success also depends on public acceptance of the systems. Additionally, It is desired that minimal Caltrans staff and resources be required for the maintenance of the systems.

As shown in Table 7 the data collected to measure the effectiveness includes (1) crashes, (2) vehicle speed, (3) erratic maneuvers, (4) motorist survey, and (5) maintenance survey. This section details the methodology for the collection and analysis of each of these data elements.

To collect this data, a total of four site visits were completed over the course of the evaluation. The first trip occurred on June 4-6, 1998, approximately nine months prior to the final installation of the dynamic curve warning system, and included the collection of the baseline speed and erratic maneuver data. Shortly after the completion of the dynamic curve warning system installation, the next visit was made on May 18 and 19, 1999 in order to see how drivers were initially reacting to the new systems. Only four of the five sites were visited at this time, due to construction taking place at the Salt Creek site. Although traffic was moving at the Salt Creek site, the lane closure and construction activities made any data collection invalid. Data measurements at Salt Creek were collected during the remaining two trips. The motorist survey was conducted for the first time during this trip, as well. The third trip was made three months later on August 17-19, 1999 to observe if drivers were becoming desensitized to the dynamic curve warning systems, and to determine if system effectiveness was reduced over time. The final visit was made on January 3 and 4, 2000 to see if there was any further desensitization and if drivers behaviors differed under potentially inclement weather conditions. In addition to the data collected at each curve, the second administration of the motorist survey was completed during this fourth trip. The curve data were collected during daylight hours and the survey was administered during both daylight and nighttime hours. The weather for all of the sites for each of the trips was sunny and clear, with the exception of the Sidehill Viaduct and O'Brien sites in January 2000 when it was raining and/or the roadway was wet.

Crashes

Reductions in crashes are a substantial measure of effectiveness for safety improvements in transportation systems. Costs can be associated with each crash to determine the dollar savings that correspond to the reduction in crashes. Combined with the costs of the system, these values can be converted into a benefit-cost ratio, which is a standard form used to express the effectiveness of a safety improvement (2).

Crash records for the five years prior to dynamic curve warning system installations were gathered and a 6-month average was calculated. For each curve, the crashes taking place between the dynamic curve warning system location (or planned location) and one-tenth of a mile following the endpoint of the particular curve were examined. Once the pre-installation crashes were compiled, post-installation crash records were gathered for comparison purposes. Due to the short period of time between the installation of the dynamic curve warning system and the completion of this evaluation, insufficient data have been collected to determine if any observed reductions in crashes were statistically significant. Rather than statistically testing, crash frequencies were simply examined to determine if there were any changes within the first six months following the dynamic curve warning installation.

Speeds

During each of the four site visits, vehicle speeds were measured at two locations at each site: at the CMS location (or planned location) and then at the approximate beginning of the curve.

Method of Speed Measurement

According to *Traffic Engineering*, speed data are typically collected using one of four measurement methods, including (1) the use of a speed measuring unit (i.e., radar or laser) to find spot speeds, (2) timing drivers as they cross over a relatively short, pre-measured distance for spot speeds, (3) timing drivers as they pass through a longer section of roadway (also pre-measured) to determine space mean speeds in the area, and (4) timing several test runs through sections of the road, also for space mean speeds (14). For this evaluation, a spot speed was desired. The manual timing method was chosen over the use of a radar or laser unit for various reasons, as discussed below.

Radar may bias the sample by (1) placing an obstruction near the traveled way, and (2) imitating speed enforcement. When using radar, there is an error associated with the angle between the radar path and the line of traffic. To minimize this error, data collectors would control and read the radar units from parked vehicles in the shoulder (as close to the traveled way as possible to achieve the best measurements). It is commonly accepted that free-flow speed is affected by obstacles within close lateral proximity to the traveled way (18). In terms of bias associated with the imitation of enforcement, drivers with radar detectors may slow their speeds upon receipt of the radar signal. Similarly, when drivers without detectors catch their first glimpse of a parked vehicle with a radar unit, they may reduce their speeds for fear an enforcement official is measuring speeds. Reductions in speed resulting from fear of enforcement might affect the dynamic curve warning system effectiveness.

Because concerns exist with the accuracy of the stopwatch method, a comparison was made between stopwatch-measured and radar-measured speeds. Speeds were measured at the O'Brien and La Moine sites using stop watches while, simultaneously, the same vehicle speeds were measured with a radar unit along the roadside. In all, 42 vehicles were measured. Stopwatch-measured speeds averaged 1.1 mph lower than the speeds measured by radar units (see Appendix A). Assuming (1) a normal distribution, (2) a 95% confidence interval and (3) the radar-measured speed is the accurate speed, the stopwatch-measured speed will have an error of less than 1.5 mph. In actuality, however, the radar-measured speed is likely in error by as much as 0.5 mph due to rounding, because it measures speed to the nearest 1mph. Although the stopwatch method does contain some error, the researchers believed the stopwatch method to be the best viable option, due to radar's potential for measurement error and its probable influence on speeds, as discussed previously.

In addition to biasing the data, the data collectors were concerned about safety risks associated with positioning an obstruction (i.e., the radar collection setup) near the traveled way. The manual speed measurement method allowed data collection personnel to measure speeds from a vantagepoint well away from traffic. This method was felt to be a safer alternative and it minimized adverse effects on traffic flow compared to radar measurement methods. Road tubes also were considered, but could not accurately track the same vehicle through both measurement sections without significant costs associated with both setup and software development.

One disadvantage of measuring speeds by use of a stopwatch is that this method primarily determines a vehicle's average speed over a given distance. Thus, there is an inability to know if, and at what point, reductions in speed are occurring over the course of the marked distance. According to *Traffic Engineering*, however, the times produced with the stopwatch method can be used to calculate instantaneous spot speeds (14).

Statistical procedures, which took into account such factors as the type of highway, determined that approximately 50 to 100 vehicles at each curve would serve as sufficient sample size for proposed analyses. In order to use statistical tests, data must be random and independent of other data in the datasets. To ensure the selection of vehicles complied with statistical requirements and to include all types of vehicles (e.g., fast vehicles, slow vehicles, commercial trucks, and platoon leaders), every fifth vehicle was chosen for inclusion in the sample (14). Any number could have been chosen as long as there was consistency (i.e., every vehicle, every tenth vehicle, etc.), so the use of every fifth vehicle was based on abilities of data collectors to keep up with the rate of data collection. Collecting data on every vehicle was not possible due to the amount of data elements collected and every tenth vehicle would have been too time-consuming. Vehicle selections do not exclude those traveling at encumbered speeds, but due to the low traffic volumes at the designated study sites, all vehicles can be considered to be operating at a free-flow speed. Radios were used to communicate the description of the vehicle to the downstream data collectors in order to track the same vehicle through both speed measurement sections.

Positioning for Measurement

The recommended speed measurement section lengths range from 50-300 feet, based on the expected average speed. The advisory speeds of the curves ranged from 50-60 mph and, therefore, a length of 300 feet was utilized for the speed measurement sections (14). Speed section locations were chosen to correspond with (1) the beginning of the curve, and (2) the planned or actual CMS location. Speeds measured in the second section (i.e., at the entrance to the curve) collected during different visits were compared with one another to determine if the dynamic curve warning signs were effectively warning drivers of the curve. In other words, if speeds as vehicles were entering the curve during post-installation trips were slower than speeds measured during the pre-installation trip, it could be inferred that the sign was having a desired effect by reducing speeds. The average changes in speed between the two measurement sections also were analyzed to assess the effectiveness of the dynamic curve warning system.

The first speed measurement section was measured from the CMS location to 300 feet upstream, and the second section was measured from the approximate beginning of the curve to 300 feet upstream. Brightly colored paint was used on the laneline to mark the beginning and endpoint of each speed section. To observe the vehicles and record the requisite information, data collectors sat between the two points. Because a tire from each vehicle could be followed as it crossed the painted marks, parallax error was negligible (14). Figures 13-17 display site diagrams from each site, showing the speed measurement section setup and positioning of the data collectors.

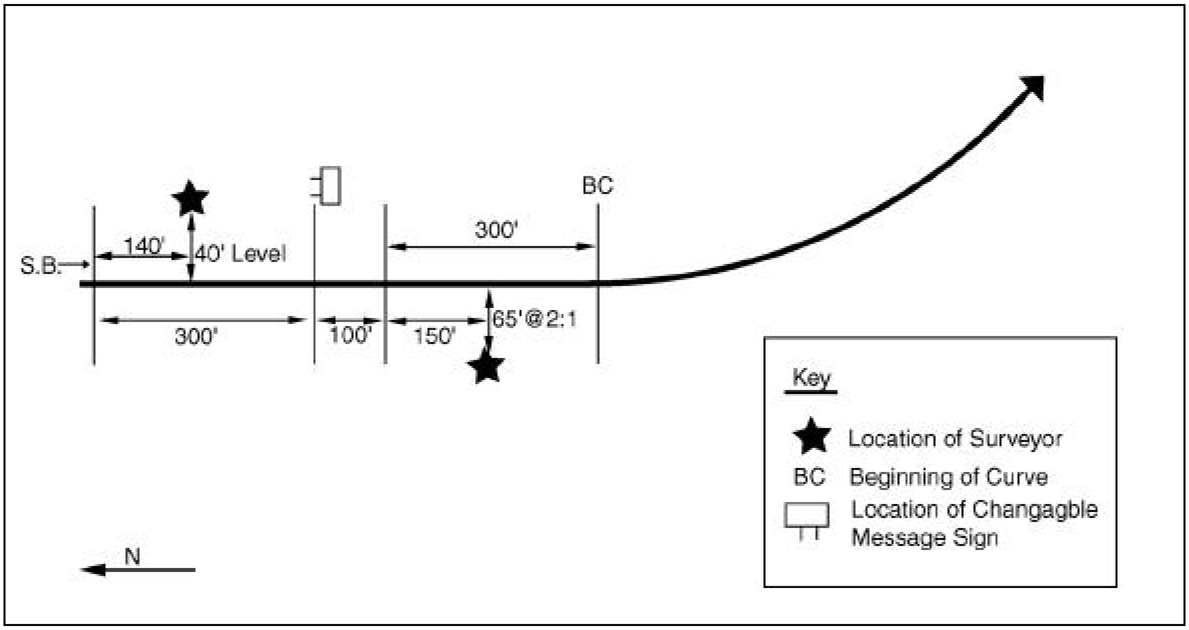


Figure 13: Site Diagram: Sidehill Viaduct

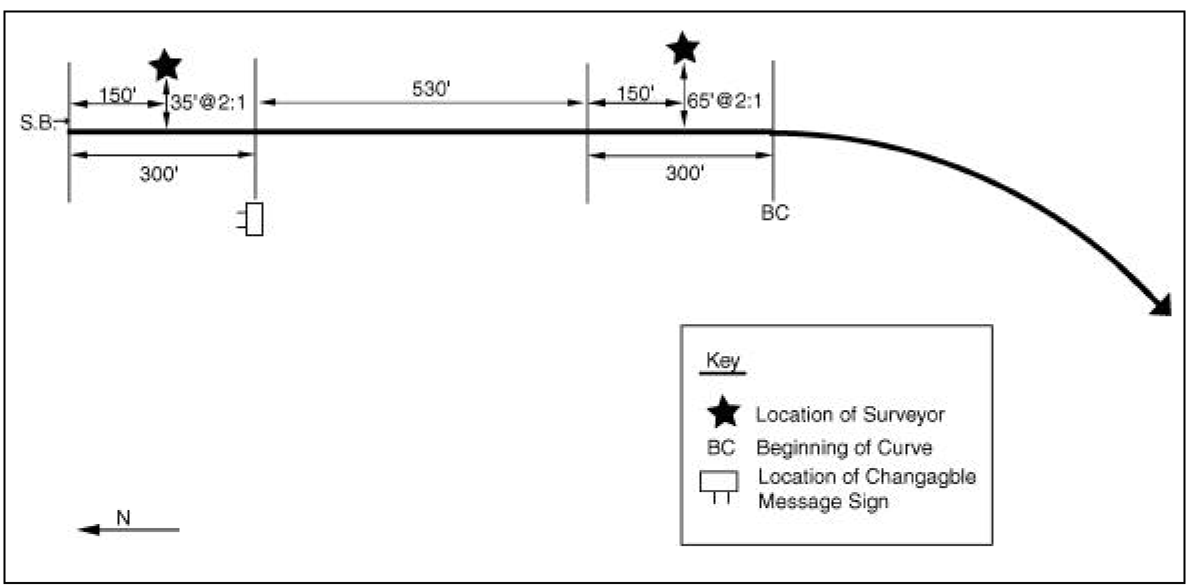


Figure 14: Site Diagram: O'Brien

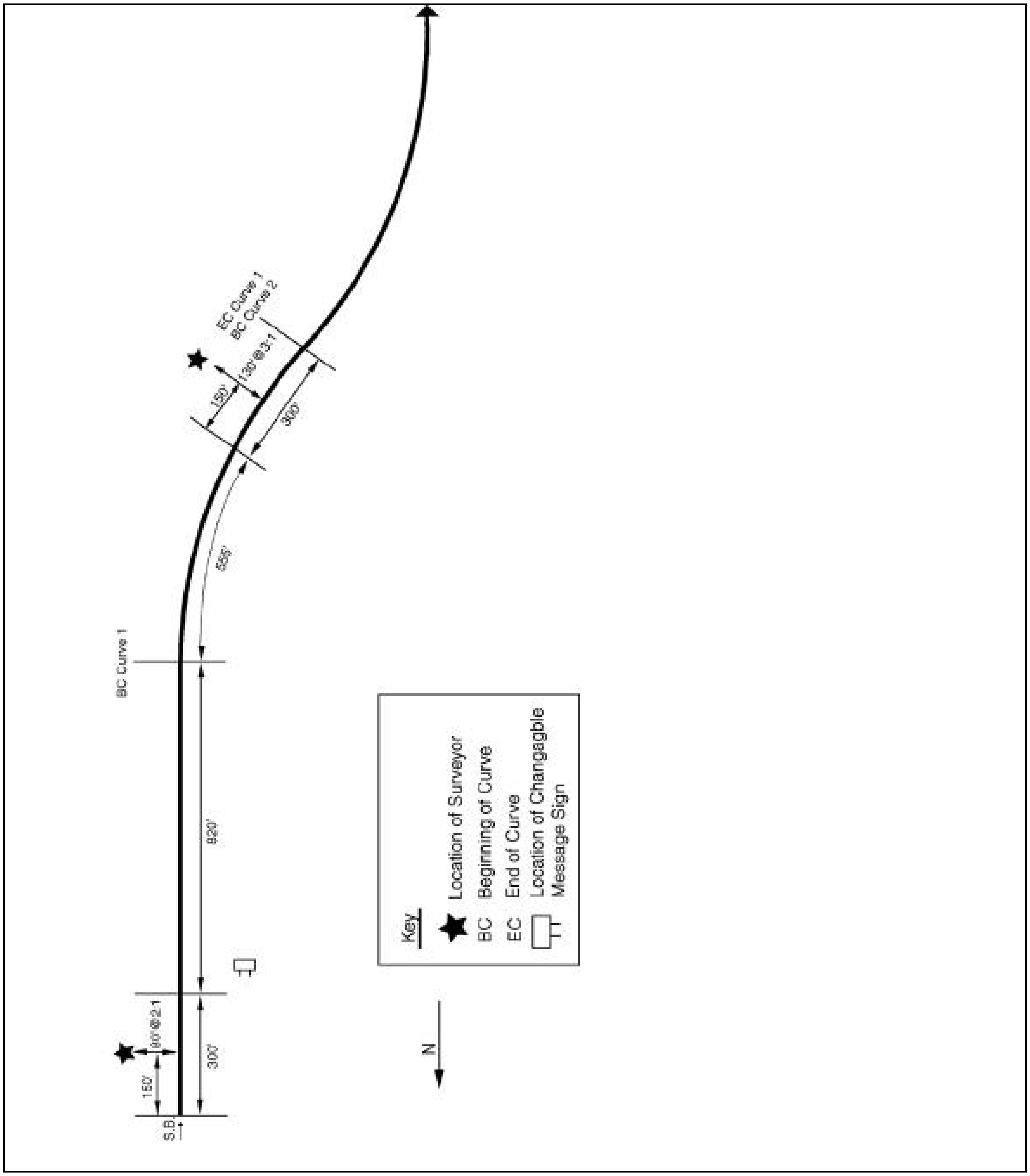


Figure 15: Site Diagram: Salt Creek

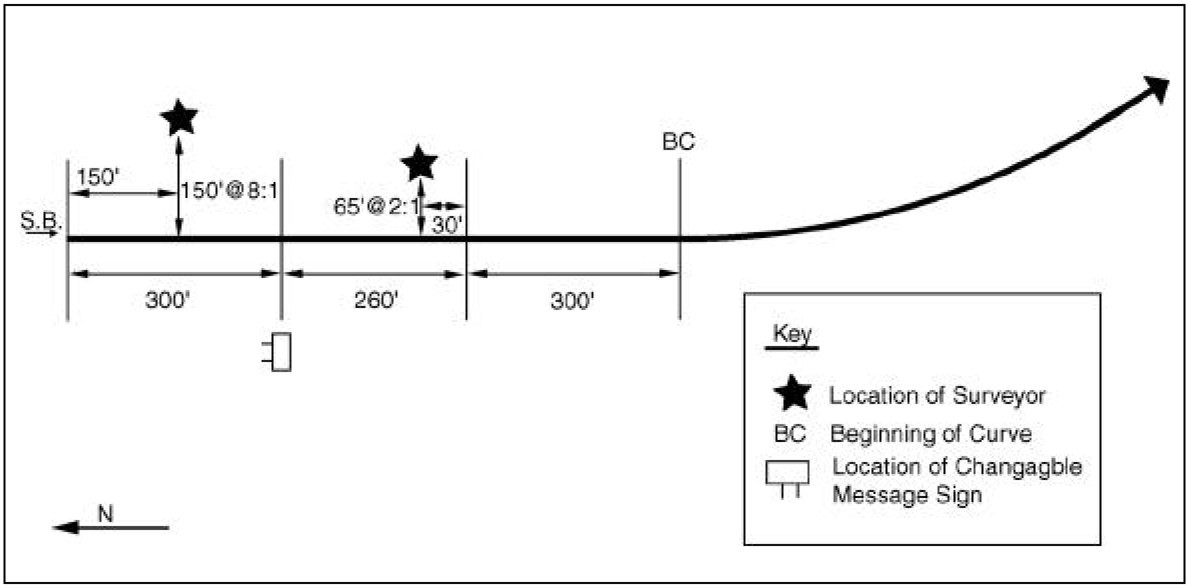


Figure 16: Site Diagram: La Moine

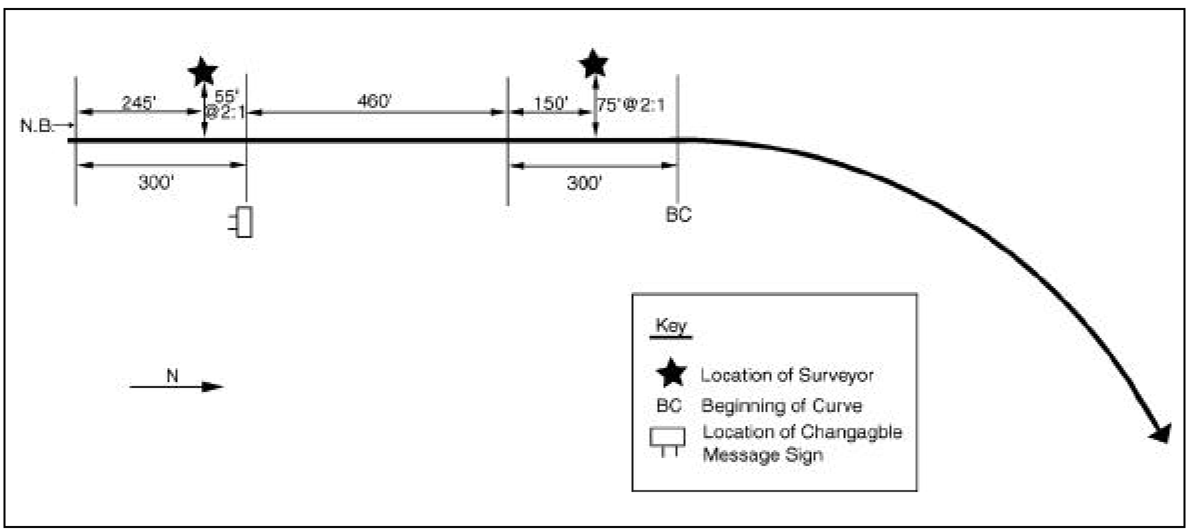


Figure 17: Site Diagram: Sims Road

Three people were stationed at each site: two people at the first speed measurement section, and one at the second. One person at the first speed section collected vehicle characteristics (i.e., vehicle type, lane of travel) and measured vehicle times, while the other person communicated which vehicle was chosen to the collector at the second speed section. The person at the second speed measurement section read the time measurement and recorded any movement outside the lane boundaries or braking activity.

Erratic Maneuvers

Maneuvers conducted while a vehicle is in the curve, such as the actuation of brake lights or lane line encroachments, *may* indicate drivers are attempting to complete a curve at an unsafe speed and correcting for their actions. It is important to understand that these maneuvers are not necessarily indicative of emergency reactions but, rather, may have been executed so as to make drivers feel more comfortable as the curve is traveled. In some cases, brake action may be caused by the curve being located in a continuous downgrade. The number of these maneuvers at a site, however, may be related to crash frequency; therefore, these measurements were studied to monitor changes at curves equipped with the dynamic curve warning signs.

Any erratic maneuvers made while traveling the curve, including lane encroachments and brake light actuations except at the rather steep downgrades at or prior to Sidehill Viaduct, Salt Creek, and LaMoine, suggest the corresponding drivers *may* be traveling at a speed too fast for safe negotiation of the curve. During each trip, any erratic maneuvers were recorded at each site to determine how drivers handled the curve. The maneuver data were collected on the same vehicles as the speed information, which enabled statistical analyses to be conducted in conjunction with the corresponding speed data.

Lane Line Encroachments

While in the process of traveling a curve, vehicles sometimes leave the lane and/or traveled way. This may or may not indicate a driver is having problems safely completing the curve. However, a lane or traveled way departure could result in a crash if it causes the driver to lose control of the vehicle. If the vehicle leaves the traveled way, it could collide with roadside obstacles, or if it crosses the lane boundaries, it could strike another vehicle in an adjacent or opposing lane. Rain, snow, or slippery roads can exacerbate these effects. It is possible the driver may be moving in such a way as to simply flatten out the curve for a smoother drive, change lanes after passing another vehicle, or miss uneven bumps in a lane. In such cases, safety is less apt to be an issue and the maneuvers are less accurately defined as "erratic". However, the frequency and type of the maneuvers *may* correlate to the frequency of crashes and, therefore, these actions were recorded for analysis.

There are several different ways for a vehicle to leave the lane, which are described below in Figures 18-20. The inside lane maneuver refers to the lane that is on the inside of the curve (i.e., for a left curve, the left lane would be the inside lane). An outside lane maneuver, on the other hand, refers to the lane opposite the curve.

Inside/Outside Edgeline: This particular type of maneuver occurred when the vehicle crossed the painted stripe with two wheels from the inside or outside lane and then returned to the travel lane (Figure 18).

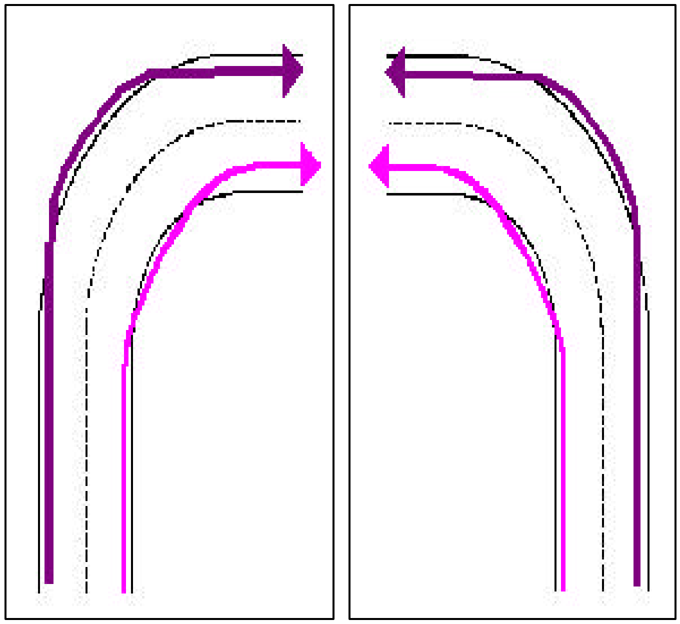


Figure 18: Erratic Maneuvers – Inside/Outside Edgeline

Cross Laneline: Records were kept when the vehicle crossed the laneline to the other lane and then returned to the original lane (Figure 19).

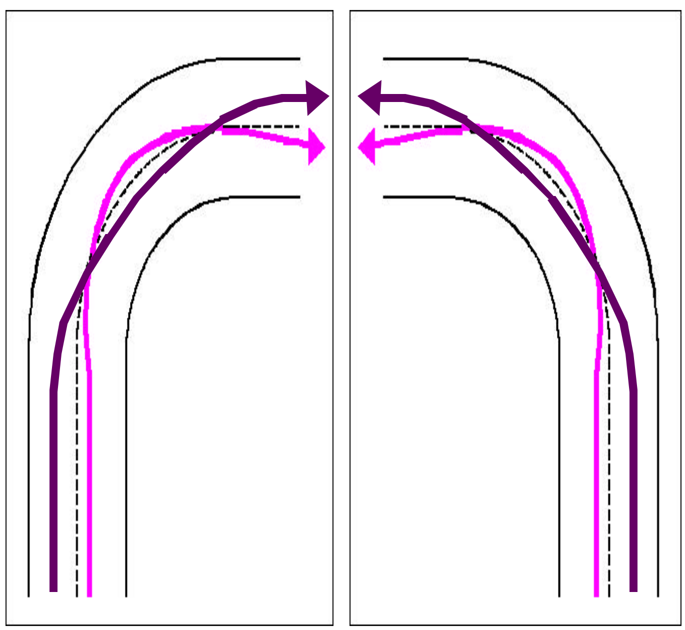


Figure 19: Erratic Maneuvers – Cross Laneline

Lane Change: If a vehicle was performing a full lane change during the curve, this was classified as a "Lane Change" maneuver (Figure 20).

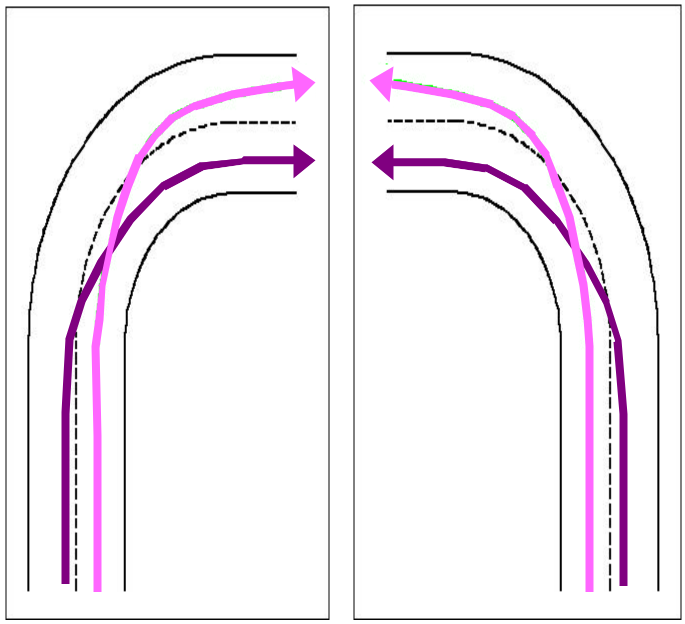


Figure 20: Erratic Maneuvers – Lane Change

Brake Light Actuation

Observing the driver's brake lights is another good way to determine if drivers may be prepared for a particular curve. If brakes are not used during a curve, the driver apparently felt comfortable completing the curve at the speed he was traveling when he entered the curve. Conversely, if the brake lights are actuated during a curve, this implies a driver *may* have been uncomfortable with the speed he was traveling. Brakes are often used by drivers to continually slow themselves when a downgrade or vertical curve is present in the horizontal curve, so this action does not necessarily mean the driver is traveling at an unsafe speed. The only brake light actuations that were recorded were those that occurred while the vehicle was in the curve.

Motorist Survey

During the second and fourth site visits, a motorist survey was conducted to collect input about the dynamic curve warning system from the driving public. The motorist survey consisted of questions for the public concerning their opinions of the importance, placement, and visibility of the signs. The survey was designed to gather information from commercial vehicle operators, passenger car drivers, and recreational vehicle drivers. A copy of the survey instrument can be found in Appendix B. Furthermore, all results have been broken down by vehicle type, with the exception of the answers to the visibility question, where results were separated by the time of day the survey was administered (day versus night).

A total of 250 surveys per trip was completed during each administration, with the sample split between locations and times as follows: (1) 100 surveys were administered during the daytime at the 76 Travel Center in Redding, south of all sites; (2) 50 surveys were administered at the same truck stop after dark; and (3) 100 surveys were administered during the daytime at the Lakehead Rest Area, south of the La Moine site. The 76 Travel Center was used as a survey location to reach operators of commercial vehicles. Surveys collected at night were at the request of the study sponsor to evaluate the visibility of the CMS during dark conditions. Surveys completed at the Lakehead Rest Area focused on the opinions of passenger car and recreational vehicle drivers. Dates and times of survey administrations are as follows:

- The 76 Travel Center on May 20, 1999 from 11:00 AM to 4:00 PM;
- The 76 Travel Center on January 6, 2000 from 10:30 AM to 2:30 PM;
- The 76 Travel Center on May 20, 1999 from 10:00 PM to 11:30 PM;

- The 76 Travel Center on January 6, 2000 from 7:00 PM to 8:30 PM;
- The Lakehead Rest Area on May 21, 1999 from 11:00 AM to 2:30 PM; and
- The Lakehead Rest Area on January 5, 2000 from 9:30 AM to 12:30 PM.

Surveyors verbalized each question to the participating respondents; every attempt was made to ask survey questions without biasing the responses. Brochures with pictures and additional information were used to help describe the signs, and participants were allowed to keep them if they chose to do so.

Maintenance Personnel Interviews

Telephone interviews were conducted with selected Caltrans personnel to determine any construction and maintenance issues associated with the dynamic curve warning system. Interviews were held prior to the third data collection trip in August 1999, and again in March 2000. Among the interviewed Caltrans District 2 employees were Roy Arnett, Electrical Supervisor for Maintenance Crew; Tim Huckabay, Chief Traffic Operations; Jim Elgin, Transprtation Engineer/Electrical; Chuck Lees, Project Engineer; and Norville Hanke, Maintenance Road Supervisor. An informal method of interviewing was used, but certain key topics were addressed with each individual. Questions included:

- Has any maintenance been required on the dynamic curve warning system since installation?
- If so, who conducted these activities (Caltrans or a vendor)?
- If there were maintenance activities, rate the difficulty/ease of the activities completed by Caltrans or the task of working with vendors.

In addition, any general comments were welcomed and recorded.

Statistical Analysis

In order to determine if observed changes in vehicle speeds or erratic maneuvers were statistically significant, standard statistical analysis methods were used, as described by Kleinbaum, Kupper, and Muller (19). Statistically significant differences would indicate the dynamic curve warning signs are effective in reducing speeds and/or erratic maneuvers. For each statistical test, a 95% confidence level ($\alpha = 0.05$) was used to determine statistical significance. Throughout the remainder of this document, any reference to a significant difference in the before/after comparisons refers to statistical significance at the $\alpha = 0.05$ level. It was assumed that data collected for trucks could differ immensely from passenger car data; therefore, each vehicle was classified as a truck or non-truck for purposes of analysis. Specifically, the truck category includes commercial vehicles, vehicles towing trailers, and recreational vehicles; the non-truck category includes passenger cars and pickups. Commercial vehicles and automobiles towing trailers share a speed limit of 55 mph through all of the study sites, but recreational vehicles have a 65 mph speed limit, just as the passenger cars and pickups do. This could have biased the speed results. However, there were not many recreational vehicles. Therefore, the bias in this case has been assumed to negligible.

Speed and erratic maneuver data were compared using two sample t-tests and two sample binomial tests. Among other assumptions, both types of tests require that the data be collected independent of other collected data (19). As mentioned previously, every fifth vehicle was observed in order to comply with the sampling requirements.

Two sample t-tests are used when there are two sets of data that are not dependent on one another. For instance, speeds collected of separate vehicles were independent of each other. A comparison was made between one set of measurements collected during the pre-installation visit and another set gathered after the installation of the dynamic curve warning system. A two sample t-test was used in this case to determine if there was a statistically significant difference in speed after the installation of the system (19). The two sample t-test also was used to compare the differences in speed (between the CMS and beginning of the curve) between each data collection visit.

When comparing two percentage values that are not dependent on each other, a two sample binomial test can be used (19). A two sample binomial test was conducted to compare the percentage of drivers executing erratic maneuvers before and after the dynamic curve warning system was installed.

Unfamiliar Motorists

Because unfamiliar drivers are less aware of the road geometrics than drivers who frequently travel the route, they may drive with a different level of attentiveness and caution. Familiar drivers may ignore posted advisory speeds, relying on their familiarity with the geometry of the roadway to determine an appropriate travel speed. Thus, the dynamic curve warning system may have different effects on familiar and unfamiliar drivers. In an attempt to categorize drivers on the basis of their familiarity with the roadway, license plates were used as a surrogate measure of a driver's experience with the route. That is, if the license plate was from a different state, the driver was assumed to be an unfamiliar driver. Statistical analysis of these data yielded inconclusive results.

After further consideration, it was acknowledged that an out-of-state license plate does not necessarily mean a driver is unfamiliar with the route. Conversely, in-state license plates do not necessarily mean a driver is familiar with the specific segment of roadway being studied. Therefore, these data have been omitted from the evaluation.

DATA ANALYSIS: CRASHES

As mentioned previously, reductions in crashes can be a primary measure of effectiveness when evaluating safety improvements. Crashes occurring within the postmile location of the CMS (or planned CMS location) and one-tenth of a mile following the end of the curve were evaluated. The official contract completion date for dynamic curve warning system installation was April 18, 1999; however, the system was operational in mid-March. For purposes of this report, March 15, 1999 was used as the installation date for all five dynamic curve warning systems. Five years of crash data before the signs were installed (March 15, 1994 – March 14, 1999) were obtained. The time between the installation of the dynamic curve warning system and the completion of this report was very limited. The data included in this analysis incorporates crash records from the Caltrans Traffic Accident Surveillance and Analysis System (TASAS) database through July 31, 1999. In addition, some crash reports were available for crashes that occurred between August 1 and September 15, 1999. Information from these crash reports was also used.

Seasonal variations in traffic and weather conditions can affect the number of crashes occurring at a given location. To account for this variation, crashes that occurred prior to the dynamic curve warning system installation date were separated into a time period equivalent with the post-installation data (i.e., March 15 – September 15 for 1994, 1995, 1996, 1997, and 1998). The totals were divided by five for comparison with the corresponding totals for the post-installation data. Crashes have been categorized by severity, primary collision factor of "speeding", and vehicle type (if a truck/trailer was involved in the collision). Trucks and trailers included in the tables below included pickups with trailers, trucks/truck tractors with or without trailers, single unit tankers, and trucks/tractors with tanker trailers. The selected vehicles have lower speed limit of 55 mph through the Sacramento River Canyon, while other automobiles have a 65 mph speed limit. Tables 8-13 list the number of before installation crashes that took place between March 15, 1994 and March 14, 1999 by site location, and the number of after installation crashes that took place between March 15, 1999 and September 14, 1999.

Table 8: Crashes at the Sidehill Viaduct Site (PM 29.00 - 29.88 SB only) (20)

	Total	Fatal	Injury	PDO	Speed	Trucks
Crashes in 5 Years Prior to System Installation Date (3/15/94-3/14/99)	30	1	14	15	17	14
Crashes in Equivalent Period Prior to System Installation Date (3/15 – 9/14 of 1994, 1995, 1996, 1997, & 1998)	17	1	9	7	10	8
Average Number of Crashes in Equivalent Period Prior to System Installation Date (per period)	3.4	0.2	1.8	1.4	2	1.6
Crashes in 6 months After System Installation Date (3/15/99-9/14/99)	3	0	2	1	3	0

Table 9: Crashes at the O'Brien Site (PM 31.77 - 32.30 SB only) (20)

	Total	Fatal	Injury	PDO	Speed	Trucks
Crashes in 5 Years Prior to System Installation Date (3/15/94-3/14/99)	14	0	5	9	6	5
Crashes in Equivalent Period Prior to System Installation Date (3/15 – 9/14 of 1994, 1995, 1996, 1997, & 1998)	8	0	2	6	3	4
Average Number of Crashes in Equivalent Period Prior to System Installation Date (per period)	1.6	0	0.4	1.2	0.6	0.8
Crashes in 6 months After System Installation Date (3/15/99-9/14/99)	2	0	0	2	1	1

Table 10: Crashes at the Salt Creek Site (PM 36.80 - 37.53 SB only) (20)

	Total	Fatal	Injury	PDO	Speed	Trucks
Crashes in 5 Years Prior to System Installation Date (3/15/94-3/14/99)	9	0	1	8	4	1
Crashes in Equivalent Period Prior to System Installation Date (3/15 – 9/14 of 1994, 1995, 1996, 1997, & 1998)	4	0	0	4	1	1
Average Number of Crashes in Equivalent Period Prior to System Installation Date (per period)	0.8	0	0	0.8	0.2	0.2
Crashes in 6 months After System Installation Date (3/15/99-9/14/99)	4	0	2	2	1	0

Table 11: Crashes at the La Moine Site (PM 48.49 - 49.23 SB only) (20)

	Total	Fatal	Injury	PDO	Speed	Trucks
Crashes in 5 Years Prior to System Installation Date (3/15/94-3/14/99)	22	0	10	12	9	8
Crashes in Equivalent Period Prior to System Installation Date (3/15 – 9/14 of 1994, 1995, 1996, 1997, & 1998)	8	0	2	6	3	3
Average Number of Crashes in Equivalent Period Prior to System Installation Date (per period)	1.6	0	0.4	1.2	0.6	0.6
Crashes in 6 months After System Installation Date (3/15/99-9/14/99)	0	0	0	0	0	0

Table 12: Crashes at the Sims Road Site (PM 57.90 - 58.32 NB only) (20)

	Total	Fatal	Injury	PDO	Speed	Trucks
Crashes in 5 Years Prior to System Installation Date (3/15/94-3/14/99)	13	0	3	10	6	7
Crashes in Equivalent Period Prior to System Installation Date (3/15 – 9/14 of 1994, 1995, 1996, 1997, & 1998)	7	0	2	5	4	3
Average Number of Crashes in Equivalent Period Prior to System Installation Date (per period)	1.4	0	0.4	1	0.8	0.6
Crashes in 6 months After System Installation Date (3/15/99-9/14/99)	0	0	0	0	0	0

Table 13: Total Crashes at the Study Sites (20)

	Total	Fatal	Injury	PDO	Speed	Trucks
Crashes in 5 Years Prior to System Installation Date (3/15/94-3/14/99)	88	1	33	54	42	35
Crashes in Equivalent Period Prior to System Installation Date (3/15 – 9/14 of 1994, 1995, 1996, 1997, & 1998)	44	1	15	28	21	19
Average Number of Crashes in Equivalent Period Prior to System Installation Date (per period)	8.8	0.2	3	5.6	4.2	3.8
Crashes in 6 months After System Installation Date (3/15/99-9/14/99)	9	0	4	5	5	1

As can be seen in Tables 8-13, there have been slight reductions in total crashes at the Sidehill Viaduct, La Moine, and Sims Road sites, but the O'Brien, and Salt Creek sites appear to have experienced small increases. When comparing the crash data for the equivalent six-month periods in the five years prior to the dynamic curve warning system installation and the six-month period following the installation date, the Sidehill Viaduct site has experienced reductions in total crashes and crashes involving trucks and automobiles with trailers. The number of crashes occurring primarily due to speed increased at the Sidehill Viaduct site. There were increases in the total crashes and those related to speed or involving trucks at the O'Brien site. The Salt Creek site had a reduction in crashes with trucks, but increases in the total number of crashes and the number of those caused by speed. The numbers of total crashes, those caused by speed, and the number involving trucks were reduced at the La Moine and Sims Road sites.

Table 13 summarizes the total number of crashes amongst the five different study sites. There was a decrease in crashes involving trucks, which was a primary objective with the dynamic curve warning systems. There were increases in the number of total crashes and those caused primarily by speed.

Although slight variations in crash frequency or severity may be noted, it is not possible to attribute any observed changes to the presence of the dynamic curve warning systems. Until sufficient data are available to establish the statistical significance of any differences in before/after comparisons, any attempts to credit the dynamic curve warning systems with observed changes in crash frequency or severity are unfounded.

DATA ANALYSIS: SPEED MEASUREMENTS

Speed measurement data were collected at each of the five sites on four different occasions. To reiterate, one trip was made prior to the dynamic curve warning system installation, while the remaining three took place after the systems were in place and functioning. The data gathered on the first trip were compared to the data collected on all three of the trips after the dynamic curve warning systems were in place. The similarities and differences noted in the analyses will help determine the effectiveness of the dynamic curve warning systems. The collected speed measurement data is included in Appendix C.

Mean Speed Results

Speeds were measured and recorded as the vehicles were traveling through the speed measurement section at the beginning of the curve at each site. A mean speed was found for each data collection trip at each site; Figures 21 and 22 graphically depicts the mean speeds. The speed data were separated by vehicle type: Figure 21 shows the speed data collected for commercial vehicles, vehicles towing trailers, and recreational vehicles; Figure 22 shows the speed data for passenger cars. The black columns signify the average speeds found at each study site during the trip made prior to the dynamic curve warning system installation. The gray columns are the speeds observed after the dynamic curve warning systems were in place, and correspond specifically to the second, third, and fourth trips from left to right. The white column for each site represents the average of the speed measurements obtained on the second, third and fourth trips (i.e., all the data collected after the dynamic curve warning system was installed). The gray arrow appearing in some of the columns indicates a significant decrease in speed ($\alpha = 0.05$)

when these data were compared with the data collected on the first trip (i.e., before the dynamic curve warning system). If no arrow is present, there was either no significant change or there was an increase in mean speed from before to after the installation of the dynamic curve warning system. An increase in speed or no change in speed between the before and after the dynamic curve warning system installation data (denoted by no arrow in the corresponding column) suggest the dynamic curve warning system may be ineffective at reducing speeds at the specific location.

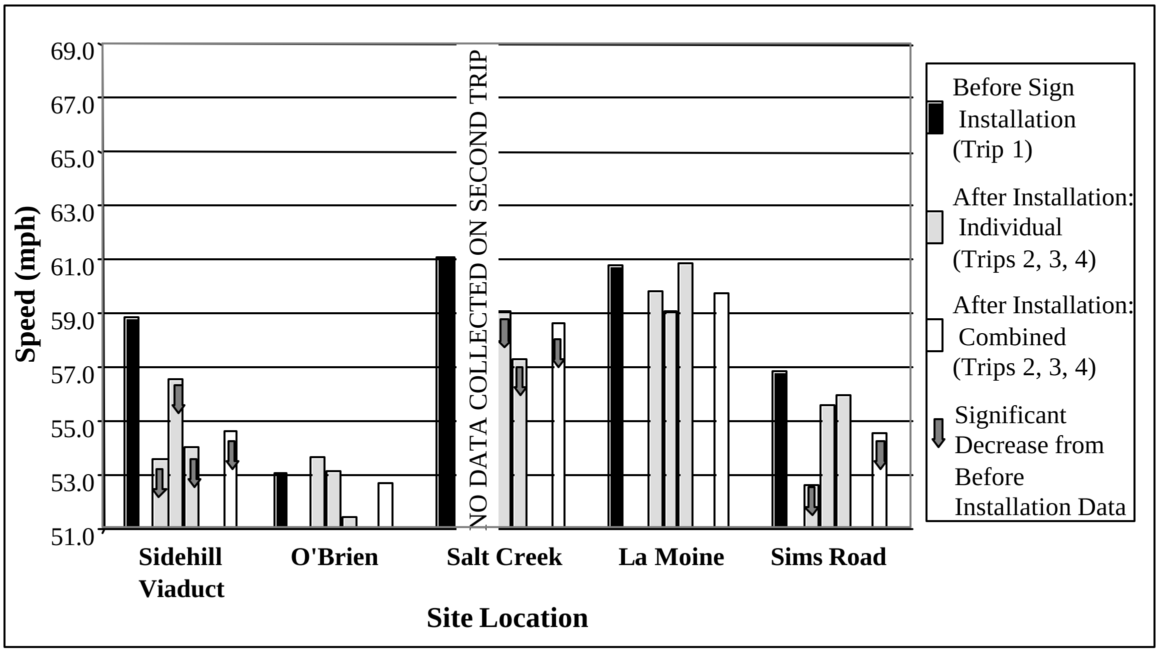


Figure 21: Mean Truck Speeds At the Curve At All Five Sites

As can be noted in Figure 21, there were significant decreases in speed at the curves at the Sidehill Viaduct, Salt Creek, and Sims Road sites. Sidehill Viaduct and Salt Creek both showed significant decreases in all post-installation periods. An examination of roadway characteristics reveals that these two sites are the only curves located on steep downgrades exceeding a 5% grade. The speeds at the Sims Road site significantly decreased initially (64.1 mph to 61.9 mph), but then continued to rise over time. Overall, mean post-installation truck speed was significantly lower than the corresponding pre-installation speed at Sims Road, but given the increases in speed noted in the data collected on the third and fourth trips, it would appear that desensitization to the dynamic curve warning system is a possibility at this site. The truck speeds collected at the O'Brien and LaMoine sites did not show any significant decreases after the dynamic curve warning system was in place.

During the fourth data collection trip, there were wet weather conditions at the Sidehill Viaduct and O'Brien sites, which could have had some effect on the speed measurements. When roadways are wet, drivers may reduce their travel speeds, thereby affecting the measured speeds at these sites.

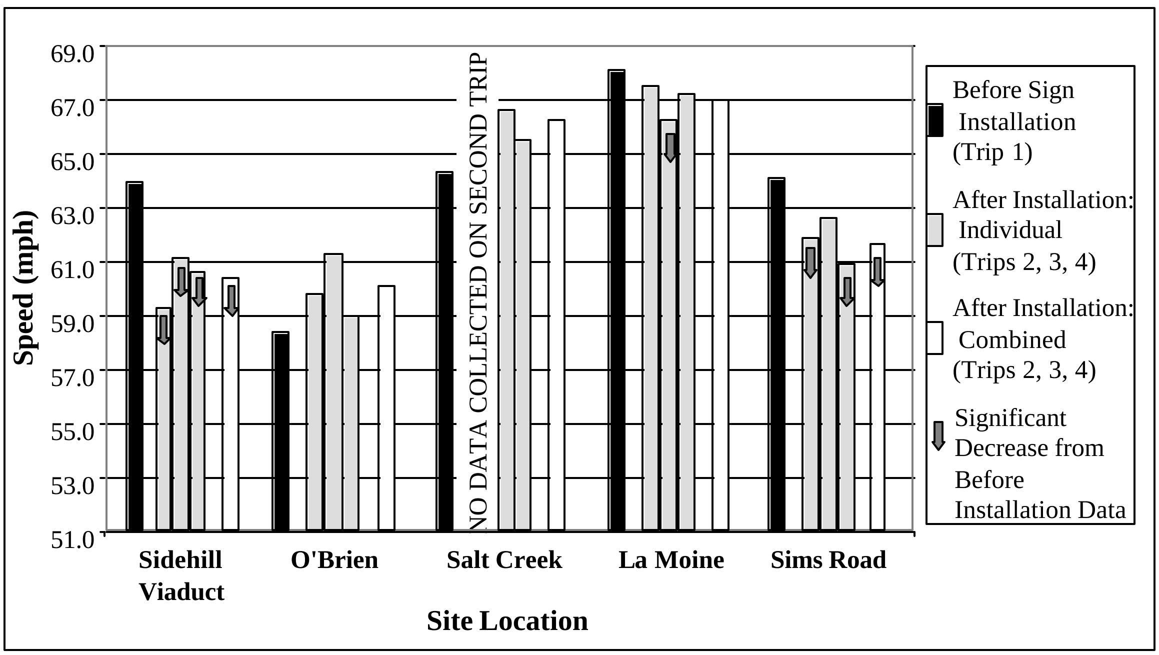


Figure 22: Mean Non-Truck Speeds At the Curve At All Five Sites

The results of the passenger car speed analyses indicate the Sidehill Viaduct and Sims Road sites have experienced significant speed decreases. The speeds collected on all three of the post-installation trips at Sidehill Viaduct showed statistically significant decreases. There was one statistically significant reduction in mean speeds at the La

Moine site. The mean speeds of the remaining trips were not significant reductions, and the reduction represented by the combined average of the three post-installation mean speeds was not a statistically significant change. The reductions in mean speed at the La Moine site may or may not have been attributable to the installation of the dynamic curve warning system. However, the speed reductions at Sidehill Viaduct and Sims Road provide convincing evidence that the dynamic curve warning system may be effective at reducing non-truck speeds at these curves.

The data collected for passenger cars at the O'Brien and Salt Creek sites did not show a significant decrease in speeds in the period following the dynamic curve warning system installation. In fact, average speeds at these sites actually increased in the post-installation period. A change in the area that may have influenced the speed results is the increase in the posted speed limit that would have affected the Sidehill Viaduct, O'Brien, and Salt Creek sites. Between the first and second trips, the speed limit for passenger cars was raised from 55 to 65 mph, although the curve advisory speed remained at 50 mph for each curve. It seems reasonable to assume that an increase in the posted speed limit might be reflected in higher mean speeds at the curves, despite the warnings and advisory speeds provided on the dynamic curve warning system. Although this theory would help to explain increases observed at the O'Brien and Salt Creek sites, the data collected at the Sidehill Viaduct do not support this theory. In fact, the decreases in mean speeds at this site were the most dramatic of any and provided the strongest indication of the dynamic curve warning system's effectiveness at reducing non-truck speeds. Another factor that may be contributing to the speed reductions is the fact that Sidehill Viaduct is the only site where an animated graphic is included amongst messages on the CMS. This graphic may be more effective at slowing traffic than other messages and graphics used at other sites.

As mentioned previously, weather also could have had some contributing effects on the data. Conditions were clear and dry for the majority of the data collection trips, with the exception of the fourth trip to Sidehill Viaduct and O'Brien where it was raining and/or the roadway was wet. Reductions in speeds at these two sites may have been due, at least in part, to drivers slowing their speeds because of the roadway conditions. Again, however, the discrepancy between the two sites remains unexplained.

Changes in Speeds

In addition to the speeds recorded at the beginning of the curve, speeds were collected at the CMS location (or planned CMS location before the installation). The differences in speeds observed between the location of the CMS and the beginning of the curve were compared between trips to determine if the difference changed from before to after the dynamic curve warning system installation. Table 14 displays the measured differences in speed. A negative value indicates vehicles are slowing down between the CMS and the curve, while a positive value denotes an increase in speed. Shaded cells denote statistically significant changes between the results found during the pre-installation trip and the remaining post-installation trips.

Table 14: Speed Changes Between the CMS (or Planned CMS Location) and the Curve

Site	Speed Reduction for Trip #1 (mph)	Speed Reduction for Trip #2 (mph)	Speed Reduction for Trip #3 (mph)	Speed Reduction for Trip #4 (mph)
Sidehill Viaduct	-0.9	1.1	0.7	0.4
O'Brien	-2.4	-2.2	-2.3	-1.8
Salt Creek	1.2	N/A*	0.5	-1.7
La Moine	1.5	2.1	-0.4	0.5
Sims Road	-1.3	-2.4	-1.5	-2.4

* No data was collected, due to ongoing construction

Observed increases or decreases in speed between the CMS location and the approximate beginning of the curve are less indicative of the dynamic curve warning system's effectiveness than an overall reduction in speed in the area at the beginning of the curve following the installation of the dynamic curve warning system, as found in the previous section. Decreases in speeds between the two speed measurement sections may indicate drivers are slowing for the curve, but this does not necessarily mean the dynamic curve warning system was more effective in reducing speeds than a static curve warning sign. Increases in speeds between the CMS and the beginning of the curve may indicate drivers have overadjusted their speeds and then sped up to complete the curve. This initial reduction in speed could suggest the dynamic curve warning system was so effective at slowing the driver, they slowed down too much. Because of the possibility of two interpretations, conclusions concerning the effectiveness of the dynamic curve warning system at reducing speeds in the distance between the CMS and the entrance to the curve are less definitive.

Once again, the speed limit increase for passenger cars (from 55 to 65 mph between the first and second trips) at the Sidehill Viaduct, O'Brien, and Salt Creek sites complicates the interpretation of the findings. In theory, the higher posted speed limit should not have affected this analysis as much as the mean speed analysis in the previous section. If anything, a higher traveling speed as cars approached the CMS should have resulted in a greater decrease in speed as they entered the curve, if they adjusted their speed in response to the dynamic curve warning system advisory. The results reported in Table 14, however, do not support this theory.

Positioning of the speed measurement sections may have influenced the results of the speed reduction analysis. Placement of the first section was intended to measure the speed at the driver's first reaction to the dynamic curve warning system. In retrospect, it might have been more appropriate to have positioned the first speed measurement section farther upstream so as to measure the speed at the driver's first sight of the dynamic curve warning system. It is possible that drivers had already seen the dynamic curve warning system and began their deceleration process before reaching the first speed measurement section, in which case both the initial speed measurement and the overall change in speed would have been underestimated. This would have adversely affected the results of the analysis.

Radar Speed Measurements

After reviewing the Interim Report, Caltrans representatives requested that subsequent data collection activities be modified to include the use of a radar unit. Some individuals still had doubts about the accuracy and reliability of the stopwatch method of gathering speed data. More importantly, perhaps, was concern over positioning of the upstream data collection point.

The speed measurement location for the radar unit were selected as follows:

- Location 1: 1000 feet upstream of the CMS

- Location 2: middle of the first stopwatch speed measurement section (150 feet upstream of the CMS)
- Location 3: middle of second stopwatch speed measurement section (150 feet upstream of the beginning of the curve)

The results collected with the radar units were not evaluated, but are listed in Appendix D (Tables D1 through D15), which show the speed results for each site, broken down by vehicle type. If complete speed readings were not obtained for a particular vehicle at any of the three locations, the data for that vehicle were eliminated from the analysis.

Typically, the speed data at Locations 1 and 2 were collected from a single vehicle placed near the dynamic curve warning system and data at Location 3 were collected from a second vehicle placed near the curve. Because of the alignment limitations at Sidehill Viaduct, data at Location 1 were collected by the first vehicle; data at Locations 2 and 3 were collected by the second vehicle. At the Sims Road site, there was no safe place for the second vehicle to park, therefore, speed data were collected for Location 3 using the "Stalker", a hand-held battery-powered radar unit.

Every attempt was made to measure speeds for a random set of vehicles at free flow speed. However, some vehicle speeds could not be recorded due to problems with other vehicles blocking them from view. These omissions are indicated by blanks in the data sheets in Appendix D. Radar-equipped vehicles were placed as discretely as possible, in a location where line of sight was optimized and the vehicle could be parked off the shoulder of the roadway.

Model K-55 MPH Industries radar units were used. Radar unit accuracy was tested with a tuning fork and by measuring known speeds (i.e., pointing the radar unit at the ground in front of the vehicle while traveling a constant speed). All radar units were accurate to within 1-2 miles per hour.

In general, the following conclusions can be made on the basis of the descriptive data provided in the tables. First, it appears that drivers of vehicles traveling at higher speeds will typically slow down to a greater extent for the curve than will drivers of slower vehicles. Secondly, regardless of the initial speed, the average speed at the entrance to the curve is close to the advisory speed for that particular curve (60 mph for La Moine, 50 mph for the rest of the study sites). It must be reemphasized that these observations are not substantiated by any statistical analyses.

DATA ANALYSIS: ERRATIC MANEUVERS

In addition to the speeds at which drivers were traveling, two measures of driver behavior and vehicular movements during the negotiation of the curves were observed and recorded. Specifically, these “erratic” maneuvers included lane encroachments and brake light actuations that occurred while the vehicle was in the curve. As discussed previously, both phenomena could indicate that drivers *may* have been traveling too fast for safe negotiation of the curve and had to react to correct their actions. However, it is possible a driver may have performed an erratic maneuver even though he was able to safely complete the curve. For instance, a driver may swing wide simply to smooth out a curve, but this erratic maneuver also could indicate that a driver was compensating for approaching a curve too fast. Because of the uncertainty in interpreting erratic maneuvers, less emphasis was placed on the results of this analysis. Statistical tests were conducted to determine if the percentage of drivers performing *any* type of erratic maneuver changed significantly between data collection periods. No statistical analyses were conducted distinguishing between different vehicle types or individual types of erratic maneuvers.

Figures 23-32 include erratic maneuver information recorded at each site during each data collection trip. Although statistical analysis was not conducted by vehicle type, the figures show data broken up by trucks (commercial vehicles, automobiles with trailers, and recreational vehicles) and non-trucks (passenger cars and pickups). While lane encroachment categories are mutually exclusive, it is quite possible for a driver to apply his brakes and cross the boundaries of the travel lane during his negotiation of the curve. Therefore, some drivers are double-counted in the following figures.

Sidehill Viaduct

Figure 23 and 24 displays the erratic movements or use of brakes by truck and non-truck drivers during data collection at the Sidehill Viaduct site, respectively.

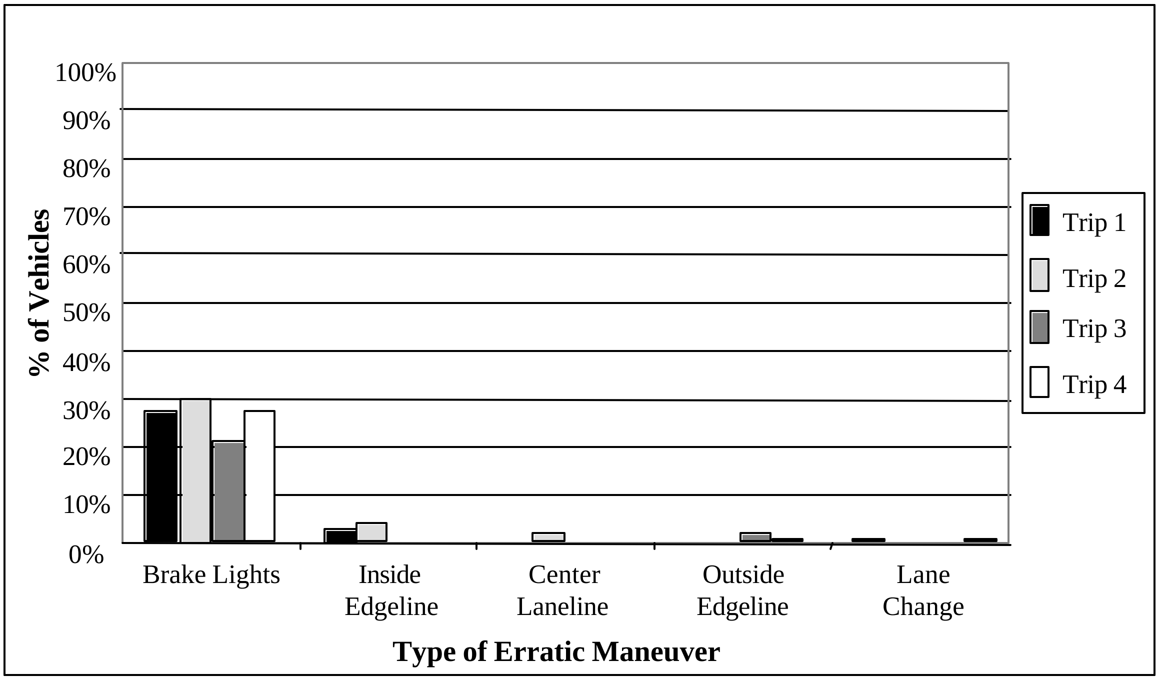


Figure 23: Sidehill Viaduct: Types of Erratic Maneuvers Performed by Trucks

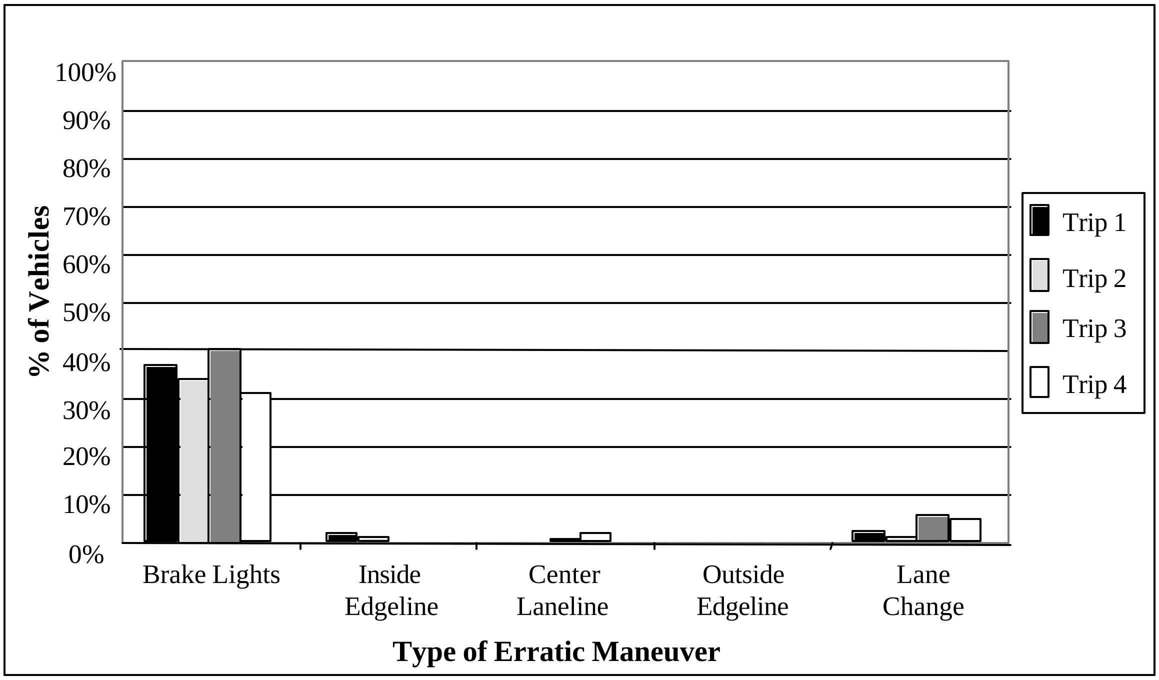


Figure 24: Sidehill Viaduct: Types of Erratic Maneuvers Performed by Non-truck Drivers

Results and trends of the different vehicle types were similar. Lane line encroachments were seldom executed at this site; at most, only 6% of the total vehicles that passed through this curve were observed crossing over their lane boundaries. Brake lights actuations were much more commonly recorded, ranging from 58% to 64% of the total observed vehicles, depending on the trip, and more non-truck drivers were observed using their brakes (this could be do to a higher sample size of non-truck drivers). There was a small reduction in the percentage of drivers who utilized their brakes over time. This curve is positioned on a steep downgrade (-6.0%) and, therefore, the application of brakes in the curve could be required to maintain speed due to the slope of the road, alone, or in combination with the curve, more than a perception of excessive speed on the driver's part. Tests to determine statistical significance were only completed on the total number of vehicles performing any maneuver, not on specific maneuvers, as explained previously. There were not any statistically significant changes in the number of combined erratic maneuvers.

O'Brien

The types of erratic movements performed at the O'Brien site during each of the data collection trips are shown in Figure 25 and 26.

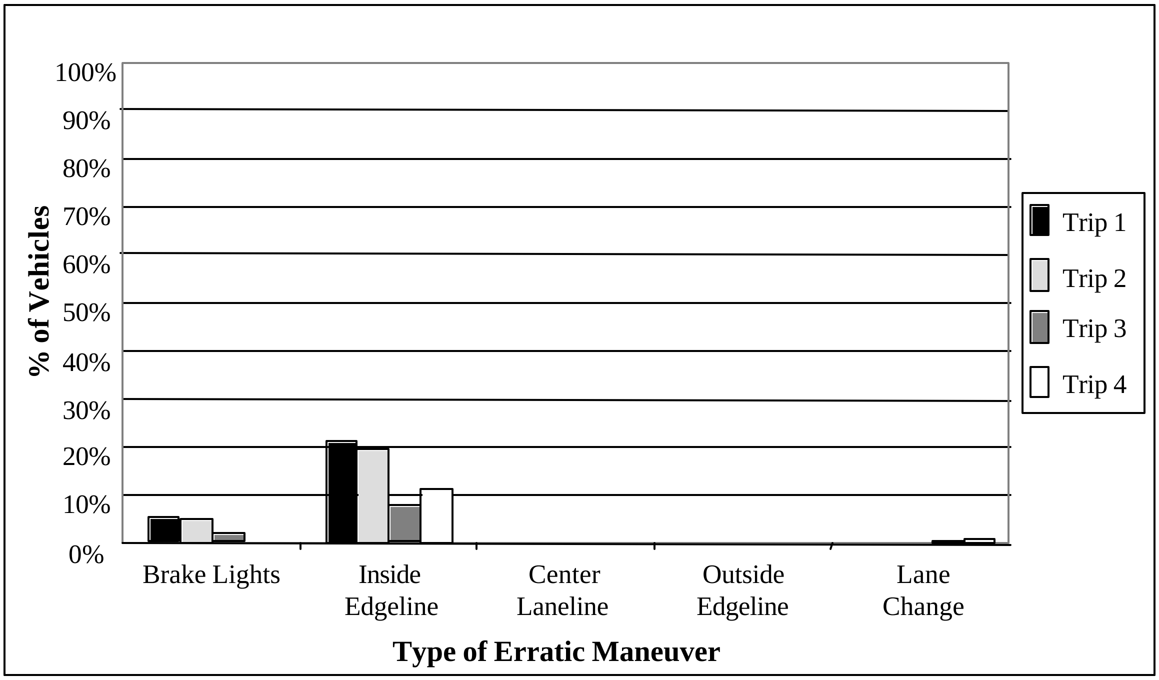


Figure 25: O'Brien: Types of Erratic Maneuvers Performed by Truck Drivers

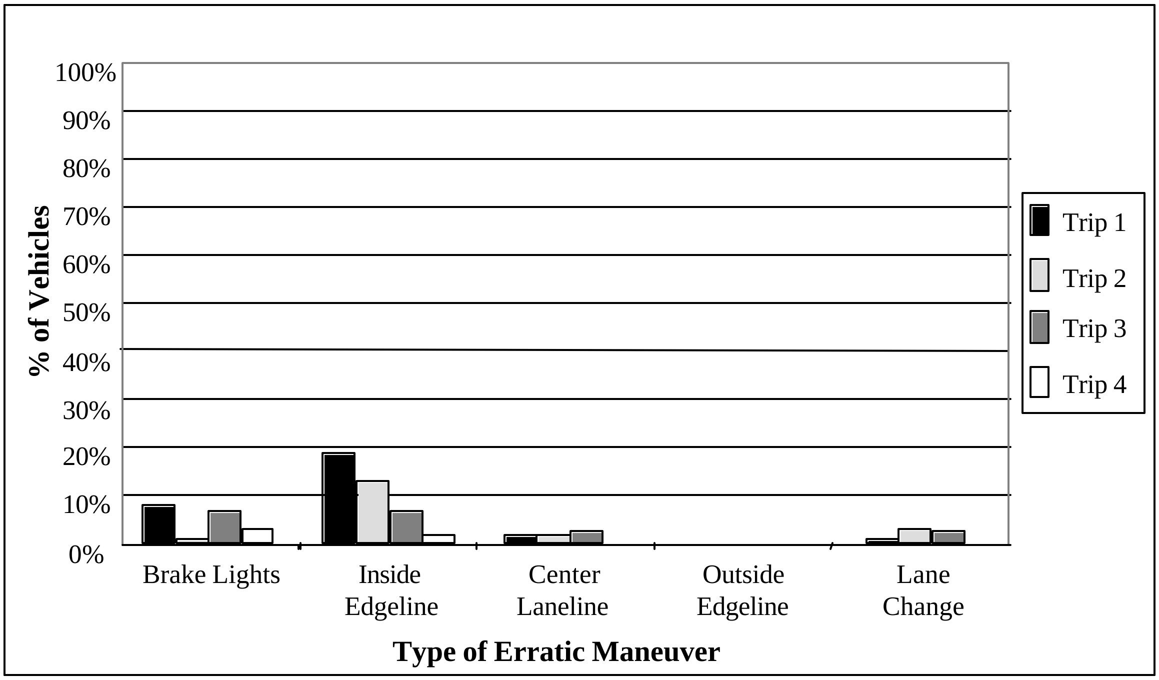


Figure 26: O'Brien: Types of Erratic Maneuvers Performed by Non-truck Drivers

Again, results and trends were similar amongst the different vehicle types. At the O'Brien site, the most common erratic maneuver (ranging from 13% to 40% of the observed vehicles) was the inside edgeline movement. This site is one of two right-hand curves, and because most vehicles travel in the driving (right) lane, this maneuver might have been made to smooth the curve to lessen or avoid the need to slow down. As seen in Figures 25 and 26, the number of inside edge maneuvers was noticeably reduced over time, although these findings are somewhat counter to increased speeds at this site that were noted in the speed analysis section. It would seem that drivers traveling at higher speeds would be more likely to apply their brakes or cross outside their lane, but the speed data collected during the first and second trips, in particular, do not support this hypothesis. During the first and second trips, the roadway at the curve was damaged and drivers may have been leaving the lane to avoid potholes. Resurfacing of the roadway at this curve occurred between the second and third trips, and this could have influenced the erratic maneuver results at this site.

Salt Creek

Figures 27 and 28 illustrate the fact that less than 10% of the vehicles were observed making any type of lane line encroachment at the Salt Creek site.

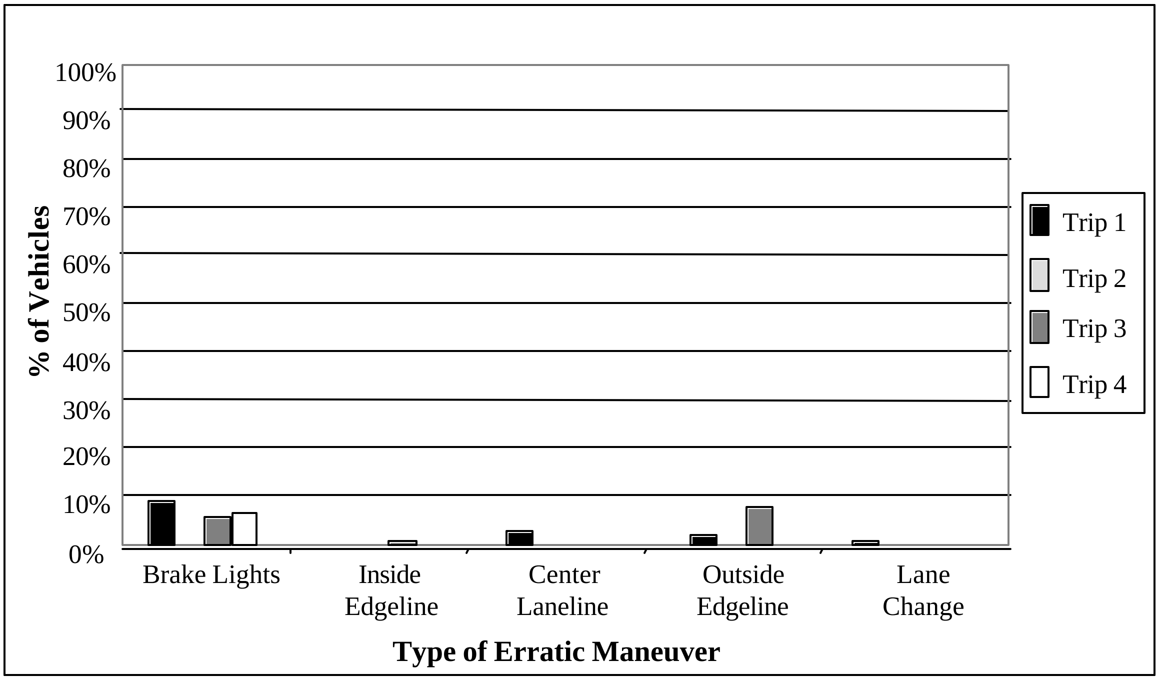


Figure 27: Salt Creek: Types of Erratic Maneuvers Performed by Truck Drivers

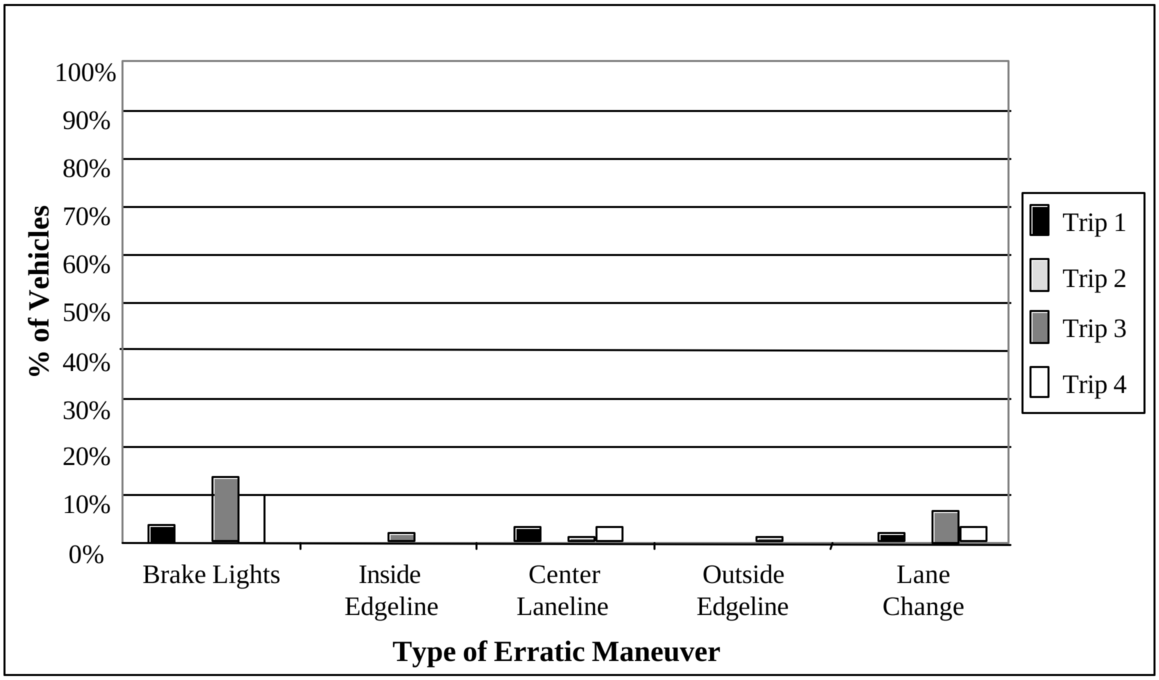


Figure 28: Salt Creek: Types of Erratic Maneuvers Performed by Non-truck Drivers

Results were fairly similar for each of the vehicle types. Brakes were used in the Salt Creek curve by 14% to 20% of the drivers in observed vehicles (depending on the data collection trip), which could be partly due to the downgrade and vertical curve in this segment. The erratic maneuver data collected at Salt Creek are fairly inconclusive because there are no statistically significant trends in the data, and there does not appear to be a dominant type of lane line encroachment. Again, it should be noted that no data were collected during Trip 2 because of ongoing construction activities.

La Moine

During each data collection, the majority of drivers viewed at the LaMoine site (over 90%) did not perform any lane line encroachments, as can be seen in Figures 29 and 30.

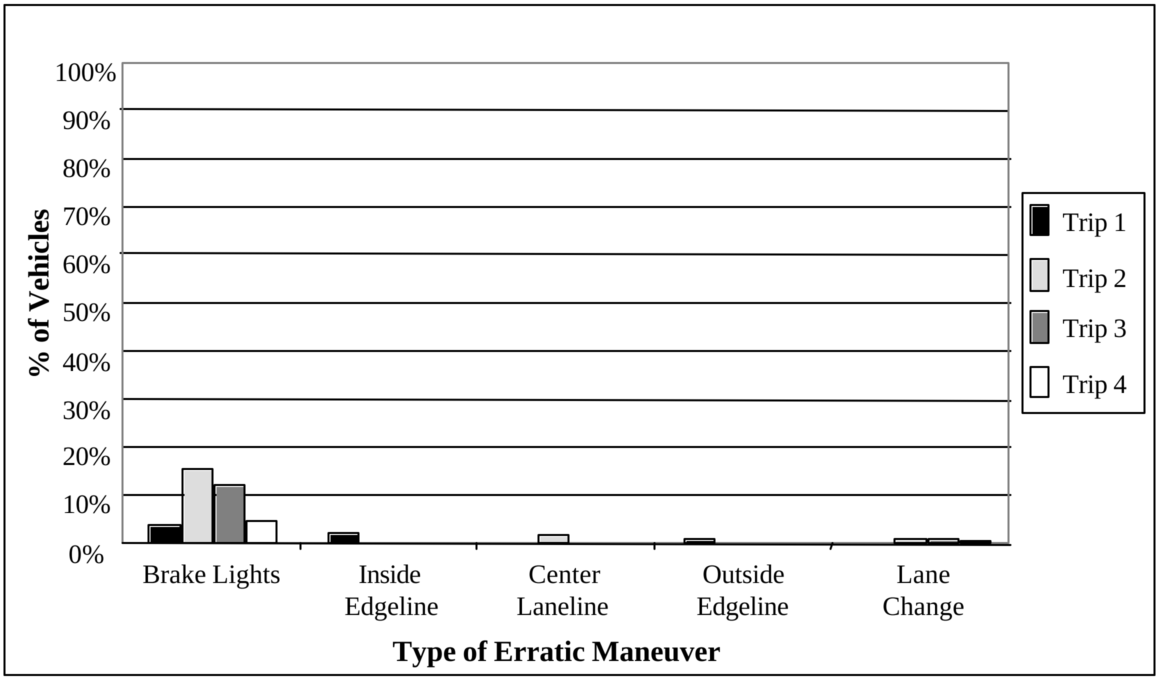


Figure 29: La Moine: Types of Erratic Maneuvers Performed by Truck Drivers

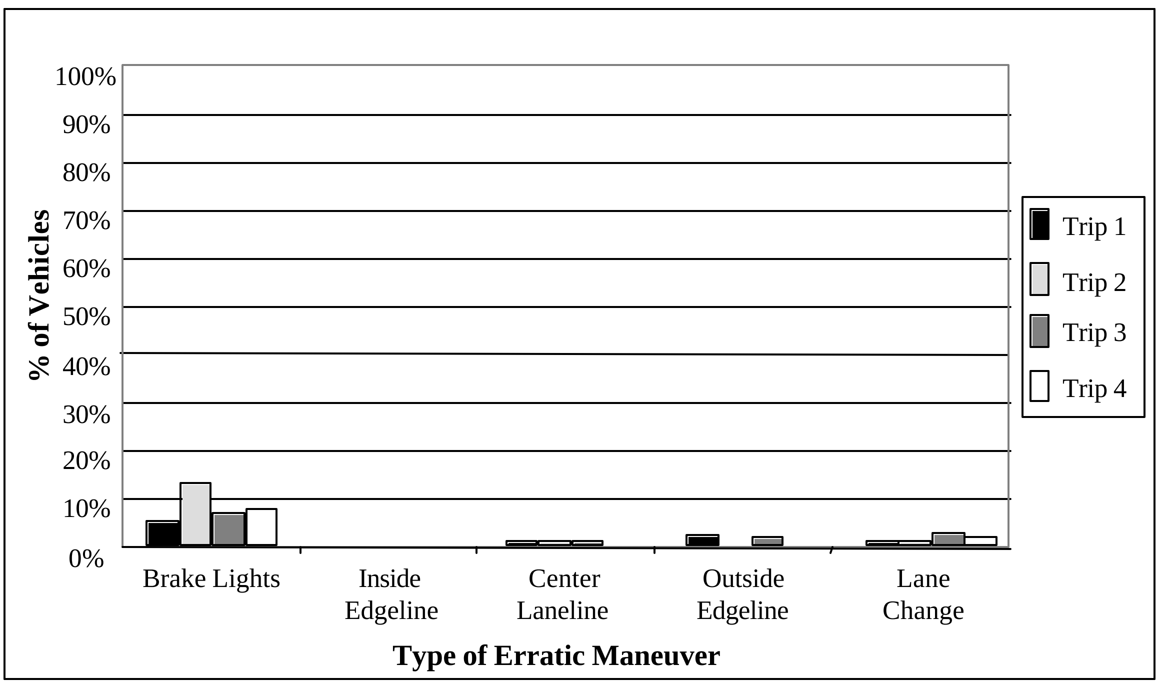


Figure 30: La Moine: Types of Erratic Maneuvers Performed by Non-truck Drivers

For the two different vehicle types, the erratic maneuver results and trends were similar. Compared to all of the study sites besides Sidehill Viaduct, brake light actuations were fairly common in this curve (ranging from 10% to 29%). In theory, drivers traveling at higher speeds are more likely to use their brakes to safely complete a curve. Therefore, there would be a correlation between the mean speed and the number of drivers utilizing their brakes. However, the speed data at the La Moine site do not follow the same trend displayed by the brake light actuation data, which cannot be explained. A higher percentage of drivers using their brakes may be due to the fairly steep downgrade prior to the first curve in the LaMoine sequence, but this should not affect the trend of changes and results amongst different trips should be consistent. There were no significant reductions in the erratic maneuver data at the La Moine site.

Sims Road

Figures 31 and 32 display the different ways in which vehicles left the lane boundaries at the Sims Road site and the percentage of drivers who used their brakes while traveling the curve.

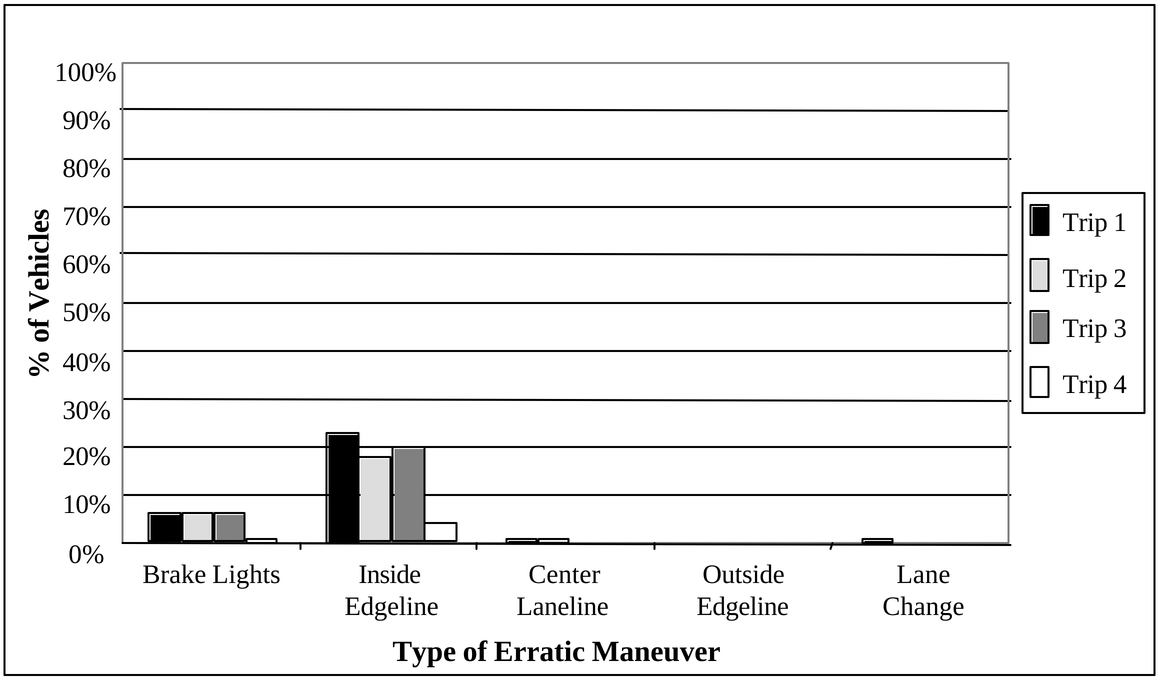


Figure 31: Sims Road: Types of Erratic Maneuvers Performed by Truck Drivers

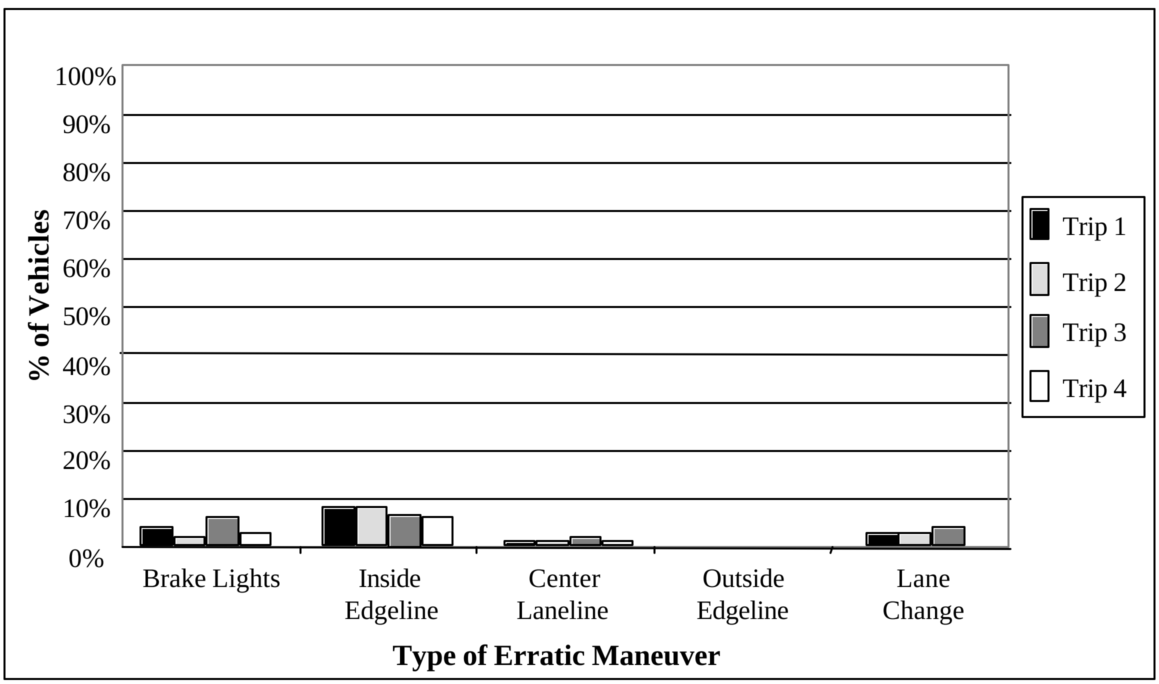


Figure 32: Sims Road: Types of Erratic Maneuvers Performed by Non-truck Drivers

Trends were similar between the different vehicle types at the Sims Road site, but more truck drivers than non-truck drivers are performing inside edgeline maneuvers. The curve at this site experienced a large group of drivers (10% to 30%) who drifted over the inside edge as they traveled the curve. Other than this type of lane line encroachment, most motorists executed this curve without leaving their designated lanes, and only 4% to 12% of the drivers used their brakes around the curve. The percentage of drivers performing each particular type of erratic maneuvers remained relatively constant through the first three data collection trips, but dropped rather noticeably in the fourth trip.

Similar to the O'Brien site, the high number of inside edge encroachments at the Sims Road site (which is also a right hand curve) could be attributed to drivers using the shoulder to give themselves more room around the curve. Although a breakdown by vehicle type was not selected for inclusion in this document, it was of interest that truck drivers were responsible for a majority of the inside edge maneuvers (60% at O'Brien and 70% at Sims Road).

DATA ANALYSIS: MOTORIST SURVEY

Response percentages for the questions pertaining to the dynamic curve warning sign are provided in Figures 33-43. Examining the travel trends of the survey respondents concerning vehicle type, trip purpose, and frequency of travel through this section of Interstate 5, responses were found to be similar between the two different survey administrations. Out of the different vehicle types represented at each survey location, it was noted that at the 76 Travel Center, 99% of drivers who participated in the survey in the daylight and 98% of drivers who participated in the survey after dusk were commercial vehicle operators. At the Lakehead Rest Area, 79% of the survey respondents were passenger car drivers and 14% were recreational vehicle drivers. Without exception, all of the truck drivers surveyed were traveling strictly for business purposes, while 77% of the passenger car drivers and 97% of the recreational vehicle operators were traveling for pleasure purposes. When asked about the frequency of driving the particular segment of Interstate 5 where the signs are located, approximately 12% of the truck drivers stated they travel it less than once a month, while 75% of the passenger car drivers and 97% of the recreational vehicle users made the same claim. 27% of truck drivers, 19% of passenger car drivers, and 3% of recreational vehicle drivers claimed to drive the same section on I-5 one to three times a month. 61% of truck drivers, 6% of passenger car drivers, and no surveyed recreational vehicle drivers reported to frequent the section more than three times per month. First time visitors to the area are included in this category, as well. It can be inferred from these figures that the truck drivers are more familiar with the route than their non-truck counterparts.

Commercial Vehicles

During the first survey administration in May 1999, 153 commercial vehicle drivers were surveyed, while 162 participated in the second survey administration in January 2000. Figure 33 shows the response distribution when commercial vehicle drivers were asked if they thought the speed information given on the new dynamic curve warning signs was useful. As can be seen in Figure 33, the 73% and 70% of survey participants (during the second and fourth visits, respectively) who were operating trucks believed the signs were helpful during both survey administrations.

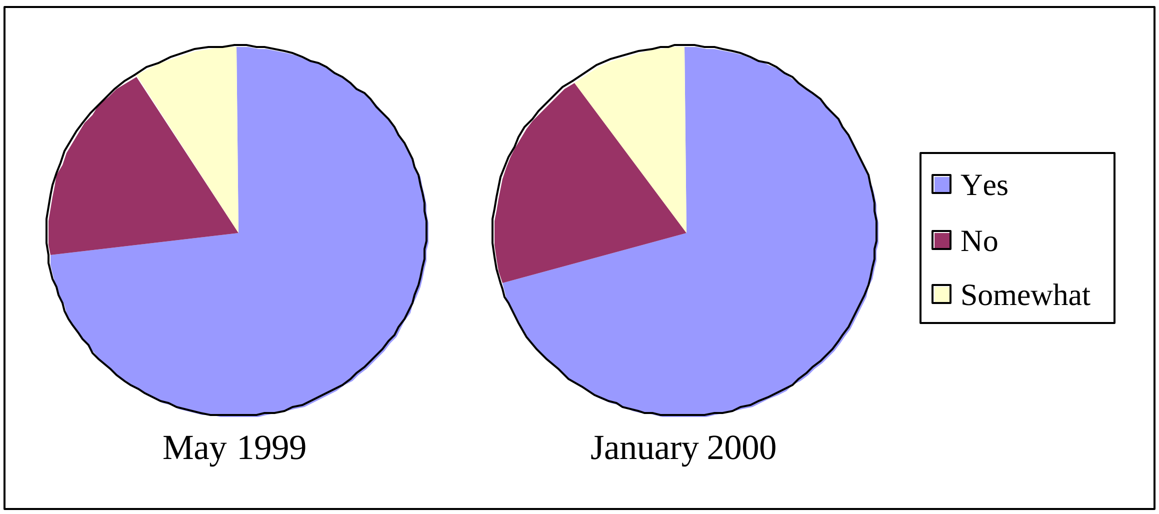


Figure 33: Commercial Vehicle Operators' Responses to "Do you think this speed information was useful to you in driving safely through the curve?"

Figure 34 displays the answers given when truck-driving respondents were asked if they personally responded or adjusted their travel speed through the curve, as advised by the sign. These results may differ from the previous question because some drivers said they thought the signs gave useful information, but felt they were already driving slowly enough that they didn't have to adjust their speeds, or felt they knew their current speed was safe for the particular curve due to experience driving in the area. Interestingly, however, the proportion of truck drivers who reportedly responded to the curve warning sign (76% and 69%) is roughly equivalent to the proportion who felt the information provided on the sign was useful (Figure 33).

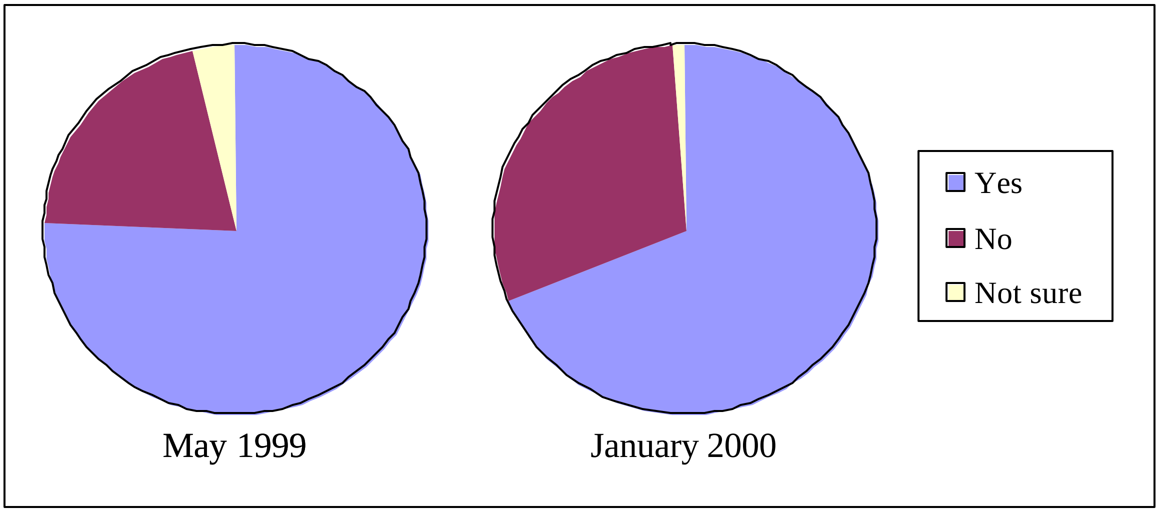


Figure 34: Commercial Vehicle Operators' Responses to "Did you respond and adjust your travel speed through the curve as advised?"

When asked if the positions of the warning signs were adequate, most of the truck drivers (79% and 84%) felt they were positioned well. Comments were made about the O'Brien dynamic curve warning system location, noting that by the time drivers complete the previous curve, there may not be enough time for them to read more than one or two messages on the sign. Drivers familiar with the area also felt the dynamic curve warning system at the Salt Creek site was difficult to respond to because they knew they would subsequently have to adjust their speed to make the upgrade in the second curve. All of the respondents who didn't think the position was suitable felt the CMS was too close to the curve. Figure 35 shows the proportions of responses to this question made by the commercial vehicle operators during each survey administration.

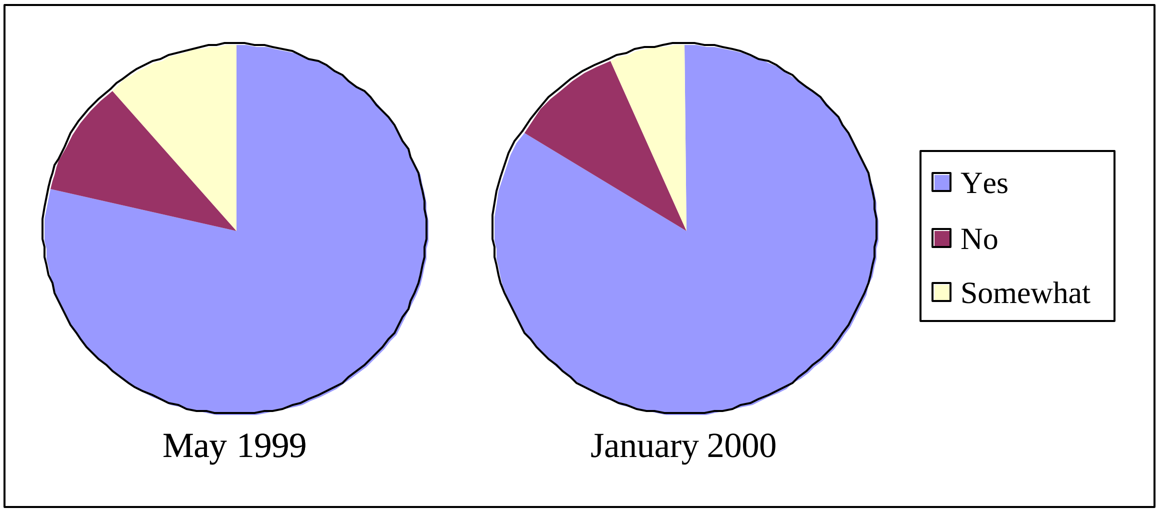


Figure 35: Commercial Vehicle Operators' Responses to "Was the location of the changeable speed warning sign adequate for you to respond?"

<u>Passenger Cars</u>

Survey participants driving passenger cars may have different opinions of the dynamic curve warning system than the commercial vehicle operators due to different traveling habits, such as the purpose of their trips and frequency of travel through the study area. Vehicle size also may affect the driver's ability to slow for each curve upon warning, which may affect opinions about the positioning of the dynamic curve warning systems. The location of the survey administration was south of the La Moine site, which meant for those seeing the dynamic curve warning system for the first time, the only dynamic curve warning system seen at the time of the survey was at the La Moine site. For these reasons, the survey answers received from passenger car drivers have been separated from those of the truck drivers (as are the results of recreational vehicle operators reported in the next section).

Eighty-nine passenger car drivers were surveyed in May 1999; 77 passenger car drivers responded in January 2000. Figure 36 shows the responses from passenger car drivers when asked if they thought the information on the dynamic curve warning systems was useful. As can be seen, 78% and 85% of the respondents (during the second and fourth site visits, respectively) said they did believe the information was useful. When compared with the results of the truck drivers, the number of passenger car drivers who thought the information was useful is notably higher.

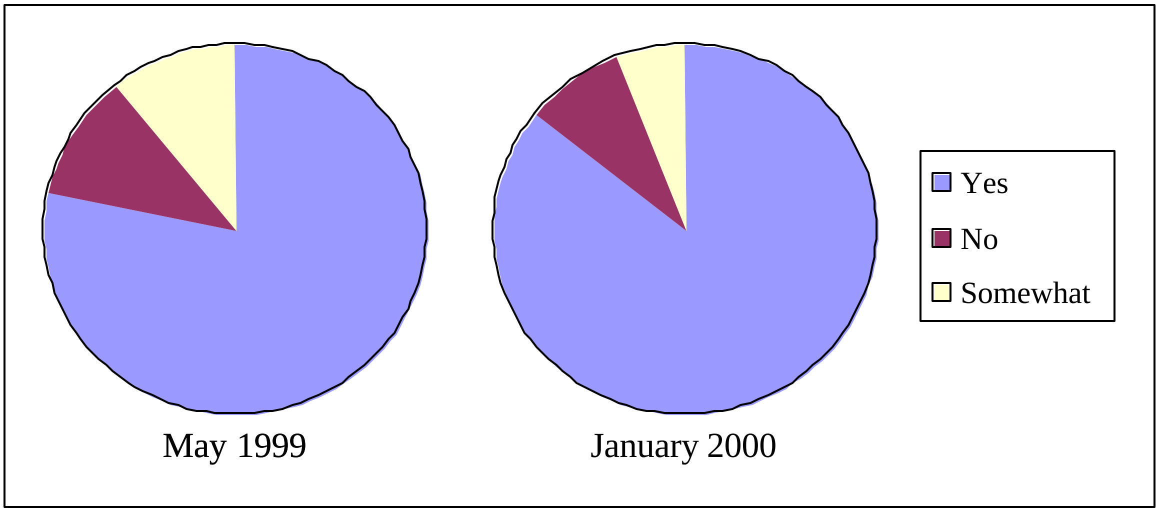


Figure 36: Passenger Car Drivers' Responses to "Do you think this speed information was useful to you in driving safely through the curve?"

The responses of passenger car drivers to the question concerning whether they each, personally, responded to the dynamic curve warning system message are displayed in Figure 37. A smaller percentage of the passenger car drivers adjusted their speed in response to the dynamic curve warning system (60% and 69%), compared to the corresponding percentage who felt the advisory information was useful.

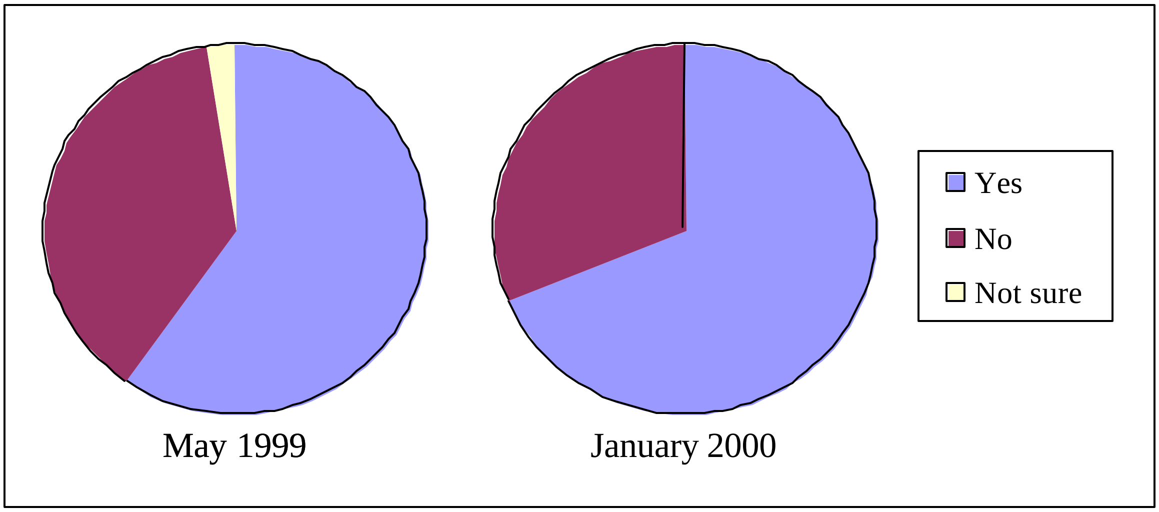


Figure 37: Passenger Car Drivers' Responses to "Did you respond and adjust your travel speed through the curve as advised?"

As some drivers were interviewed, they added that they did not have to slow down because they were already driving at a speed lower than the advisory. This response was categorized as "No" because of the wording of the question, although it is acknowledged that this does, to some extent, underestimate the effectiveness of the dynamic curve warning system at changing driver behavior (i.e., reducing speed).

Figure 38 illustrates the distribution of responses of those driving passenger cars to the CMS position question. Approximately 84% and 90% of the passenger car drivers thought the positioning of the sign at the La Moine site was adequate. Twelve of the 13 people who thought the positioning was inadequate added that the CMS was too close to the curve.

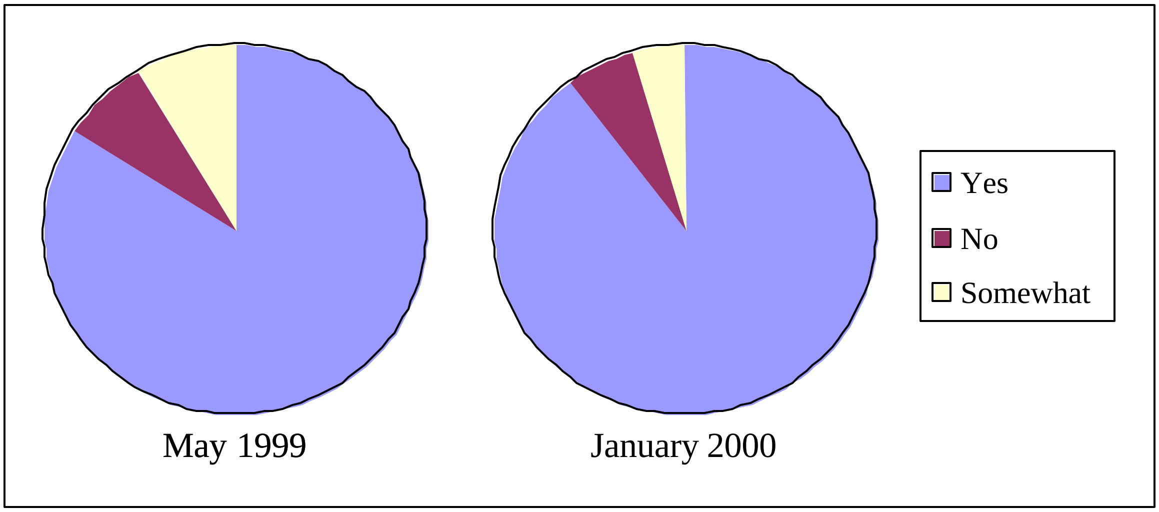


Figure 38: Passenger Car Drivers' Responses to "Was the location of the changeable speed warning sign adequate for you to respond?"

Recreational Vehicles

The survey responses for drivers of recreational vehicles were separated from the rest of the data. Drivers of vehicles traveling for pleasure purposes might have different opinions of the dynamic curve warning system than those traveling for business. Because 97% of the surveyed recreational vehicle drivers stated they traveled this segment of Interstate 5 less than once a month, this was quite possibly the first time some of these drivers had seen the dynamic curve warning system.

The sample sizes of recreational vehicle drivers are small compared to the other vehicle types: only 11 participated in May 1999 and 20 participated in January 2000. Results of this analysis, therefore, should be interpreted with caution. As can be seen in Figure 39, most surveyed recreational vehicle drivers (100% and 87% for the second and fourth visits, respectively) believed the speed information given on the dynamic curve warning systems was useful.

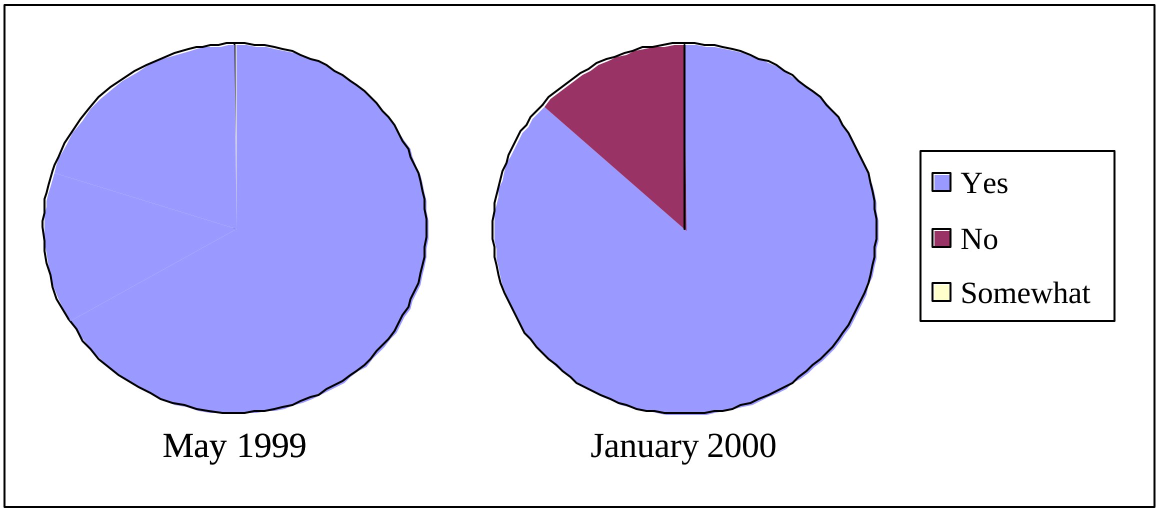


Figure 39: Recreational Vehicle Drivers' Responses to "Do you think this speed information was useful to you in driving safely through the curve?"

Although the percentage of recreational vehicle drivers who reportedly responded to the dynamic curve warning systems was high for the first survey administration (89%), half of the respondents said they did not adjust their speed during the second administration of the survey. As noted earlier, this high percentage of persons who did not respond to the dynamic curve warning systems could be a reflection of drivers already traveling at speeds lower than the dynamic curve warning systems advisory speed by the time the warning was received.

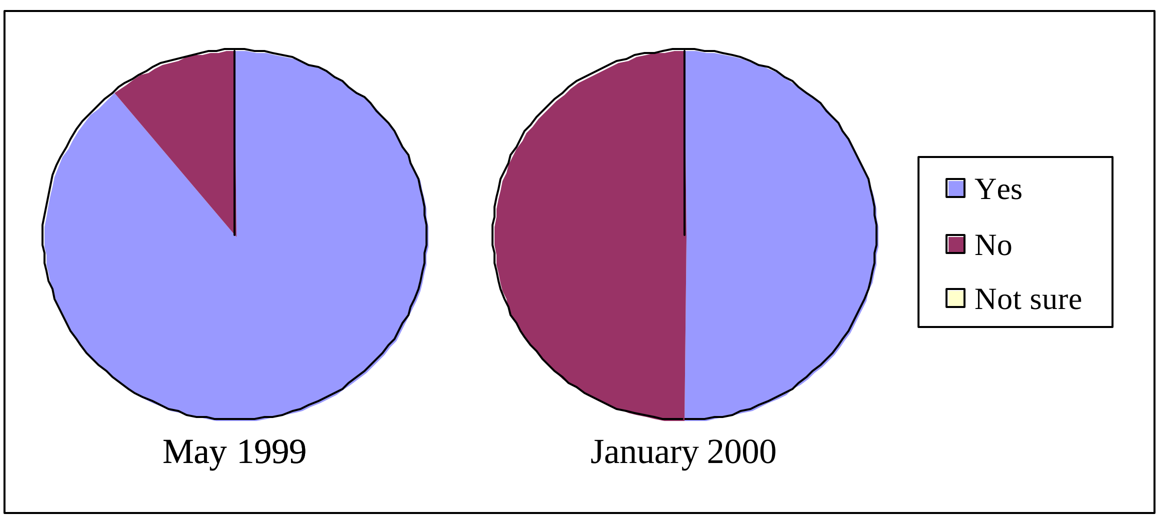


Figure 40: Recreational Vehicle Drivers' Responses to "Did you respond and adjust your travel speed through the curve as advised?"

All of the recreational vehicle drivers surveyed during the second site visit stated the positioning of the sign was adequate, while only 67% of the drivers responded the same way during the fourth visit, as can be see in Figure 41. The extremely small sample sizes make interpretation of any differences in response percentages problematic.

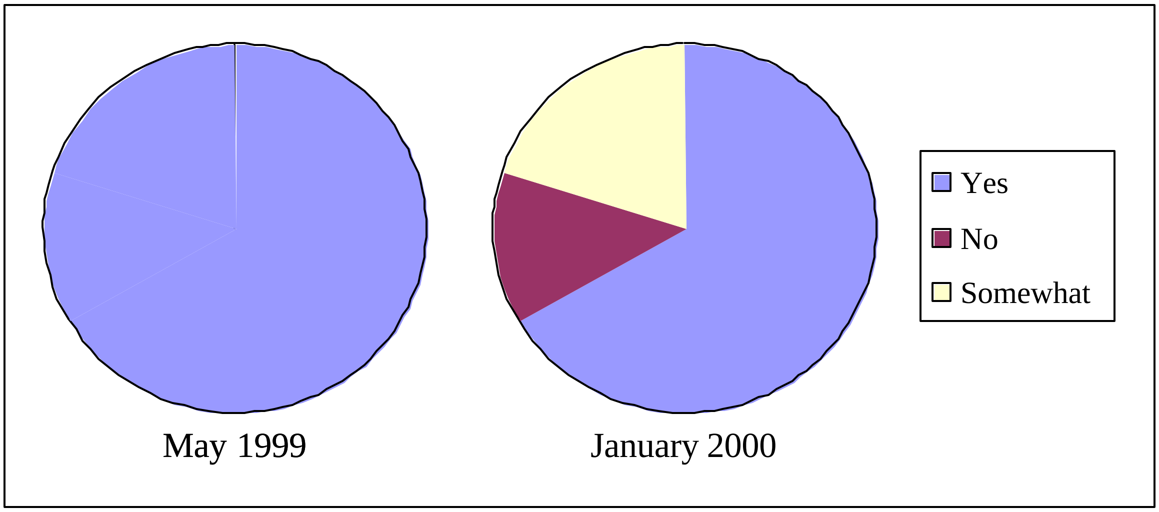


Figure 41: Recreational Vehicle Drivers' Responses to "Was the location of the changeable speed warning sign adequate for you to respond?"

Visibility

The question related to the visibility of the sign has been broken down by survey time (i.e., day or night), as opposed to vehicle type, as shown in Figures 42 and 43. The 98% and 99% of the respondents (during the second and fourth site visits, respectively) felt the visibility of the CMS in terms of the brightness of the lights was adequate. The few who didn't think the visibility of the CMS was adequate either thought the lights were too bright or didn't comment.

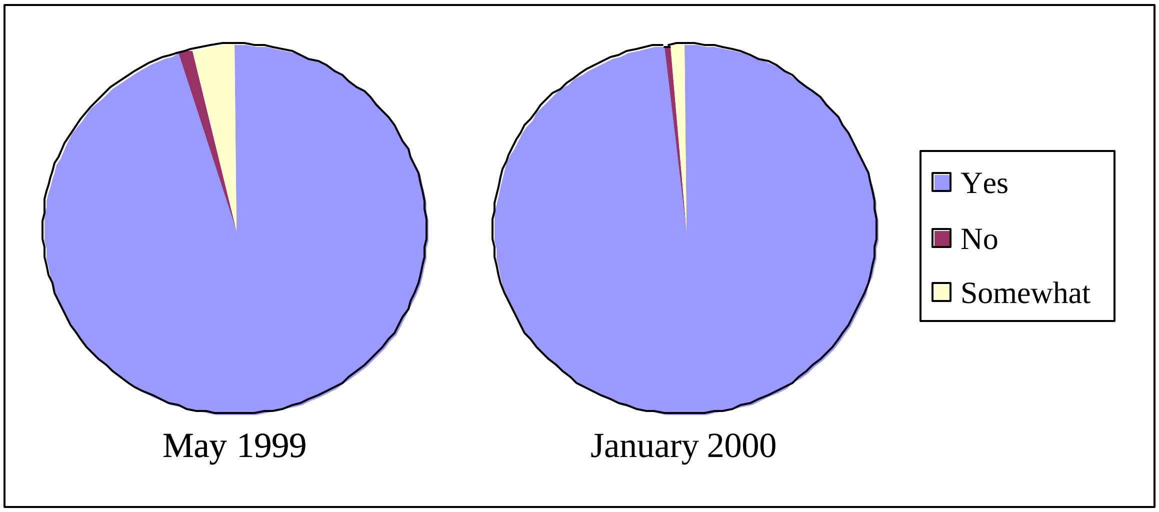


Figure 42: Daytime Responses to “Was the visibility of the changeable message speed warning sign adequate for you to respond?”

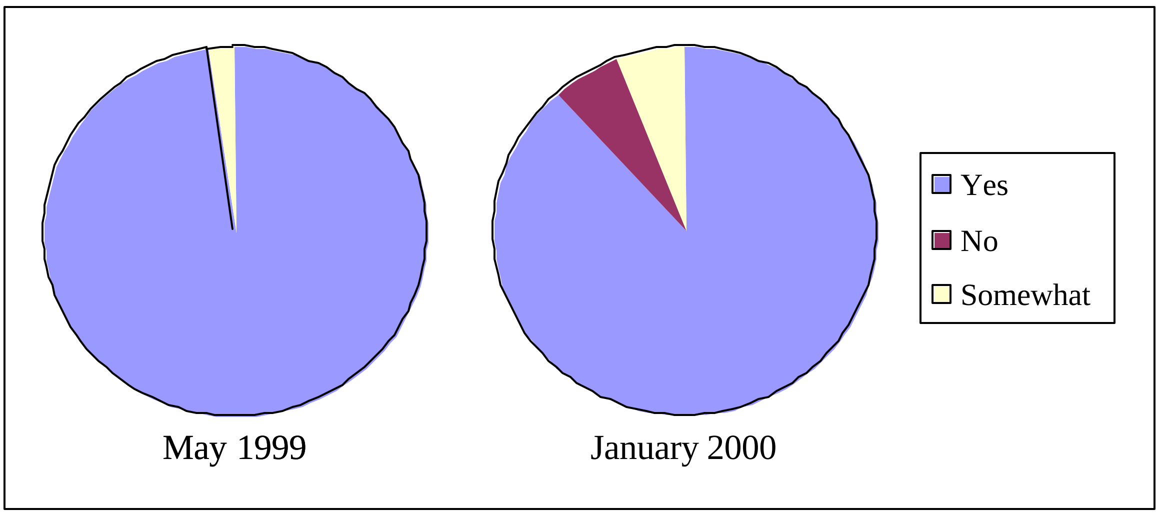


Figure 43: Nighttime Responses to “Was the visibility of the changeable message speed warning sign adequate for you to respond?”

DATA ANALYSIS: MAINTENANCE PERSONNEL INTERVIEWS

The dynamic curve warning system is designed as a stand-alone system and requires no dedicated staff for its day-to-day operation. As long as the system is in good working condition, power and communication costs are the only operational costs associated with the system. These typically average approximately $60 per month (21).

One initial problem with the system was identified from interviews with Caltrans maintenance personnel. The radar units chosen for the system are incapable of distinguishing between north- and southbound directions of traffic. The Sidehill Viaduct and O'Brien sites are divided and separated by enough space that this is not an issue; at the Salt Creek, La Moine, and Sims Road sites, however, this limitation can result in an inaccurate reading and message being displayed to drivers when there are vehicles traveling in the opposite direction. When there are not vehicles in the opposing lanes, the dynamic curve warning system will read correct readings. The positioning and the angle of the radar units have been adjusted, but the cones of vision cannot be changed enough to exclude the traffic in the opposite lanes. For future installations, a different radar unit model that can distinguish between the different directions of travel will be used (21). Aside from the initial problem, there have been no other documented maintenance or operational difficulties with the dynamic curve warning system, although a final suggestion was made by maintenance personnel that a laptop computer would be useful so the dynamic curve warning system messages could be controlled from the field (22).

CONCLUSIONS

This report summarizes the results of an evaluation of the effectiveness of the CMS and radar portions of the dynamic curve warning systems in the Sacramento River Canyon. Measures of effectiveness (MOEs) used in the analysis as shown in Table 15 which include (1) frequency of crashes (for trucks and passenger cars), (2) frequency of erratic maneuvers (for trucks and passenger cars), (3) operating speeds (for trucks and passenger cars), (4) reported change in driver behavior (for trucks and passenger cars), (5) public opinion, and (6) maintenance requirements.

Table 15: Measures of Effectiveness

Goal	Measure of Effectiveness	Data Source
Improved Truck Safety	Change in Frequency of Truck Crashes	TASAS Crash Database
	Change in Frequency of Truck Erratic Maneuvers	Manual Erratic Maneuver Counts
	Change in Truck Operating Speeds	Manual Speed Measurements
	Reported Change in Truck Driver Behavior	Motorist Survey
Improved Passenger Car Safety	Change in Frequency of Passenger Car Crashes	TASAS Crash Database
	Change in Frequency of Passenger Car Erratic Maneuvers	Manual Erratic Maneuver Counts
	Change in Passenger Car Operating Speeds	Manual Speed Measurements
	Reported Change in Passenger Car Driver Behavior	Motorist Survey
Positive Public Acceptance	Reported Public Acceptance	Motorist Survey
Minimal Required Maintenance	Reported Maintenance Requirements	Maintenance Personnel Interviews

Frequency of Crashes

Due to the lack of sufficient crash data following the installation date of the dynamic curve warning system, a meaningful before-after analysis could not be made at the time of this report. However, reductions in total crashes were noted in the available data obtained for the Sidehill Viaduct, La Moine, and Sims Road sites, while there were increases in the frequencies of crashes at the O'Brien and Salt Creek curves. When the crash data was combined for all five sites, a reduction in truck-related crashes was observed.

Operating Speeds

Speed data were collected at the approximate beginning of each designated curve, using a manual stopwatch method at all of the sites during each of the four site visits. Data were analyzed by vehicle type. Decreases in truck speeds (including commercial vehicles, recreational vehicles, and vehicles towing trailers) were found to be statistically significant ($\alpha = 0.05$) at the Sidehill Viaduct and Salt Creek sites, which are the only curves located in steep downgrades (-5.0% to –6.0%). The Sims Road site experienced a significant reduction in truck speeds immediately following the installation of the dynamic curve warning system, but the speed data collected at this site on subsequent visits indicate the mean speeds rose steadily thereafter. There were no significant decreases in truck speeds at the O'Brien and La Moine sites.

Passenger car speeds were found to significantly decrease at the Sidehill Viaduct and Sims Road sites, while the O'Brien, Salt Creek, and La Moine sites did not experience any statistically significant decreases in speeds.

Frequency of Erratic Maneuvers

Erratic maneuvers were monitored in an attempt to measure possible effects of the dynamic curve warning system on driving behavior, including lane line encroachments and brake applications in the curve. Erratic maneuvers *may* be an indication that drivers were traveling at unsafe speeds as they entered the curve. Statistical analyses were completed only on the total number of drivers performing erratic maneuvers at each site. Ambiguity of the interpretation of this MOE and insufficient sample sizes prevented further analysis of individual maneuvers. Statistically significant decreases in the number of vehicles performing erratic maneuvers at the O'Brien site were found when comparisons were made with the data collected on the first trip and each of the post-installation trips. A significant reduction was found in the number of vehicles performing erratic maneuvers at the Sims Road site between the first and fourth trips.

Reported Driver Behavior

The same survey was given on two different occasions: one shortly after the installation date, and another approximately nine months after the installation date. Responses from each trip were very similar and have been combined for comparison purposes in this conclusion. 64% of surveyed drivers of passenger cars and recreational vehicles reportedly responded to the advisory speed provided on the dynamic curve warning system (i.e., reduced their speeds to comply with the advisory) less often than did the 72% of their truck driving counterparts.

Public Acceptance

Overall, the public was supportive of the dynamic curve warning system applications in the Sacramento River Canyon. The same survey was given on two different occasions: one shortly after the installation date, and another approximately nine months after the installation date. Responses from each trip were very similar and have been combined for comparison purposes in this conclusion. Amongst the survey respondents, 72%, 82%, and 92% of drivers of commercial vehicle, passenger car, and recreational vehicle drivers, respectively, felt the speed information given by the dynamic curve warning system was useful. 83% and 96% of the reactions of survey participants in terms of sign placement and visibility were positive, respectively.

Maintenance Requirements

Some of the Caltrans maintenance personnel were interviewed to see if there were any problems in the field with the dynamic curve warning system. An initial problem with the setup of the sign systems included having to adjust the direction of radar units to maximize accurate readings (i.e., to prevent the units from reading the oncoming traffic speeds). The problem with the radar unit installation cannot be solved with the current system, so a new radar unit with adequate directional distinguishing capabilities will be chosen for future applications of the dynamic curve warning system. There have not been any other maintenance or operational problems associated with the CMS and radar units reported by Caltrans personnel. Expenses associated with power and communication are the only sources of operational costs involved with the system and typically average $60 per month.

In addition to the MOEs described previously, there may be other less quantifiable effects of the dynamic curve warning systems, such as increasing driver awareness at the specific curve locations. This relatively new and different form of warning may catch the attention of drivers better than conventional signs and, therefore, drivers may enter the curve with an increased awareness of potential hazards.

The dynamic curve warning system appears to be effective in lowering speed in areas of steep downgrades and level terrain. The system has also been successful in reducing the number of accidents involving trucks, which was a primary objective of the system.

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Appendix A: Experimental Data for Stopwatch Versus Radar Collection

Weather Conditions: Sunny, Warm

MEASURED SPEEDS: LA MOINE (6/5/97)

#	Radar (mph)	Stop Watch (s)	Stop Watch (mph)	error	abs error
1	62	3.445	59.37	-2.63	2.63
2	67	3.203	63.86	-3.14	3.14
3	63	3.388	60.37	-2.63	2.63
4	61	3.44	59.46	-1.54	1.54
5	62	3.394	60.27	-1.73	1.73
6	66	3.158	64.77	-1.23	1.23
7	74	2.806	72.90	-1.10	1.10
8	57	3.666	55.80	-1.20	1.20
9	66	3.199	63.94	-2.06	2.06
10	71	2.944	69.48	-1.52	1.52
11	55	3.775	54.18	-0.82	0.82
12	57	3.613	56.61	-0.39	0.39
13	71	2.999	68.20	-2.80	2.80
14	59	3.615	56.58	-2.42	2.42
15	58	3.63	56.35	-1.65	1.65
16	65	3.273	62.49	-2.51	2.51
17	56	3.728	54.87	-1.13	1.13
18	65	3.2	63.92	-1.08	1.08

MEASURED SPEEDS: O'BRIEN (6/6/97)

#	Radar (mph)	Stop Watch (s)	Stop Watch (mph)	error	abs error
1	58	3.65	56.04	-1.96	1.96
2	57	3.7	55.28	-1.72	1.72
3	55	3.84	53.27	-1.73	1.73
4	53	4.01	51.01	-1.99	1.99
5	56	3.77	54.26	-1.74	1.74
6	52	4.03	50.76	-1.24	1.24
7	56	3.72	54.99	-1.01	1.01
8	72	2.96	69.10	-2.90	2.90
9	67	3.06	66.84	-0.16	0.16
10	54	3.86	52.99	-1.01	1.01
11	52	3.95	51.78	-0.22	0.22
12	53	3.78	54.11	1.11	1.11
13	60	3.47	58.95	-1.05	1.05
14	44	4.65	43.99	-0.01	0.01
15	59	3.52	58.11	-0.89	0.89
16	52	3.99	51.26	-0.74	0.74
17	57	3.62	56.50	-0.50	0.50
18	69	2.95	69.34	0.34	0.34
19	56	3.56	57.46	1.46	1.46
20	64	3.2	63.92	-0.08	0.08
21	50	4.15	49.29	-0.71	0.71
22	61	3.48	58.78	-2.22	2.22
23	54	3.79	53.97	-0.03	0.03
24	54	3.47	58.95	4.95	4.95

Average	-1.09	
Standard Deviation	1.41	
Maximum Positive	4.95	
Maximum Negative	-3.14	
Average Absolute Error	1.46	
Maximum Absolute Error	4.95	
Minimum Absolute Error	0.01	
Sample Size, n	42	
95% confidence interval	-1.51	-0.66
99% confidence interval	-1.65	-0.53

<u>Appendix B: Motorist Survey Instrument</u>

California Department of Transportation Sacramento River Canyon Advanced Curve Warning Motorist Survey

Date: ________________ Weather: ________________________

Time: ________________ Interviewer: ______________________

1. What type of vehicle are you driving today?

   ____ Car/Pick-up/Van ____ Commercial Truck ____ RV

2. What is the purpose of your trip on I – 5 today?

   ____ Work ____ Pleasure ____ Other

3. How often have you driven this section of I – 5?

   ____ <1/Month ____ 1-3/Month ____ >3/Month

4. Did you notice the Changeable Message Sign (CMS) displaying your vehicle speed?

   ____ Yes ____ No ____ Not sure

   If yes, do you think this speed information was useful to you in driving safely through the curve?

   ____ Yes ____ No ____ Somewhat

5. Did you respond and adjust your travel speed through the curve as advised?

   ____ Yes ____ No ____ Not sure

6. Was the location of the changeable speed warning sign adequate for you to respond?

   ____ Yes ____ No ____ Somewhat

   If no, what was your difficulty with the sign location?

   ____ Too close to curve ____ Too far from curve

7. Was the visibility of the changeable message speed warning sign adequate for you to respond?

   ____ Yes ____ No ____ Somewhat

   If no, what was your difficulty with the sign visibility?

   ____ Too bright ____ Too dim

8. ______ Age ______ Sex

9. Driver comments, if offered

Appendix C: Speed Measurement Collection

Location: SIDE HILL VIADUCT
Date: 6/6/98 (Trip 1)
Speed Trap 1 Distance (FT): 300
Speed Trap 2 Distance (FT): 300

		State		Vehicle Lane		Trap 1	Trap 2	Brake Lights In Curve	Encroachment				Speed		Speed
Veh ID	Vehicle Type	In	Out	Drive Ln (x)	Pass Ln (x)	Time	Time	(x) for yes	Inside Edge	Center Laneline	Outside Edge	Lane Change	Trap 1 mph	Trap 2 mph	Reduction mph
1	C	X		X		3.21	3						63.721	68.182	-4.460
2	C		X	X		2.81	3.68	X					72.792	55.583	17.209
3	C		X	X		2.886	2.99	X					70.875	68.410	2.465
4	T		X	X		3.632	3.63	X					56.318	56.349	-0.031
5	C	X		X		3.343	3.31	X					61.186	61.796	-0.610
6	T		X	X		3.543	3.52	X					57.732	58.110	-0.377
7	C	X		X		3.577	3.43	X					57.184	59.634	-2.451
8	T	X		X		3.258	3.3	X	X				62.783	61.983	0.799
9	C	X		X		3.097	2.96						66.046	69.103	-3.057
10	C	X		X		3.531	3.59						57.928	56.976	0.952
11	T		X	X		3.429	3.42	X					59.652	59.809	-0.157
12	C		X	X		2.983	2.85	X					68.570	71.770	-3.200
13	C			X		3.097	3.34						66.046	61.241	4.805
14	T		X	X		3.228	3.35	X	X				63.366	61.058	2.308
15	C		X	X		2.665	2.92	X					76.753	70.050	6.703
16	C				X	3.406	3.63	X					60.054	56.349	3.706
17	C	X			X	3.403	3.61	X					60.107	56.661	3.447
18	T			X		3.544	3.55	X					57.716	57.618	0.098
19	T	X		X		3.388	3.36	X					60.374	60.877	-0.503
20	C		X	X		2.911	3.11	X					70.266	65.770	4.496
21	T	X		X		3.5	3.57	X					58.442	57.296	1.146
22	UH		X	X		3.563	3.29						57.408	62.172	-4.764
23	T		X	X		3.94	3.93	X					51.915	52.047	-0.132
24	UH			X		3.29	3.2	X					62.172	63.920	-1.749
25	T	X		X		3.41	3.63	X				X	59.984	56.349	3.635
26	C		X	X		3.153	3.34	X					64.873	61.241	3.632
27	C	X		X		3.232	3.16	X					63.288	64.730	-1.442
28	C	X		X		3.573	3.37						57.248	60.696	-3.448
29	C		X	X		2.752	3.13	X				X	74.326	65.350	8.976
30	C	X		X		2.904	2.99	X					70.436	68.410	2.026
31	C	X		X		3.181	3.04						64.302	67.285	-2.982
32	C		X	X		3.86	3.83	X	X				52.991	53.406	-0.415
33	C		X	X		2.993	3.4	X					68.341	60.160	8.181
34	PU W/B	X		X		3.483	3.66	X					58.727	55.887	2.840
35	T		X	X		3.481	3.76	X					58.761	54.400	4.360
36	C	X		X		3.363	3.31						60.822	61.796	-0.974
37	T			X		3.199	3.06	X					63.940	66.845	-2.904
38	C	X		X		3.33	3.55	X					61.425	57.618	3.807
39	C	X			X	3.171	3.11	X					64.505	65.770	-1.265
40	C	X		X		2.611	2.53						78.340	80.848	-2.508
41	C	X		X		2.948	2.96						69.384	69.103	0.281
42	C	X		X		3.572	3.66						57.264	55.887	1.377
43	T		X	X		4.191	4.05	X					48.806	50.505	-1.699
44	C	X		X		2.512	3.52						81.427	58.110	23.318
45	C	X		X		3.632	3.62						56.318	56.504	-0.187
46	C		X	X		3.434	3.51						59.565	58.275	1.290
47	C	X			X	2.853	3.13						71.695	65.350	6.345
48	C	X		X		3.344	3.66						61.168	55.887	5.281
49	C		X		X	3.05	3.25	X					67.064	62.937	4.127
50	C		X	X		2.839	2.95	X					72.048	69.337	2.711
51	T		X	X		3.86	3.63	X					52.991	56.349	-3.358
52	T	X		X		3.38	3.69	X					60.516	55.432	5.084
53	C	X		X		3.009	2.94	X					67.978	69.573	-1.595
54	C		X	X		3.163	3.31						64.668	61.796	2.872
55	C		X		X	3.085	2.94	X					66.303	69.573	-3.270
56	C	X		X		3.387	3.2						60.391	63.920	-3.529
57	C		X	X		3.11	3.24					X	65.770	63.131	2.639
58	C		X	X		3.366	3.26		X				60.768	62.744	-1.976
59	C		X	X		3.054	3.18						66.976	64.322	2.654
60	C	X		X		3.05	3.11	X					67.064	65.770	1.294
61	C	X		X		3.491	3.37						58.592	60.696	-2.104
62	C		X		X	3.336	3.27						61.315	62.552	-1.238
63	MH	X		X		3.314	3.28						61.722	62.361	-0.640
64	C	X		X		2.994	3.31						68.318	61.796	6.522
65	T	X		X		3.11	3.33	X					65.770	61.425	4.345
66	C		X	X		3.102	2.95	X					65.940	69.337	-3.398

Location: O'BRIEN
Date: 6/6/98 (Trip 1)
Speed Trap 1 Distance (FT): 300
Speed Trap 2 Distance (FT): 300

		State		Vehicle Lane		Trap 1	Trap 2	Brake Lights In Curve	Encroachment			Lane	Speed		Speed
Veh ID	**Vehicle Type**	**In**	**Out**	**Drive Ln (x)**	**Pass Ln (x)**	**Time**	**Time**	**(x) for yes**	**Inside Edge**	**Center Laneline**	**Outside Edge**	**Change**	**Trap 1 mph**	**Trap 2 mph**	**Reduction mph**
1	T			X		3.793	3.99						53.927	51.265	2.663
2	C			X		3.917	3.95						52.220	51.784	0.436
3	C			X		3.482	3.95						58.744	51.784	6.960
4	T		X	X		3.823	3.85						53.504	53.129	0.375
5	C	X		X		3.763	3.64						54.357	56.194	-1.837
6	C	X		X		3.886	4.36						52.637	46.914	5.722
7	C			X		3.406	3.35	X	X				60.054	61.058	-1.004
8	C			X		3.088	3.5					X BC	66.239	58.442	7.797
9	C		X	X		3.493	3.57						58.559	57.296	1.263
10	C	X		X		3.175	3.59						64.424	56.976	7.447
11	C	X		X		3.554	3.31		X				57.554	61.796	-4.243
12	C	X		X		3.164	3.06					X BC	64.648	66.845	-2.197
13	C	X		X		3.437	3.3						59.513	61.983	-2.471
14	C	X		X		3.745	3.51	X				X BC	54.618	58.275	-3.657
15	C			X		3.471	3.76						58.930	54.400	4.529
16	PU W/T	X		X		4.147	4.41		X				49.324	46.382	2.942
17	C		X	X		3.276	3.5			X			62.438	58.442	3.996
18	C	X		X		3.509	3.59		X				58.292	56.976	1.315
19	C	X		X		3.159	3.7		X				64.750	55.283	9.468
20	T		X	X		3.597	4.17		X				56.866	49.052	7.814
21	C	X		X		3.701	3.73						55.268	54.838	0.430
22	C		X	X		3.853	4.19						53.087	48.818	4.270
23	T		X	X		3.779	3.97		X				54.127	51.523	2.604
24	C	X		X		3.421	3.45		X				59.791	59.289	0.503
25	C		X	X		3.595	3.85						56.897	53.129	3.769
26	T		X	X		4.119	4.51		X				49.659	45.354	4.305
27	C		X	X		3.643	3.88						56.148	52.718	3.430
28	T			X		3.251	3.42						62.918	59.809	3.109
29	C		X	X		3.431	3.3						59.617	61.983	-2.367
30	T	X		X		4.198	4.81						48.725	42.525	6.199
31	T	X		X		3.814	3.8						53.630	53.828	-0.198
32	C		X	X		3.681	3.7		X				55.568	55.283	0.285
33	C		X	X		3.769	3.7		X				54.270	55.283	-1.012
34	T		X	X		3.98	4.33		X				51.393	47.239	4.154
35	MH		X	X		3.468	3.66		X				58.981	55.887	3.094
36	C	X		X		3.298	3.11						62.021	65.770	-3.749
37	T	X		X		3.374	3.25						60.624	62.937	-2.313
38	C	X		X		3.395	3.54						60.249	57.781	2.468
39	T		X	X		3.687	3.85		X				55.477	53.129	2.349
40	C	X		X		3.241	3.5						63.112	58.442	4.670
41	C		X	X		3.513	3.44	X	X				58.225	59.461	-1.236
42	C		X	X		3.38	3.28						60.516	62.361	-1.845
43	C		X	X		3.175	3.56		X				64.424	57.457	6.967
44	C		X	X		3.437	3.4						59.513	60.160	-0.648
45	SUB W/T			X		3.865	4.05						52.922	50.505	2.417
46	T		X	X		3.58	3.54		X				57.136	57.781	-0.646
47	T		X	X		3.515	3.7		X				58.192	55.283	2.910
48	T		X	X		3.441	3.45		X				59.444	59.289	0.155
49	C		X	X		3.357	3.63		X				60.931	56.349	4.582
50	C	X		X		3.612	3.6						56.629	56.818	-0.189
51	T		X	X		3.575	3.92		X				57.216	52.180	5.036
52	C	X		X		3.509	3.64	X					58.292	56.194	2.098
53	C	X		X		3.403	3.36						60.107	60.877	-0.769
54	C	X		X		3.615	3.63						56.582	56.349	0.234
55	C		X		X	2.646	2.88		X			X	77.304	71.023	6.281
56	T		X	X		3.867	4.49		X				52.895	45.556	7.339
57	C		X	X		3.781	3.53	X					54.098	57.945	-3.847
58	T		X	X		3.319	3.63		X				61.629	56.349	5.280
59	T		X	X		3.373	4.37						60.642	46.807	13.835
60	T		X	X		3.608	3.76	X	X				56.692	54.400	2.292
61	C		X	X		3.384	3.45						60.445	59.289	1.156
62	C		X	X		2.96	3.37						69.103	60.696	8.407
63	C		X	X		3.101	3.27		X				65.961	62.552	3.409
64	C	X		X		2.884	3.11						70.924	65.770	5.154
65	MH	X		X		3.593	4.03	X	X				56.929	50.756	6.173
66	C	X			X	2.42	2.81			X			84.523	72.792	11.731

Location:	SALT CREEK														
Date:	6/5/98	(Trip 1)													
Speed Trap 1 Distance (FT):			300												
Speed Trap 2 Distance (FT):			300												
								Brake Lights	**Encroachment**				**Speed**		**Speed**
		State		**Vehicle Lane**		**Trap 1**	**Trap 2**	**In Curve**	**Inside**	**Center**	**Outside**	**Lane**	**Trap 1**	**Trap 2**	**Reduction**
Veh ID	**Vehicle Type**	**In**	**Out**	**Drive Ln (x)**	**Pass Ln (x)**	**Time**	**Time**	**(x) for yes**	**Edge**	**Laneline**	**Edge**	**Change**	**mph**	**mph**	**mph**
1	C				X	3.165	2.95						64.627	69.337	-4.710
2	C			X		3.301	3.11						61.965	65.770	-3.806
3	C			X		3.843	3.76						53.225	54.400	-1.175
4	C			X		3.248	3.24						62.976	63.131	-0.155
5	C			X		3.261	3.38						62.725	60.516	2.208
6	T			X		3.344	3.31						61.168	61.796	-0.628
7	C				X	2.872	3.32						71.221	61.610	9.610
8	T			X		3.805	3.42						53.757	59.809	-6.052
9	C				X	3.119	3.22			X			65.580	63.523	2.057
10	C			X		3.675	3.5						55.659	58.442	-2.783
11	PU W/T		X	X		3.992	3.76						51.239	54.400	-3.162
12	RV				X	3.779	3.75				X		54.127	54.545	-0.419
13	C			X		3.593	3.34						56.929	61.241	-4.312
14	C				X	2.71	2.66						75.478	76.897	-1.419
15	C			X		3.006	3.05	X					68.046	67.064	0.982
16	T			X		3.778	3.51	X					54.141	58.275	-4.134
17	T			X		3.878	3.59	X					52.745	56.976	-4.231
18	C			X		3.494	3.45						58.542	59.289	-0.747
19	C				X	3.546	3.29						57.683	62.172	-4.488
20	C	X		X		3.332	3.31		X BC				61.388	61.796	-0.408
21	C	X		X		3.743	3.71						54.647	55.134	-0.486
22	C				X	2.923	3						69.978	68.182	1.796
23	C		X		X	2.896	3.19						70.630	64.121	6.510
24	T		X	X		3.589	3.32						56.992	61.610	-4.618
25	T			X		3.51	3.3			X			58.275	61.983	-3.708
26	C			X		3.607	3.51						56.708	58.275	-1.567
27	C	X			X	3.023	3.13						67.663	65.350	2.313
28	C				X	3.503	3.59						58.392	56.976	1.415
29	C			X		3.435	3.4						59.547	60.160	-0.613
30	C			X		3.167	3.13						64.587	65.350	-0.763
31	C			X		3.275	3.61						62.457	56.661	5.796
32	T		X	X		3.453	3.18	X					59.237	64.322	-5.085
33	T				X	3.26	3.06				X BC		62.744	66.845	-4.101
34	T				X	3.225	3.24			X			63.425	63.131	0.294
35	T			X		3.164	2.9			X BC			64.648	70.533	-5.885
36	C			X		2.64	2.81						77.479	72.792	4.687
37	C			X		3.942	3.77		X BC				51.889	54.256	-2.367
38	T			X		3.462	3.36						59.083	60.877	-1.794
39	C			X		2.858	2.92					X	71.569	70.050	1.520
40	C				X	3.166	2.84						64.607	72.023	-7.416
41	C				X	2.846	2.92				X BC		71.871	70.050	1.821
42	C				X	3.029	2.79	X				X	67.529	73.314	-5.785
43	T			X		3.459	3.16	X					59.134	64.730	-5.595
44	C			X		2.856	2.85						71.620	71.770	-0.151
45	T			X		3.943	3.52	X					51.876	58.110	-6.234
46	C		X		X	2.905	3.45						70.412	59.289	11.123
47	C				X	3.209	3.15						63.741	64.935	-1.194
48	PU W/T				X	3.423	3.23					X	59.756	63.327	-3.571
49	C			X		3.804	3.59						53.771	56.976	-3.205
50	C			X		3.091	3.27	X					66.175	62.552	3.622
51	T			X		3.177	3.35	X					64.383	61.058	3.325
52	MH			X		3.658	3.63		X BC				55.917	56.349	-0.431
53	C				X	3.058	3.06						66.889	66.845	0.044
54	T			X		3.472	3.66		X BC				58.913	55.887	3.026
55	C				X	3.137	3.4						65.204	60.160	5.044
56	C			X		3.61	3.56		X BC	X			56.661	57.457	-0.796
57	C			X		2.919	2.88						70.074	71.023	-0.949
58	C				X	3.108	3.01						65.813	67.955	-2.143
59	C				X	3.031	3.05						67.484	67.064	0.420
60	C			X		3.714	3.59						55.074	56.976	-1.902
61	C			X		3.306	3.27						61.871	62.552	-0.681
62	C				X	2.899	2.95						70.557	69.337	1.220
63	C			X		2.877	2.84						71.097	72.023	-0.926
64	C			X		3.152	2.97						64.894	68.871	-3.977
65	C			X		3.741	3.63						54.677	56.349	-1.672
66	C				X	3.329	3.34						61.444	61.241	0.202

Location:	LA MOINE														
Date:	6/5/98	(Trip 1)													
Speed Trap 1 Distance (FT):			300												
Speed Trap 2 Distance (FT):			300												
		State		Vehicle Lane		Trap 1	Trap 2	Brake Lights	Encroachment				Speed		Speed
								In Curve	Inside	Center	Outside	Lane	Trap 1	Trap 2	Reduction
Veh ID	Vehicle Type	In	Out	Drive Ln (x)	Pass Ln (x)	Time	Time	(x) for yes	Edge	Laneline	Edge	Change	mph	mph	mph
1	T			X		3.538	3.49						57.814	58.609	-0.795
2	C			X		3.146	3.09						65.018	66.196	-1.178
3	C			X		3.134	3.04						65.267	67.285	-2.018
4	C				X	3.168	3.08						64.566	66.411	-1.845
5	T			X		3.169	3.01	X					64.546	67.955	-3.410
6	C			X		3.211	3.25						63.701	62.937	0.764
7	T		X	X		3.437	3.38	X BC					59.513	60.516	-1.004
8	C			X		3.117	3.14						65.623	65.142	0.481
9	C			X		2.851	2.59					X	71.745	78.975	-7.230
10	C			X		3.293	3.31						62.115	61.796	0.319
11	T			X		3.228	3.2						63.366	63.920	-0.554
12	C				X	2.828	3.07						72.329	66.627	5.701
13	C			X		2.925	2.95						69.930	69.337	0.593
14	C			X		2.845	2.96						71.896	69.103	2.793
15	C	X		X		3.12	2.99						65.559	68.410	-2.850
16	T			X		3.27	3.16				X		62.552	64.730	-2.177
17	C			X		3.08	2.95						66.411	69.337	-2.927
18	C			X		3.209	3.03						63.741	67.507	-3.766
19	C			X		2.86	2.77						71.519	73.843	-2.324
20	C			X		3.163	3.08						64.668	66.411	-1.743
21	PU W/C			X		3.194	3.16						64.041	64.730	-0.689
22	T			X		3.365	2.94						60.786	69.573	-8.787
23	C				X	2.899	2.9	X BC					70.557	70.533	0.024
24	C			X		3.114	2.94						65.686	69.573	-3.888
25	VAN W/C			X		3.231	3.19						63.307	64.121	-0.814
26	T			X		3.571	3.49						57.280	58.609	-1.329
27	T				X	3.231	3.63						63.307	56.349	6.959
28	C			X		2.909	2.87						70.315	71.270	-0.955
29	C				X	2.866	2.72						71.370	75.201	-3.831
30	C				X	2.433	2.38	X					84.071	85.943	-1.872
31	C				X	2.856	2.74				X BC		71.620	74.652	-3.032
32	T			X		3.09	3.04	X	X				66.196	67.285	-1.089
33	C				X	2.768	2.88						73.896	71.023	2.874
34	PU W/C		X	X		3.29	3.25						62.172	62.937	-0.765
35	T			X		3.714	3.66						55.074	55.887	-0.813
36	C			X		3.169	3.22						64.546	63.523	1.022
37	PU W/T				X	3.31	5.28						61.796	38.740	23.057
38	T			X		3.72	3.6	X					54.985	56.818	-1.833
39	C				X	2.97	2.81						68.871	72.792	-3.921
40	C				X	2.877	2.76						71.097	74.111	-3.014
41	T			X		3.113	3.13						65.707	65.350	0.357
42	C			X		3.097	3.31						66.046	61.796	4.250
43	C				X	2.96	2.84						69.103	72.023	-2.920
44	C			X		3.023	2.87						67.663	71.270	-3.607
45	C				X	2.797	2.56						73.130	79.901	-6.770
46	T			X		3.156	2.79	X	X				64.812	73.314	-8.502
47	C			X		3.419	3.35			X			59.826	61.058	-1.232
48	PU W/C			X		3.711	3.59						55.119	56.976	-1.858
49	C			X		3.013	3						67.888	68.182	-0.294
50	C			X		3.435	3.32						59.547	61.610	-2.063
51	T			X		3.961	3.68						51.640	55.583	-3.943
52	C			X		3.327	3.11						61.480	65.770	-4.290
53	C			X		3.748	3.46						54.575	59.117	-4.543
54	C				X	2.783	2.72						73.498	75.201	-1.702
55	C				X	3.093	2.87						66.132	71.270	-5.138
56	C			X		3.5	3.56						58.442	57.457	0.985
57	T			X		3.531	3.65						57.928	56.040	1.889
58	C				X	2.78	2.71						73.578	75.478	-1.901
59	T			X		3.598	3.45						56.850	59.289	-2.439
60	C				X	2.954	2.83						69.244	72.278	-3.034
61	C	X		X		3.252	3.22						62.898	63.523	-0.625
62	C			X		3.35	3.25						61.058	62.937	-1.879
63	C			X		3.066	3.09						66.714	66.196	0.518
64	C			X		3.502	3.4		X BC				58.408	60.160	-1.752
65	T			X		3.531	3.46						57.928	59.117	-1.189
66	C			X		3.371	3.3						60.678	61.983	-1.305

Location:	Sims Road														
Date:	6/4/98 (Trip 1)														
Speed Trap 1 Distance (FT):			300												
Speed Trap 2 Distance (FT):			300												
		State		**Vehicle Lane**		**Trap 1**	**Trap 2**	**Brake Lights In Curve**	**Encroachment**				**Speed**		**Speed**
									Inside	**Center**	**Outside**	**Lane**	**Trap 1**	**Trap 2**	**Reduction**
Veh ID	**Vehicle Type**	**In**	**Out**	**Drive Ln (x)**	**Pass Ln (x)**	**Time**	**Time**	**(x) for yes**	**Edge**	**Laneline**	**Edge**	**Change**	**mph**	**mph**	**mph**
1	C		X	X		3.259	3.27		X				66.651	59.216	7.435
2	T		X	X		3.42	4.03						63.513	48.049	15.465
3	C		X	X		3.745	3.07						58.002	63.074	-5.072
4	C			X		3.089	2.84						70.319	68.182	2.137
5	C	X		X		2.763	2.72		X				78.616	71.190	7.426
6	C		X		X	3.666	3.41						59.251	56.785	2.467
7	C		X		X	3.106	3.17						69.934	61.084	8.850
8	C	X		X		3.031	2.73		X				71.665	70.929	0.736
9	T			X		3.163	3.43		X				68.674	56.454	12.220
10	T		X	X		3.69	3.41		X				58.866	56.785	2.081
11	C	X			X	3.22	3.03					X	67.458	63.906	3.552
12	C	X		X		3.066	3.06						70.847	63.280	7.567
13	C			X		3.313	3.16		X				65.565	61.277	4.287
14	T		X	X		3.531	3.17	X	X				61.517	61.084	0.433
15	T		X	X		3.633	3.19		X				59.790	60.701	-0.911
16	C		X	X		3.406	3.05		X				63.774	63.487	0.287
17	T		X	X		3.67	3.24						59.187	59.764	-0.577
18	T		X	X		3.921	4.05		X				55.398	47.811	7.587
19	C				X	3.23	2.88						67.250	67.235	0.015
20	T			X		3.61	3.51		X				60.171	55.167	5.004
21	T		X	X		3.764	3.45		X				57.709	56.126	1.582
22	C		X		X	3.021	2.64					X	71.902	73.347	-1.445
23	C		X		X	3.3	2.8						65.823	69.156	-3.333
24	T		X	X		3.719	3.44		X				58.407	56.290	2.117
25	C			X		3.354	3.04		X				64.763	63.696	1.067
26	C			X		3.361	2.79					X BC	64.628	69.404	-4.775
27	C		X		X	3.696	2.74						58.771	70.670	-11.900
28	T			X		3.94	3.32		X BC				55.131	58.324	-3.193
29	C		X		X	3.071	2.77						70.731	69.905	0.827
30	T		X	X		4.082	3.59		X				53.213	53.938	-0.725
31	C	X		X		3.945	3.8						55.061	50.957	4.104
32	T			X		3.535	3.37	X	X				61.447	57.459	3.988
33	MH		X	X		3.818	3.33		X				56.893	58.149	-1.256
34	C			X		3.457	2.95		X				62.834	65.639	-2.806
35	T		X	X		3.576	3.19		X BC				60.743	60.701	0.042
36	T			X		3.568	3.22		X				60.879	60.136	0.743
37	C			X		3.413	3.06		X BC				63.644	63.280	0.364
38	T		X	X		3.697	3.22	X	X BC				58.755	60.136	-1.381
39	T		X	X		4.009	3.57		X				54.182	54.240	-0.058
40	C			X		3.405	2.93		X BC				63.793	66.087	-2.294
41	C			X		3.699	3.34						58.723	57.975	0.748
42	C				X	3.157	2.73	X		X			68.805	70.929	-2.125
43	T			X		4.222	3.76						51.449	51.499	-0.050
44	C	X		X		3.771	3.57						57.602	54.240	3.362
45	T		X	X		3.612	3.06						60.137	63.280	-3.143
46	T		X	X		3.734	3.22		X BC				58.172	60.136	-1.963
47	T	X		X		3.543	3.34	X					61.308	57.975	3.334
48	T		X	X		4.052	3.45		X				53.607	56.126	-2.519
49	T			X		4.185	3.74						51.903	51.774	0.129
50	PU W/T			X		3.232	3.13		X				67.208	61.865	5.343
51	T			X		3.5	3.05	X	X				62.062	63.487	-1.426
52	T			X		3.91	3.63						55.554	53.343	2.211
53	T			X		4.147	3.75						52.379	51.636	0.743
54	C				X	3.571	3.12	X					60.828	62.063	-1.235
55	C			X		3.19	2.88						68.093	67.235	0.858
56	C		X		X	3.09	2.94						70.296	65.863	4.434
57	C		X		X	3.542	2.91						61.326	66.542	-5.216
58	C			X		4.024	3.41						53.980	56.785	-2.805
59	T			X		3.734	3.52						58.172	55.010	3.162
60	C			X		3.217	3.06						67.521	63.280	4.241
61	C			X		3.248	2.91						66.877	66.542	0.335
62	C				X	3.277	2.8						66.285	69.156	-2.871
63	T			X		3.826	3.23		X				56.774	59.949	-3.176
64	T			X		3.769	3.4						57.632	56.952	0.680
65	C				X	3.169	3.03					X	68.544	63.906	4.638
66	C		X	X		3.4	2.99		X				63.887	64.761	-0.874

Location:	SIDE HILL VIADUCT
Date:	5/19/99 (Trip 2)
Speed Trap 1 Distance (FT):	300
Speed Trap 2 Distance (FT):	300

		State		Vehicle Lane		Trap 1	Trap 2	Brake Lights In Curve	Encroachment			Lane	Speed		Speed Reduction
									Inside	Center	Outside		Trap 1	Trap 2	
Veh ID	Vehicle Type	In	Out	Drive Ln (x)	Pass Ln (x)	Time	Time	(x) for yes	Edge	Laneline	Edge	Change	mph	mph	mph
1	T			X		4.31	3.98	X		X			47.458	51.393	-3.935
2	C	X			X	2.85	2.97						71.770	68.871	2.900
3	C	X		X		3.85	3.74	X				X	53.129	54.691	-1.563
4	C	X		X		4.37	3.97						46.807	51.523	-4.716
5	T		X	X		4.1	3.95	X					49.889	51.784	-1.895
6	C		X		X	3.22	3.87						63.523	52.854	10.669
7	C	X			X	3	3.39	X					68.182	60.338	7.844
8	T		X	X		4.16	3.87	X					49.170	52.854	-3.685
9	T		X	X		3.78	3.49	X					54.113	58.609	-4.496
10	RV	X		X		4	3.51	X					51.136	58.275	-7.139
11	T		X	X		3.91	3.63	X	X				52.313	56.349	-4.035
12	T			X		3.81	3.55						53.686	57.618	-3.932
13	C	X		X		3.69	3.27	X					55.432	62.552	-7.120
14	C,RV	X		X		3.44	3.42						59.461	59.809	-0.348
15	C		X		X	2.82	3.09						72.534	66.196	6.338
16	C	X		X		4.13	3.45						49.527	59.289	-9.762
17	T		X	X		4.56	4.04	X					44.856	50.630	-5.774
18	C		X	X		4.19	3.98	X					48.818	51.393	-2.576
19	C		X		X	2.93	3.19	X					69.811	64.121	5.690
20	C	X		X		3.68	3.44						55.583	59.461	-3.878
21	C	X			X	3.38	3.22	X					60.516	63.523	-3.007
22	C	X			X	2.88	3.25						71.023	62.937	8.086
23	C		X	X		4.22	4.08						48.470	50.134	-1.663
24	C	X		X		3.19	2.77						64.121	73.843	-9.722
25	C	X		X		3.63	3.15						56.349	64.935	-8.586
26	C	X			X	3.25	3.41	X					62.937	59.984	2.953
27	C		X	X		4.44	3.95	X					46.069	51.784	-5.715
28	C		X	X		3.96	3.72						51.653	54.985	-3.332
29	C	X		X		3.78	4.14						54.113	49.407	4.705
30	C,RV	X		X		4.62	4.16	X	X				44.274	49.170	-4.896
31	C	X			X	3.22	3.31	X					63.523	61.796	1.727
32	T		X	X		5.03	4.48		X				40.665	45.657	-4.992
33	C	X		X		3.94	3.93	X					51.915	52.047	-0.132
34	C	X		X		3.34	3.43	X					61.241	59.634	1.607
35	T	X		X		4.66	3.86	X					43.894	52.991	-9.097
36	C	X		X		3.03	3.18						67.507	64.322	3.184
37	C	X		X		3.41	3.16	X					59.984	64.730	-4.746
38	C	X		X		3.35	3.27	X					61.058	62.552	-1.494
39	C		X		X	3.62	3.73	X					56.504	54.838	1.666
40	C	X		X		4	3	X					51.136	68.182	-17.045
41	T		X	X		4.13	3.74	X					49.527	54.691	-5.165
42	C		X	X		3.88	3.67	X					52.718	55.734	-3.017
43	C			X		3.15	2.81		X				64.935	72.792	-7.857
44	C		X	X		3.75	3.47	X					54.545	58.947	-4.401
45	C	X		X		3.59	3.46	X					56.976	59.117	-2.141
46	C			X		3.31	3.48						61.796	58.777	3.019
47	T	X			X	3.53	3.41						57.945	59.984	-2.039
48	T		X	X		3.97	3.77	X					51.523	54.256	-2.733
49	C	X			X	3	3.18	X					68.182	64.322	3.859
50	T		X		X	3.72	3.7	X					54.985	55.283	-0.297
51	C	X			X	3.25	3.36	X					62.937	60.877	2.060
52	T			X		3.91	3.84	X					52.313	53.267	-0.954
53	C		X		X	3.09	3.27	X					66.196	62.552	3.644
54	T	X		X		4.21	4.09	X					48.586	50.011	-1.425
55	T	X		X		4.62	4.13						44.274	49.527	-5.253
56	C		X	X		4	3.66						51.136	55.887	-4.750
57	T				X	3.75	3.81	X					54.545	53.686	0.859
58	C	X			X	3.19	3.4	X					64.121	60.160	3.960
59	C	X		X		4.22	4.06						48.470	50.381	-1.910
60	C	X		X		3.66	3.21						55.887	63.721	-7.835
61	T	X		X		3.75	3.38	X					54.545	60.516	-5.971
62	T		X	X		4.13	4.26						49.527	48.015	1.511
63	C	X			X	3.03	3.37	X					67.507	60.696	6.811
64	C	X		X		3.59	3.33						56.976	61.425	-4.449
65	T		X	X		4.25	4.09	X	X				48.128	50.011	-1.883
66	C	X		X		3.57	3.79						57.296	53.970	3.326

Location: O'BRIEN
Date: 5/19/99 (Trip 2)
Speed Trap 1 Distance (FT): 300
Speed Trap 2 Distance (FT): 300

		State		Vehicle Lane		Trap 1	Trap 2	Brake Lights In Curve	Encroachment				Speed		Speed Reduction
Veh ID	Vehicle Type	In	Out	Drive Ln (x)	Pass Ln (x)	Time	Time	(x) for yes	Inside Edge	Center Laneline	Outside Edge	Lane Change	Trap 1 mph	Trap 2 mph	mph
1	C		X	X		3.35	3.41						61.058	59.984	1.074
2	C			X		3.35	3.84						61.058	53.267	7.791
3	C			X		3.25	3.26						62.937	62.744	0.193
4	C		X	X		3.63	3.42						56.349	59.809	-3.460
5	T		X	X		3.44	3.86		X				59.461	52.991	6.470
6	C		X	X		3.38	3.4		X				60.516	60.160	0.356
7	C	X		X		3.16	3.23						64.730	63.327	1.403
8	C	X			X	3.84	3.82						53.267	53.546	-0.279
9	T			X		3.56	4.02						57.457	50.882	6.575
10	T			X		3.38	3.95		X				60.516	51.784	8.733
11	C		X	X		3.03	3.34						67.507	61.241	6.266
12	C		X	X		2.66	2.81			X			76.897	72.792	4.105
13	C				X	2.91	3.29			X			70.291	62.172	8.119
14	T			X		3.41	4.01						59.984	51.009	8.975
15	T			X		3.35	3.34		X				61.058	61.241	-0.183
16	T			X		3.37	3.64						60.696	56.194	4.502
17	C			X		3.78	4.05						54.113	50.505	3.608
18	C	X		X		3	3.13						68.182	65.350	2.832
19	C		X	X		2.66	3.05		X				76.897	67.064	9.833
20	C		X		X	3.28	3.21						62.361	63.721	-1.360
21	T		X	X		3.38	3.81		X				60.516	53.686	6.830
22	C		X	X		3.65	3.86						56.040	52.991	3.049
23	T			X		3.9	3.77		X				52.448	54.256	-1.809
24	C		X	X		3.06	3.27						66.845	62.552	4.293
25	T			X		4.28	4.45		X				47.791	45.965	1.826
26	C			X		3.34	3.41		X				61.241	59.984	1.257
27	C				X	2.78	2.82						73.578	72.534	1.044
28	C	X			X	3.28	3.3						62.361	61.983	0.378
29	RV		X		X	3.78	3.77						54.113	54.256	-0.144
30	UHAUL			X		3.79	3.85		X				53.970	53.129	0.841
31	T			X		3.53	3.41		X				57.945	59.984	-2.039
32	C		X	X		3.16	3.59		X				64.730	56.976	7.753
33	T			X		3.47	3.55		X				58.947	57.618	1.328
34	C			X		3.1	3.2						65.982	63.920	2.062
35	C		X	X		4.12	4.38						49.647	46.700	2.947
36	C	X			X	3.03	2.93						67.507	69.811	-2.304
37	C		X	X		3.88	4.01		X				52.718	51.009	1.709
38	C		X	X		3.1	3.3		X				65.982	61.983	3.999
39	C	X		X		3.19	3.29						64.121	62.172	1.949
40	T			X		3.6	3.34	X					56.818	61.241	-4.423
41	T		X	X		3.72	4.26	X	X				54.985	48.015	6.970
42	C	X		X		3.34	4.01		X				61.241	51.009	10.232
43	C	X		X		3.16	3.13						64.730	65.350	-0.620
44	C	X		X		3.94	3.86						51.915	52.991	-1.076
45	T		X	X		3.07	3.42		X				66.627	59.809	6.819
46	T		X	X		4.16	4.63	X	X				49.170	44.178	4.991
47	T		X	X		3.41	3.73						59.984	54.838	5.146
48	C		X	X		3.5	3.83		X				58.442	53.406	5.035
49	T		X	X		3.66	3.94		X				55.887	51.915	3.972
50	T	X		X		3.51	3.65						58.275	56.040	2.235
51	T		X	X		4.25	4.4						48.128	46.488	1.641
52	C	X			X	3.22	3.45					X	63.523	59.289	4.235
53	C		X	X		3.57	3.64		X				57.296	56.194	1.102
54	C		X	X		3.69	3.84						55.432	53.267	2.165
55	T			X		3.81	4.66	X	X				53.686	43.894	9.793
56	T			X		3.39	3.33		X				60.338	61.425	-1.087
57	T	X		X		3.56	3.34		X				57.457	61.241	-3.785
58	T			X		3.32	3.55						61.610	57.618	3.992
59	C			X		3.4	3.55						60.160	57.618	2.542
60	C	X		X		3.66	3.53						55.887	57.945	-2.058
61	C		X	X		3.53	3.61						57.945	56.661	1.284
62	C	X			X	3.34	3.31					X	61.241	61.796	-0.555
63	C	X		X		3.5	3.66						58.442	55.887	2.555
64	C	X			X	2.97	3.06	X					68.871	66.845	2.026
65	C, TRAILER		X	X		3.85	3.95						53.129	51.784	1.345
66	T		X	X		3.57	3.56		X				57.296	57.457	-0.161

Location:	La Moine														
Date:	5/19/99	(Trip 2)													
Speed Trap 1 Distance (FT):			300												
Speed Trap 2 Distance (FT):			300												
								Brake Lights	**Encroachment**				**Speed**		**Speed**
		State		**Vehicle Lane**		**Trap 1**	**Trap 2**	**In Curve**	**Inside**	**Center**	**Outside**	**Lane**	**Trap 1**	**Trap 2**	**Reduction**
Veh ID	**Vehicle Type**	**In**	**Out**	**Drive Ln (x)**	**Pass Ln (x)**	**Time**	**Time**	**(x) for yes**	**Edge**	**Laneline**	**Edge**	**Change**	**mph**	**mph**	**mph**
1	T			X		3.62	3.41	X					56.504	59.984	-3.480
2	T	X		X		3.47	3.21						58.947	63.721	-4.775
3	T		X	X		3.28	3.31	X					62.361	61.796	0.565
4	C		X	X		3.65	3.55						56.040	57.618	-1.579
5	C		X	X		3.03	2.81	X					67.507	72.792	-5.285
6	C				X	3.03	2.96						67.507	69.103	-1.596
7	T		X	X		3.9	3.53						52.448	57.945	-5.497
8	C	X		X		3.59	3.52						56.976	58.110	-1.133
9	C	X			X	3.22	3.25						63.523	62.937	0.586
10	C		X		X	2.78	2.76	X					73.578	74.111	-0.533
11	T			X		3.53	3.43						57.945	59.634	-1.689
12	T			X		3.28	3.04	X					62.361	67.285	-4.923
13	C	X			X	2.93	2.84						69.811	72.023	-2.212
14	C		X		X	3.18	3.34	X					64.322	61.241	3.081
15	T		X	X		3.87	3.61						52.854	56.661	-3.807
16	C		X	X		3.44	3.27	X					59.461	62.552	-3.091
17	C			X		3.13	3.14						65.350	65.142	0.208
18	T		X		X	3.5	3.31	X					58.442	61.796	-3.355
19	T	X		X		4.03	3.8						50.756	53.828	-3.072
20	C		X		X	2.78	2.95	X					73.578	69.337	4.240
21	C		X	X		3	3.12						68.182	65.559	2.622
22	T		X	X		3.25	3.1			X			62.937	65.982	-3.045
23	C		X	X		3.22	3.08	X					63.523	66.411	-2.887
24	C				X	2.69	2.57						76.039	79.590	-3.550
25	C	X		X		3.25	3.33						62.937	61.425	1.512
26	T		X	X		3.62	3.51	X					56.504	58.275	-1.771
27	T		X	X		3.41	3.06					X	59.984	66.845	-6.861
28	C	X			X	3.31	2.76	X					61.796	74.111	-12.314
29	T		X	X		3.25	3.31						62.937	61.796	1.141
30	C		X	X		3	2.9						68.182	70.533	-2.351
31	C		X	X		3.03	3.09						67.507	66.196	1.311
32	T			X		3.34	3.14	X					61.241	65.142	-3.901
33	C	X		X		2.87	2.94						71.270	69.573	1.697
34	C		X		X	2.75	2.6	X					74.380	78.671	-4.291
35	C	X		X		3.3	3.27						61.983	62.552	-0.569
36	T		X	X		3.56	3.38						57.457	60.516	-3.060
37	T		X	X		3.91	3.73						52.313	54.838	-2.525
38	C	X		X		3.16	3.16						64.730	64.730	0.000
39	C		X	X		3.25	3.05	X					62.937	67.064	-4.127
40	T		X	X		3.47	3.55	X					58.947	57.618	1.328
41	C	X		X		3.56	3.4					X	57.457	60.160	-2.704
42	T		X	X		3.9	3.72	X					52.448	54.985	-2.538
43	C			X		3.22	3.3						63.523	61.983	1.540
44	T		X	X		3.66	3.45						55.887	59.289	-3.402
45	C		X		X	2.97	2.98						68.871	68.639	0.231
46	C		X	X		3.16	3.16						64.730	64.730	0.000
47	C	X		X		3.18	3.02						64.322	67.730	-3.408
48	T		X	X		3.31	3.18						61.796	64.322	-2.526
49	C,RV		X	X		3.25	3.16						62.937	64.730	-1.793
50	C,RV	X		X		3.53	3.47						57.945	58.947	-1.002
51	T		X	X		3.5	3.56	X					58.442	57.457	0.985
52	T	X		X		3.44	3.2	X					59.461	63.920	-4.460
53	C		X	X		3.15	3.06	X					64.935	66.845	-1.910
54	C		X	X		3.25	3.16						62.937	64.730	-1.793
55	C		X		X	2.88	2.81						71.023	72.792	-1.769
56	T			X		3.97	3.47						51.523	58.947	-7.424
57	C		X	X		3.16	2.91						64.730	70.291	-5.561
58	T		X	X		3.63	3.45						56.349	59.289	-2.940
59	C	X		X		3.38	3.27						60.516	62.552	-2.036
60	C,RV		X	X		4.47	4.07						45.760	50.257	-4.497
61	C		X	X		3.47	3.21						58.947	63.721	-4.775
62	T		X	X		3.44	3.31						59.461	61.796	-2.335
63	C		X	X		3.13	3.1						65.350	65.982	-0.632
64	C				X	2.97	2.94						68.871	69.573	-0.703
65	C		X	X		2.81	2.81						72.792	72.792	0.000
66	C		X	X		3.12	3.14	X					65.559	65.142	0.418

Location:	Sims Road
Date:	5/18/99 (Trip 2)
Speed Trap 1 Distance (FT):	300
Speed Trap 2 Distance (FT):	300

		State		Vehicle Lane		Trap 1	Trap 2	Brake Lights	Encroachment				Speed		Speed
								In Curve	Inside	Center	Outside	Lane	Trap 1	Trap 2	Reduction
Veh ID	Vehicle Type	In	Out	Drive Ln (x)	Pass Ln (x)	Time	Time	(x) for yes	Edge	Laneline	Edge	Change	mph	mph	mph
1	T			X		3.56	3.73						57.457	54.838	2.619
2	T			X		3.5	3.41						58.442	59.984	-1.542
3	C	X		X		3	2.96						68.182	69.103	-0.921
4	C	X		X		3.93	3.7		X				52.047	55.283	-3.235
5	T			X		3.65	3.57	X					56.040	57.296	-1.256
6	C	X		X		3.31	3.41						61.796	59.984	1.812
7	T		X	X		5.31	5.16		X				38.521	39.641	-1.120
8	T	X		X		4.03	4.22		X				50.756	48.470	2.285
9	C		X	X		3.1	3.41					X	65.982	59.984	5.998
10	C		X		X	3.06	3.84		X				66.845	53.267	13.578
11	C	X		X		3.69	4.1						55.432	49.889	5.543
12	C	X		X		3.25	3.3						62.937	61.983	0.954
13	RV	X		X		4	4.05		X				51.136	50.505	0.631
14	T		X		X	3.82	4.26		X				53.546	48.015	5.531
15	C	X		X		3.44	3.95		X				59.461	51.784	7.677
16	C	X		X		3.28	3.29						62.361	62.172	0.190
17	RV	X		X		3.81	3.89		X				53.686	52.582	1.104
18	T		X	X		3.94	4.09						51.915	50.011	1.904
19	T		X	X		3.47	3.52						58.947	58.110	0.837
20	C		X		X	3.16	3.31						64.730	61.796	2.933
21	C	X			X	3.49	3.02						58.609	67.730	-9.121
22	C,TRAILER		X		X	3.38	3.95			X			60.516	51.784	8.733
23	C	X			X	3.09	3.16						66.196	64.730	1.466
24	C	X			X	2.59	2.61						78.975	78.370	0.605
25	C,TRAILER	X		X		3.41	3.27		X				59.984	62.552	-2.568
26	T		X	X		3.41	3.77		X				59.984	54.256	5.728
27	C	X		X		3.56	3.63						57.457	56.349	1.108
28	T		X	X		3.19	3.66		X				64.121	55.887	8.234
29	T		X	X		3.91	3.84						52.313	53.267	-0.954
30	T	X		X		4.12	3.9	X	X				49.647	52.448	-2.801
31	C	X			X	3.06	3.02						66.845	67.730	-0.885
32	C	X			X	3.06	3.01						66.845	67.955	-1.110
33	C		X	X		3.1	3.6	X	X				65.982	56.818	9.164
34	C		X		X	2.87	3.09						71.270	66.196	5.074
35	C		X		X	2.75	2.93						74.380	69.811	4.569
36	C	X		X		3.78	3.8						54.113	53.828	0.285
37	T	X		X		3.43	3.77	X					59.634	54.256	5.378
38	T		X	X		3.53	3.99		X				57.945	51.265	6.680
39	C		X		X	2.93	3.57						69.811	57.296	12.515
40	C	X		X		3.6	3.48						56.818	58.777	-1.959
41	T		X	X		3.78	3.66						54.113	55.887	-1.774
42	T		X	X		3.78	3.95						54.113	51.784	2.329
43	C	X			X	3.13	4.03					X	65.350	50.756	14.594
44	C	X		X		3.16	3.1						64.730	65.982	-1.253
45	C		X	X		3.22	3.45						63.523	59.289	4.235
46	C	X		X		3.34	3.58		X				61.241	57.136	4.106
47	C	X			X	3.1	3.04			X			65.982	67.285	-1.302
48	T		X	X		3.47	3.7						58.947	55.283	3.664
49	T		X	X		3.91	4.15						52.313	49.288	3.025
50	C		X	X		3.28	3.31						62.361	61.796	0.565
51	C	X			X	2.88	2.95						71.023	69.337	1.685
52	C	X			X	3.13	3.2						65.350	63.920	1.430
53	C	X			X	3.37	3.59						60.696	56.976	3.720
54	T		X	X		3.87	4.13						52.854	49.527	3.327
55	T		X	X		3.41	3.7	X					59.984	55.283	4.701
56	T	X		X		4.22	4.52						48.470	45.253	3.217
57	C	X			X	3.03	2.99						67.507	68.410	-0.903
58	C,TRAILER		X	X		3.84	3.48	X					53.267	58.777	-5.510
59	C	X		X		3.47	3.17						58.947	64.525	-5.579
60	C		X	X		3.44	3.7						59.461	55.283	4.178
61	C		X	X		3.22	3.3						63.523	61.983	1.540
62	C	X			X	3.56	3.59						57.457	56.976	0.480
63	T		X	X		3.85	4.05						53.129	50.505	2.624
64	C	X			X	2.81	2.91						72.792	70.291	2.501
65	T		X	X		4.03	4.28						50.756	47.791	2.965
66	C		X		X	3.13	3.31						65.350	61.796	3.554

Location:	SIDE HILL VIADUCT	
Date:	8/19/99	(Trip 3)
Speed Trap 1 Distance (FT):		300
Speed Trap 2 Distance (FT):		300

		State		Vehicle Lane		Trap 1	Trap 2	Brake Lights		Encroachment			Speed		Speed
								In Curve	Inside	Center	Outside	Lane	Trap 1	Trap 2	Reduction
Veh ID	Vehicle Type	In	Out	Drive Ln (x)	Pass Ln (x)	Time	Time	(x) for yes	Edge	Laneline	Edge	Change	mph	mph	mph
1	T			X		3.43	3.69	X					59.634	55.432	4.202
2	T			X		3.75	3.54						54.545	57.781	-3.236
3	C	X			X	3.16	3.28	X					64.730	62.361	2.368
4	C	X			X	3.38	3.43	X					60.516	59.634	0.882
5	C		X	X		3.72	3.34	X					54.985	61.241	-6.256
6	C	X		X		3.75	3.3					X	54.545	61.983	-7.438
7	C			X		3.68	3.57	X				X	55.583	57.296	-1.713
8	T			X		3.75	3.57	X					54.545	57.296	-2.750
9	C	X		X		3.84	3.66	X					53.267	55.887	-2.620
10	C		X		X	3.1	3.44						65.982	59.461	6.522
11	C	X			X	3.04	3.36						67.285	60.877	6.408
12	C	X			X	2.94	3.25						69.573	62.937	6.636
13	C		X		X	3	3.55	X					68.182	57.618	10.563
14	C	X			X	3	3.31	X					68.182	61.796	6.386
15	C	X			X	2.91	2.93	X					70.291	69.811	0.480
16	RV	X		X		3.81	3.63						53.686	56.349	-2.662
17	C		X		X	3.54	3.42	X					57.781	59.809	-2.027
18	C	X			X	3.21	3.44						63.721	59.461	4.260
19	C		X		X	3.43	3.93						59.634	52.047	7.587
20	C	X		X		3.78	3.37	X					54.113	60.696	-6.583
21	C		X	X		3.54	3.54	X					57.781	57.781	0.000
22	C	X			X	2.91	3.02	X				X	70.291	67.730	2.560
23	C		X	X		3.25	2.95	X					62.937	69.337	-6.400
24	T			X		4	3.55	X					51.136	57.618	-6.482
25	T			X		3.85	3.69	X					53.129	55.432	-2.304
26	T			X		4.06	3.68						50.381	55.583	-5.202
27	C		X	X		3.44	3.34						59.461	61.241	-1.780
28	T			X		3.97	3.47	X					51.523	58.947	-7.424
29	C	X			X	3.09	3.38						66.196	60.516	5.680
30	C				X	2.75	3.22	X					74.380	63.523	10.857
31	C	X		X		3.81	3.68	X					53.686	55.583	-1.897
32	RV			X		3.78	3.48						54.113	58.777	-4.665
33	C			X		3.31	3.19					X	61.796	64.121	-2.325
34	RV			X		4.4	3.84	X					46.488	53.267	-6.779
35	T			X		3.69	3.41						55.432	59.984	-4.552
36	RV		X	X		3.78	3.61	X					54.113	56.661	-2.548
37	C	X			X	3	3.68	X					68.182	55.583	12.599
38	C		X		X	2.78	3.03	X					73.578	67.507	6.071
39	C		X		X	3.4	3.27	X					60.160	62.552	-2.392
40	C			X		3.28	2.94	X					62.361	69.573	-7.212
41	C			X		4.22	3.92	X					48.470	52.180	-3.709
42	C	X			X	3.16	3.4						64.730	60.160	4.569
43	C			X		3.5	3.15	X					58.442	64.935	-6.494
44	C	X			X	3.21	3.68						63.721	55.583	8.138
45	C	X		X		3.75	3.38						54.545	60.516	-5.971
46	C		X		X	3.16	3.54						64.730	57.781	6.948
47	C		X	X		3.6	3.52	X					56.818	58.110	-1.291
48	C				X	2.81	3.22						72.792	63.523	9.269
49	C			X		3	3.49	X					68.182	58.609	9.573
50	RV	X			X	3.29	3.74	X					62.172	54.691	7.481
51	RV			X		4.63	4.16	X					44.178	49.170	-4.991
52	C	X		X		3.44	2.99	X					59.461	68.410	-8.949
53	T			X		3.78	3.59						54.113	56.976	-2.864
54	C		X	X		3.31	3.04	X					61.796	67.285	-5.488
55	C	X		X		2.97	2.7	X				X	68.871	75.758	-6.887
56	T			X		4.29	4.09	X					47.680	50.011	-2.332
57	C	X		X		3.34	3.09						61.241	66.196	-4.955
58	C		X	X		4.37	3.99						46.807	51.265	-4.458
59	C	X		X		3.84	3.66						53.267	55.887	-2.620
60	C		X		X	3.34	3.27						61.241	62.552	-1.311
61	C	X		X		3.64	3.23	X					56.194	63.327	-7.133
62	C			X		3.72	3.41						54.985	59.984	-4.999
63	T			X		3.63	3.31	X					56.349	61.796	-5.448
64	C				X	2.87	3.11						71.270	65.770	5.500
65	T			X		4.22	3.68	X					48.470	55.583	-7.113
66	C	X		X		3.4	3.23	X				X	60.160	63.327	-3.166

Location:	O'BRIEN														
Date:	8/19/99	(Trip 3)													
Speed Trap 1 Distance (FT):			300												
Speed Trap 2 Distance (FT):			300												
		State		Vehicle Lane		Trap 1	Trap 2	Brake Lights	Encroachment				Speed		Speed
								In Curve	Inside	Center	Outside	Lane	Trap 1	Trap 2	Reduction
Veh ID	Vehicle Type	In	Out	Drive Ln (x)	Pass Ln (x)	Time	Time	(x) for yes	Edge	Laneline	Edge	Change	mph	mph	mph
1	T				X	3.5	3.54						58.442	57.781	0.660
2	C			X		4.91	5.11						41.659	40.028	1.630
3	C	X		X		3.19	3.23						64.121	63.327	0.794
4	T			X		3.91	4.31		X				52.313	47.458	4.855
5	C	X		X		3.34	3.59		X				61.241	56.976	4.265
6	C	X		X		3.44	3.41						59.461	59.984	-0.523
7	C	X		X		3.31	3.32						61.796	61.610	0.186
8	C	X		X		3.09	3.14						66.196	65.142	1.054
9	T			X		3.97	4.34		X				51.523	47.130	4.392
10	C			X		3.13	3.2						65.350	63.920	1.430
11	T			X		3.35	3.49						61.058	58.609	2.449
12	T			X		3.66	4.52		X				55.887	45.253	10.633
13	C		X	X		3.37	3.82						60.696	53.546	7.150
14	C	X		X		3.31	3.23						61.796	63.327	-1.531
15	C		X	X		3.72	3.81		X				54.985	53.686	1.299
16	C			X		4.09	4.05						50.011	50.505	-0.494
17	T			X		3.34	3.99		X				61.241	51.265	9.977
18	C		X	X		3.18	3.51						64.322	58.275	6.047
19	C	X		X		3.78	3.55						54.113	57.618	-3.506
20	C	X			X	3.28	3.61						62.361	56.661	5.701
21	C	X		X		3.44	3.34		X				59.461	61.241	-1.780
22	C			X		3.97	3.56						51.523	57.457	-5.934
23	C		X	X		3.4	3.31						60.160	61.796	-1.636
24	T			X		3.56	3.88						57.457	52.718	4.739
25	C		X	X		3.4	3.38						60.160	60.516	-0.356
26	C			X		2.75	2.84	X					74.380	72.023	2.357
27	C		X		X	3.03	3.2						67.507	63.920	3.586
28	C	X			X	2.37	2.67						86.306	76.609	9.697
29	C		X		X	3.31	3.81		X				61.796	53.686	8.110
30	C			X		3.31	3.33						61.796	61.425	0.371
31	C				X	2.9	3.16					X	70.533	64.730	5.803
32	C	X		X		3.84	4.27						53.267	47.903	5.364
33	C		X		X	2.94	3.56						69.573	57.457	12.117
34	C				X	3.09	3.02						66.196	67.730	-1.534
35	C				X	2.69	2.99						76.039	68.410	7.629
36	C	X			X	3.03	2.88			X			67.507	71.023	-3.516
37	RV	X		X		3.59	4.38						56.976	46.700	10.277
38	C			X		3	2.94						68.182	69.573	-1.391
39	C		X		X	3.12	3.14		X				65.559	65.142	0.418
40	C	X		X		3.47	3.39						58.947	60.338	-1.391
41	C	X		X		3.34	3.22						61.241	63.523	-2.282
42	C	X			X	2.81	2.91						72.792	70.291	2.501
43	C			X		3.25	3.32						62.937	61.610	1.327
44	T			X		3.63	3.73		X				56.349	54.838	1.511
45	T			X		2.07	4.42						98.814	46.277	52.537
46	C		X	X		4.4	4.08						46.488	50.134	-3.646
47	C		X	X		3.35	3.45			X			61.058	59.289	1.770
48	C	X		X		3.44	3.57						59.461	57.296	2.165
49	C	X		X		3.31	3.31						61.796	61.796	0.000
50	C	X			X	2.59	3.01	X					78.975	67.955	11.020
51	C	X		X		3.93	3.7						52.047	55.283	-3.235
52	C	X		X		3.75	3.45						54.545	59.289	-4.743
53	C		X	X		3.06	3.05						66.845	67.064	-0.219
54	C		X	X		2.81	2.76	X					72.792	74.111	-1.319
55	C		X	X		3.72	3.88	X					54.985	52.718	2.267
56	C	X			X	3.19	3.29			X			64.121	62.172	1.949
57	C	X			X	3.18	3.38						64.322	60.516	3.806
58	C			X		3.25	3.64						62.937	56.194	6.743
59	C		X	X		3.35	3.5		X				61.058	58.442	2.617
60	C	X		X		3.91	3.81		X				52.313	53.686	-1.373
61	C		X	X		4	3.86						51.136	52.991	-1.855
62	C		X		X	3.03	3.22	X					67.507	63.523	3.983
63	T			X		3.6	3.7		X				56.818	55.283	1.536
64	C	X		X		3.4	3.38						60.160	60.516	-0.356
65	RV		X	X		3.28	3.27						62.361	62.552	-0.191
66	C	X			X	2.75	2.93						74.380	69.811	4.569

Location:	SALT CREEK														
Date:	8/18/99 (Trip 3)														
Speed Trap 1 Distance (FT):			300												
Speed Trap 2 Distance (FT):			300												
		State		**Vehicle Lane**		**Trap 1**	**Trap 2**	**Brake Lights In Curve**	**Encroachment**				**Speed**		**Speed Reduction**
Veh ID	**Vehicle Type**	**In**	**Out**	**Drive Ln (x)**	**Pass Ln (x)**	**Time**	**Time**	**(x) for yes**	**Inside Edge**	**Center Laneline**	**Outside Edge**	**Lane Change**	**Trap 1 mph**	**Trap 2 mph**	**mph**
1	RV			X		5.03	4.46						40.665	45.862	-5.197
2	C				X	2.72	2.8		X				75.201	73.052	2.149
3	T			X		4.25	3.64	X	X				48.128	56.194	-8.065
4	T			X		3.94	3.41	X			X		51.915	59.984	-8.069
5	C	X			X	2.9	3.22						70.533	63.523	7.009
6	RV		X	X		3.56	3.45						57.457	59.289	-1.832
7	C				X	2.85	2.89	X					71.770	70.777	0.993
8	RV			X		3.78	3.75	X					54.113	54.545	-0.433
9	C			X		3.31	3.34						61.796	61.241	0.555
10	C	X		X		3.28	3.38						62.361	60.516	1.845
11	C		X		X	3	3.26						68.182	62.744	5.438
12	C			X		3.47	3.38						58.947	60.516	-1.570
13	C	X		X		3.47	3.12	X					58.947	65.559	-6.613
14	C				X	3	2.96						68.182	69.103	-0.921
15	T			X		4.04	3.68						50.630	55.583	-4.953
16	T			X		3.79	3.37						53.970	60.696	-6.726
17	T			X		2.91	3.13						70.291	65.350	4.941
18	C		X	X		3.03	3.06						67.507	66.845	0.662
19	T			X		4.12	3.28				X		49.647	62.361	-12.714
20	C	X			X	2.35	2.91				X		87.041	70.291	16.750
21	T			X		3.28	3.37						62.361	60.696	1.665
22	C		X		X	2.62	2.01						78.071	101.764	-23.693
23	C	X			X	3.06	3.08						66.845	66.411	0.434
24	C				X	3.1	2.98						65.982	68.639	-2.657
25	T			X		3.47	3.01				X		58.947	67.955	-9.008
26	T			X		3.82	3.41				X		53.546	59.984	-6.438
27	C		X		X	3.03	3.2						67.507	63.920	3.586
28	C	X		X		3.59	2.91						56.976	70.291	-13.314
29	C				X	2.81	3.02	X					72.792	67.730	5.062
30	C	X			X	2.78	2.7	X					73.578	75.758	-2.180
31	C	X		X		3.16	3.15						64.730	64.935	-0.205
32	RV	X			X	3.09	3.04						66.196	67.285	-1.089
33	T		X	X		3.16	3.18						64.730	64.322	0.407
34	C	X			X	2.72	3.01	X					75.201	67.955	7.245
35	T			X		3.97	3.68						51.523	55.583	-4.060
36	T			X		3.56	3.64				X		57.457	56.194	1.263
37	C	X		X		3.19	3.15						64.121	64.935	-0.814
38	C	X		X		3.28	3.35						62.361	61.058	1.303
39	C				X	2.81	3.06						72.792	66.845	5.947
40	C	X			X	2.28	2.74	X					89.713	74.652	15.061
41	C			X		2.97	3.12						68.871	65.559	3.311
42	T			X		4.06	3.36	X					50.381	60.877	-10.496
43	C	X			X	3.03	3.14						67.507	65.142	2.365
44	C		X	X		2.91	3.13	X					70.291	65.350	4.941
45	C	X		X		3.69	3.32						55.432	61.610	-6.178
46	C	X			X	3.06	3.05						66.845	67.064	-0.219
47	T			X		3.69	3.39				X		55.432	60.338	-4.906
48	C		X		X	2.69	3.89					X	76.039	52.582	23.457
49	C	X			X	3.03	2.86						67.507	71.519	-4.013
50	C		X	X		3.12	3.38						65.559	60.516	5.043
51	T			X		3.56	3.38						57.457	60.516	-3.060
52	C				X	2.65	3.14			X			77.187	65.142	12.045
53	C	X			X	2.81	3.13						72.792	65.350	7.442
54	C	X		X		3.28	3.27						62.361	62.552	-0.191
55	T			X		3.81	3.64						53.686	56.194	-2.507
56	C				X	3.03	3.18						67.507	64.322	3.184
57	C		X	X		3.16	2.86						64.730	71.519	-6.790
58	C		X	X		3.87	3.92	X					52.854	52.180	0.674
59	C	X			X	2.53	2.5	X					80.848	81.818	-0.970
60	C			X		3.16	3.08	X					64.730	66.411	-1.681
61	C		X	X		2.78	2.99					X	73.578	68.410	5.168
62	C	X		X		3.04	3						67.285	68.182	-0.897
63	C	X		X		3.25	3.27						62.937	62.552	0.385
64	C		X		X	2.66	2.66	X					76.897	76.897	0.000
65	C			X		3.16	3.35						64.730	61.058	3.671
66	C		X	X		3.15	3.35	X					64.935	61.058	3.877

Location: LA MOINE
Date: 8/19/99 (Trip 3)
Speed Trap 1 Distance (FT): 300
Speed Trap 2 Distance (FT): 300

		State		Vehicle Lane		Trap 1	Trap 2	Brake Lights	Encroachment			Lane	Speed		Speed
								In Curve	Inside	Center	Outside		Trap 1	Trap 2	Reduction
Veh ID	**Vehicle Type**	**In**	**Out**	**Drive Ln (x)**	**Pass Ln (x)**	**Time**	**Time**	**(x) for yes**	**Edge**	**Laneline**	**Edge**	**Change**	**mph**	**mph**	**mph**
1	T			X		3.44	3.44						59.461	59.461	0.000
2	RV			X		3.22	3.29	X					63.523	62.172	1.352
3	C		X		X	3.03	2.92						67.507	70.050	-2.543
4	C				X	2.91	2.84						70.291	72.023	-1.733
5	C		X		X	2.97	2.98						68.871	68.639	0.231
6	C	X			X	2.85	3.15				X		71.770	64.935	6.835
7	T			X		3.43	3.38						59.634	60.516	-0.882
8	C	X			X	3.59	3.27						56.976	62.552	-5.576
9	C	X		X		3.07	3.22						66.627	63.523	3.104
10	T			X		3.69	3.57	X					55.432	57.296	-1.863
11	T			X		3.5	3.4						58.442	60.160	-1.719
12	C	X		X		3.12	3.11						65.559	65.770	-0.211
13	C		X	X		3.59	3.37						56.976	60.696	-3.720
14	T			X		2.93	3.32	X					69.811	61.610	8.201
15	C		X	X		3.1	3.02					X	65.982	67.730	-1.748
16	C		X	X		3.12	3.12						65.559	65.559	0.000
17	C	X			X	3.25	3.2						62.937	63.920	-0.983
18	C			X		3.13	3.17						65.350	64.525	0.825
19	C			X		2.81	3.76						72.792	54.400	18.392
20	C		X	X		2.88	2.88						71.023	71.023	0.000
21	C	X			X	2.65	2.65						77.187	77.187	0.000
22	T			X		3.47	3.52						58.947	58.110	0.837
23	T			X		4	3.8	X					51.136	53.828	-2.691
24	T			X		3.47	3.31						58.947	61.796	-2.849
25	C	X		X		3.29	3.29						62.172	62.172	0.000
26	T				X	3.06	3.07						66.845	66.627	0.218
27	T			X		3.53	3.41						57.945	59.984	-2.039
28	C	X		X		2.94	2.77	X				X	69.573	73.843	-4.270
29	T			X		3.53	3.48						57.945	58.777	-0.833
30	C			X		3.06	3.04						66.845	67.285	-0.440
31	T			X		3.6	3.48	X					56.818	58.777	-1.959
32	C	X		X		2.97	3.06						68.871	66.845	2.026
33	T			X		3.68	3.56	X					55.583	57.457	-1.874
34	C		X	X		3.03	3.05						67.507	67.064	0.443
35	C	X		X		3.16	3.01						64.730	67.955	-3.226
36	C	X			X	2.87	3.16						71.270	64.730	6.541
37	C		X	X		3.18	3.15						64.322	64.935	-0.613
38	C				X	2.85	2.73						71.770	74.925	-3.155
39	T			X		3.34	3.45						61.241	59.289	1.953
40	C		X	X		2.82	2.84						72.534	72.023	0.511
41	T			X		3.63	3.63						56.349	56.349	0.000
42	C		X	X		3.19	3.4						64.121	60.160	3.960
43	C			X		3.03	3.2						67.507	63.920	3.586
44	C		X	X		3.03	2.93						67.507	69.811	-2.304
45	T			X		3.72	3.51	X					54.985	58.275	-3.290
46	C		X		X	2.81	2.84						72.792	72.023	0.769
47	T			X		3.59	3.95	X					56.976	51.784	5.193
48	C		X		X	3.12	3.02						65.559	67.730	-2.171
49	C	X		X		3.6	3.58						56.818	57.136	-0.317
50	C	X			X	3.15	3.19						64.935	64.121	0.814
51	C		X		X	2.91	3.12						70.291	65.559	4.731
52	T			X		3.44	3.41						59.461	59.984	-0.523
53	RV			X		3.43	3.47						59.634	58.947	0.687
54	T			X		3.63	3.72						56.349	54.985	1.363
55	T			X		3.62	3.62	X					56.504	56.504	0.000
56	C		X	X		3	2.9	X					68.182	70.533	-2.351
57	C			X		3.34	3.23						61.241	63.327	-2.086
58	C			X		3.31	3.02					X	61.796	67.730	-5.934
59	C	X		X		3.68	3.72						55.583	54.985	0.598
60	C		X	X		3.16	3.39						64.730	60.338	4.392
61	T			X		3.31	3.37						61.796	60.696	1.100
62	RV			X		3.53	3.38						57.945	60.516	-2.572
63	T			X		3.22	3.61						63.523	56.661	6.863
64	C		X	X		3	3.03						68.182	67.507	0.675
65	C		X	X		3.28	3.34						62.361	61.241	1.120
66	T			X		3.31	3.21						61.796	63.721	-1.925

Location:	SIMS ROAD														
Date:	8/17/99 (Trip 3)														
Speed Trap 1 Distance (FT):			300												
Speed Trap 2 Distance (FT):			300												

		State		Vehicle Lane		Trap 1	Trap 2	Brake Lights In Curve	Encroachment			Lane	Speed		Speed Reduction
Veh ID	Vehicle Type	In	Out	Drive Ln (x)	Pass Ln (x)	Time	Time	(x) for yes	Inside Edge	Center Laneline	Outside Edge	Change	Trap 1 mph	Trap 2 mph	mph
1	T			X		3.5	3.45		X				58.442	59.289	-0.847
2	C		X	X		3.1	3.28						65.982	62.361	3.621
3	T			X		3.56	3.65						57.457	56.040	1.417
4	T			X		3.5	3.29						58.442	62.172	-3.730
5	C	X		X		3.87	3.91		X				52.854	52.313	0.541
6	C	X			X	3.25	3.29						62.937	62.172	0.765
7	RV			X		3.71	3.75		X				55.134	54.545	0.588
8	C			X		3.21	3.13						63.721	65.350	-1.629
9	C		X	X		3.25	2.95		X				62.937	69.337	-6.400
10	C		X		X	3.53	3.55						57.945	57.618	0.326
11	C			X		3	2.97						68.182	68.871	-0.689
12	C	X		X		3.53	3.76						57.945	54.400	3.545
13	RV		X	X		3.9	3.88		X				52.448	52.718	-0.270
14	T			X		3.72	3.74						54.985	54.691	0.294
15	C	X		X		3.28	3.31		X				62.361	61.796	0.565
16	T			X		3.34	3.3		X				61.241	61.983	-0.742
17	C		X	X		3.37	3.74						60.696	54.691	6.005
18	T			X		4.1	4		X				49.889	51.136	-1.247
19	T			X		4.15	4.11						49.288	49.768	-0.480
20	C	X		X		3.31	3.34						61.796	61.241	0.555
21	T			X		2.97	3.24						68.871	63.131	5.739
22	T			X		4	4		X				51.136	51.136	0.000
23	C		X		X	2.81	2.89	X					72.792	70.777	2.015
24	C	X		X		3.19	3.39						64.121	60.338	3.783
25	T				X	3.38	3.58						60.516	57.136	3.381
26	T			X		3.59	3.74	X	X				56.976	54.691	2.285
27	C	X		X		4.03	3.77						50.756	54.256	-3.500
28	C		X		X	3.43	3.25						59.634	62.937	-3.303
29	C		X	X		3.84	3.88						53.267	52.718	0.549
30	C		X		X	3.22	3.31						63.523	61.796	1.727
31	C	X		X		3.06	3.27		X				66.845	62.552	4.293
32	T			X		3.62	3.81	X	X				56.504	53.686	2.818
33	T			X		4	4.05						51.136	50.505	0.631
34	T			X		3.53	3.38						57.945	60.516	-2.572
35	C		X		X	2.88	2.93						71.023	69.811	1.212
36	C				X	3.09	2.94						66.196	69.573	-3.377
37	C				X	2.59	2.83						78.975	72.278	6.698
38	T			X		4.22	4.61						48.470	44.370	4.101
39	C	X			X	3.16	3.43		X				64.730	59.634	5.095
40	C	X			X	3	2.88						68.182	71.023	-2.841
41	C		X	X		3.28	3.18						62.361	64.322	-1.961
42	C	X		X		3.13	3.09		X				65.350	66.196	-0.846
43	C	X		X		3.43	3.26						59.634	62.744	-3.110
44	C	X		X		3.09	3.17						66.196	64.525	1.671
45	C	X			X	3.03	3.4						67.507	60.160	7.346
46	C		X		X	3.56	3.55						57.457	57.618	-0.162
47	C		X	X		3.44	3.47						59.461	58.947	0.514
48	RV		X	X		3.75	3.87		X				54.545	52.854	1.691
49	T			X		3.4	3.34		X				60.160	61.241	-1.081
50	C				X	3.13	3.26						65.350	62.744	2.606
51	T			X		3.5	3.53						58.442	57.945	0.497
52	C	X			X	3.06	2.96					X	66.845	69.103	-2.258
53	T			X		3.47	3.37						58.947	60.696	-1.749
54	T			X		3.53	3.66		X				57.945	55.887	2.058
55	C	X			X	3.44	3.58						59.461	57.136	2.325
56	C	X			X	3.09	3.18						66.196	64.322	1.873
57	C	X			X	2.69	2.94						76.039	69.573	6.466
58	C	X		X		3	3		X				68.182	68.182	0.000
59	T			X		3.62	3.78		X				56.504	54.113	2.392
60	T			X		3.62	3.85	X	X				56.504	53.129	3.376
61	T			X		3.6	4.24		X				56.818	48.242	8.576
62	C		X	X		2.88	3.02	X					71.023	67.730	3.292
63	T			X		3.56	3.73	X					57.457	54.838	2.619
64	T	X		X		3.91	3.97						52.313	51.523	0.791
65	C	X			X	3	2.9					X	68.182	70.533	-2.351
66	C	X			X	3.19	3.33					X	64.121	61.425	2.696

Location:	SIDEHILL VIADUCT												
Date:	1/4/00	(Trip 4)											
Speed Trap 1 Distance (FT):			300										
Speed Trap 2 Distance (FT):			300										
						Brake Lights	**Encroachment**				**Speed**		**Speed**
	veh type	**Vehicle Lane**		**Trap 1**	**Trap 2**	**In Curve**	**Inside**	**Center**	**Outside**	**Lane**	**Trap 1**	**Trap 2**	**Reduction**
Veh ID	Track Trail	Drive Ln (x)	Pass Ln (x)	Time	Time	**(x) for yes**	**Edge**	**Laneline**	**Edge**	**Change**	**mph**	**mph**	**mph**
1	T	X		3.75	3.49	X					54.545	58.609	-4.064
2	C		X	2.91	3.12						70.291	65.559	4.731
3	C + Trailer	X		3.31	3.22	X					61.796	63.523	-1.727
4	C		X	3.13	3.7	X					65.350	55.283	10.067
5	T	X		4.37	4.41	X					46.807	46.382	0.425
6	C		X	2.87	3.4						71.270	60.160	11.110
7	C	X		3.66	3.58	X					55.887	57.136	-1.249
8	C		X	3.22	3.29	X					63.523	62.172	1.352
9	T	X		4.22	4	X					48.470	51.136	-2.666
10	T	X		3.96	3.74	X					51.653	54.691	-3.038
11	C	X		3.41	3.37						59.984	60.696	-0.712
12	C	X		3.5	3.3	X					58.442	61.983	-3.542
13	T	X		3.75	3.61	X					54.545	56.661	-2.115
14	C		X	3.22	3.36	X					63.523	60.877	2.647
15	RV	X		4.34	4.1						47.130	49.889	-2.759
16	C	X		3.15	3.22						64.935	63.523	1.412
17	C		X	2.65	3.36	X					77.187	60.877	16.310
18	C	X		3.38	2.98						60.516	68.639	-8.123
19	T	X		4.22	3.89	X					48.470	52.582	-4.112
20	C	X		3.38	3.12	X				X	60.516	65.559	-5.043
21	C	X		3.22	3.41	X					63.523	59.984	3.539
22	C	X		3.44	3.29			X			59.461	62.172	-2.711
23	T	X		3.63	3.4	X					56.349	60.160	-3.812
24	C		X	3.78	4.26	X					54.113	48.015	6.097
25	C	X		4.18	3.73						48.934	54.838	-5.904
26	T	X		4.13	3.93	X					49.527	52.047	-2.520
27	T	X		4.28	3.96						47.791	51.653	-3.862
28	C		X	3.09	3.29	X					66.196	62.172	4.024
29	C		X	3.34	3.37						61.241	60.696	0.545
30	C	X		4.6	4.12	X					44.466	49.647	-5.181
31	T	X		3.82	3.33						53.546	61.425	-7.879
32	Uhaul	X		4.75	4.52	X					43.062	45.253	-2.191
33	C	X		3.34	3.01	X		X			61.241	67.955	-6.714
34	C	X		3.28	3.61	X					62.361	56.661	5.701
35	C	X		3.53	3.32						57.945	61.610	-3.665
36	T	X		4.69	4.32	X					43.613	47.348	-3.735
37	T	X		4.44	3.98						46.069	51.393	-5.325
38	C	X		3.5	3.2					X	58.442	63.920	-5.479
39	C	X		3.44	3.3						59.461	61.983	-2.523
40	RV	X		3.84	3.66	X					53.267	55.887	-2.620
41	C	X		3.75	3.69						54.545	55.432	-0.887
42	RV	X		4	3.71						51.136	55.134	-3.997
43	C	X		3.57	3.34						57.296	61.241	-3.946
44	C		X	2.91	3.28						70.291	62.361	7.929
45	C	X		4.31	3.85	X					47.458	53.129	-5.670
46	C		X	3.19	3.79	X					64.121	53.970	10.151
47	C		X	2.85	3.21	X					71.770	63.721	8.049
48	T	X		4.63	4.32	X					44.178	47.348	-3.170
49	T	X		4.13	3.98						49.527	51.393	-1.867
50	C	X		3.28	3.17						62.361	64.525	-2.164
51	C	X		3.28	3.02					X	62.361	67.730	-5.369
52	C	X		3.41	3.24	X					59.984	63.131	-3.147
53	C	X		3.75	3.49	X					54.545	58.609	-4.064
54	T		X	3.1	3.65	X					65.982	56.040	9.943
55	C	X		3.38	3.09					X	60.516	66.196	-5.680
56	C		X	2.72	3.03	X					75.201	67.507	7.694
57	T	X		4.43	4.01	X					46.173	51.009	-4.836
58	C		X	3.22	3.96	X					63.523	51.653	11.871
59	T	X		3.82	3.62						53.546	56.504	-2.958
60	C	X		3.44	3.2						59.461	63.920	-4.460
61	C		X	3.18	3.5						64.322	58.442	5.881
62	T	X		4.22	3.91						48.470	52.313	-3.843
63	T	X		3.9	3.7						52.448	55.283	-2.835
64	T	X		3.81	3.38	X					53.686	60.516	-6.830
65	C	X		3.91	3.48	X					52.313	58.777	-6.464
66	C	X		3.66	3.16						55.887	64.730	-8.843

Location:	O'BRIEN												
Date:	1/4/00	(Trip 4)											
Speed Trap 1 Distance (FT):			300										
Speed Trap 2 Distance (FT):			300										

						Brake Lights	**Encroachment**				**Speed**		**Speed**
	veh type	**Vehicle Lane**		**Trap 1**	**Trap 2**	**In Curve**	**Inside**	**Center**	**Outside**	**Lane**	**Trap 1**	**Trap 2**	**Reduction**
Veh ID	Track Trail	Drive Ln (x)	Pass Ln (x)	Time	Time	**(x) for yes**	**Edge**	**Laneline**	**Edge**	**Change**	**mph**	**mph**	**mph**
1	T	X		4.12	4.09						49.647	50.011	-0.364
2	T	X		3.76	3.86		X				54.400	52.991	1.409
3	C		X	2.5	3.31	X					81.818	61.796	20.022
4	C	X		3.47	3.36		X				58.947	60.877	-1.930
5	C	X		3.37	3.29						60.696	62.172	-1.476
6	T	X		3.91	4.33						52.313	47.239	5.074
7	C	X		4.06	4.36						50.381	46.914	3.467
8	T	X		3.6	3.59						56.818	56.976	-0.158
9	T	X		3.84	4.22						53.267	48.470	4.797
10	C	X		3.41	3.44						59.984	59.461	0.523
11	T	X		3.75	3.95		X				54.545	51.784	2.762
12	C		X	3.32	3.62						61.610	56.504	5.106
13	C	X		3.28	3.27						62.361	62.552	-0.191
14	C		X	3.25	3.09						62.937	66.196	-3.259
15	C		X	3.12	3.2						65.559	63.920	1.639
16	T		X	3.38	3.74						60.516	54.691	5.825
17	C	X		3.97	3.94						51.523	51.915	-0.392
18	T	X		4	3.81						51.136	53.686	-2.550
19	T	X		3.84	3.93						53.267	52.047	1.220
20	T	X		3.84	3.95						53.267	51.784	1.483
21	T		X	3.38	3.8					X	60.516	53.828	6.689
22	T	X		3.59	3.63						56.976	56.349	0.628
23	C	X		3.94	3.69						51.915	55.432	-3.517
24	C	X		3.47	3.49						58.947	58.609	0.338
25	RV	X		4.66	4.38						43.894	46.700	-2.806
26	C		X	2.91	3.39						70.291	60.338	9.953
27	C + Trailer	X		3.62	3.59						56.504	56.976	-0.472
28	C	X		3.35	3.55						61.058	57.618	3.440
29	T	X		3.69	3.92		X				55.432	52.180	3.252
30	C		X	3.09	3.15						66.196	64.935	1.261
31	C		X	3.06	3.31	X					66.845	61.796	5.049
32	C	X		3.65	3.97						56.040	51.523	4.517
33	C	X		3.87	3.66						52.854	55.887	-3.033
34	C		X	3.38	3.34						60.516	61.241	-0.725
35	C		X	3.21	3.65						63.721	56.040	7.681
36	C	X		3.37	3.19						60.696	64.121	-3.425
37	C		X	2.94	3.12						69.573	65.559	4.014
38	T	X		3.75	3.99		X				54.545	51.265	3.281
39	C	X		3.93	4.04						52.047	50.630	1.417
40	C		X	3.4	3.41						60.160	59.984	0.176
41	T	X		3.75	3.81		X				54.545	53.686	0.859
42	T	X		3.63	3.81						56.349	53.686	2.662
43	T	X		3.53	3.68						57.945	55.583	2.362
44	C	X		3.81	3.56						53.686	57.457	-3.770
45	C		X	3.16	3.36						64.730	60.877	3.853
46	T	X		3.79	4.25						53.970	48.128	5.841
47	C	X		3.41	3.37						59.984	60.696	-0.712
48	C	X		3.47	3.55						58.947	57.618	1.328
49	C + Trailer	X		4.12	4.43		X				49.647	46.173	3.474
50	C	X		3.59	3.45						56.976	59.289	-2.312
51	C	X		3.5	3.54						58.442	57.781	0.660
52	C	X		3.43	3.2						59.634	63.920	-4.286
53	C	X		4.59	4.34						44.563	47.130	-2.567
54	C + Trailer	X		3.84	4.09		X				53.267	50.011	3.256
55	C	X		3.41	3.42						59.984	59.809	0.175
56	C	X		3.59	3.62						56.976	56.504	0.472
57	T	X		4.18	4.16		X				48.934	49.170	-0.235
58	C	X		3.5	3.51						58.442	58.275	0.167
59	C	X		3.72	3.54						54.985	57.781	-2.796
60	C	X		3.16	3.13						64.730	65.350	-0.620
61	C		X	3.53	3.28	X					57.945	62.361	-4.417
62	C		X	2.78	3.07						73.578	66.627	6.950
63	C	X		3.31	3.24						61.796	63.131	-1.335
64	T	X		4.04	4.05		X				50.630	50.505	0.125
65	C + Trailer	X		4.06	3.07						50.381	66.627	-16.247
66	T	X		4.19	4.62						48.818	44.274	4.544

Location: SALT CREEK
Date: 1/3/00 (Trip 4)
Speed Trap 1 Distance (FT): 300
Speed Trap 2 Distance (FT): 300

Veh ID	veh type Track Trail	Vehicle Lane Drive Ln (x)	Pass Ln (x)	Trap 1 Time	Trap 2 Time	Brake Lights In Curve (x) for yes	Encroachment Inside Edge	Center Laneline	Outside Edge	Lane Change	Speed Trap 1 mph	Trap 2 mph	Speed Reduction mph
1	T	X		2.94	3.04						69.573	67.285	2.289
2	C + Trailer	X		2.84	3.22						72.023	63.523	8.500
3	C		X	2.72	2.74			X			75.201	74.652	0.549
4	T	X		3.53	3.59						57.945	56.976	0.968
5	T	X		3.97	3.79						51.523	53.970	-2.447
6	C	X		3.13	3.39						65.350	60.338	5.012
7	C	X		2.78	3						73.578	68.182	5.396
8	C	X		3.29	3.34						62.172	61.241	0.931
9	T	X		3.41	3.49						59.984	58.609	1.375
10	C	X		3.28	3.73						62.361	54.838	7.523
11	C + Trailer	X		3.38	3.29						60.516	62.172	-1.655
12	C	X		3.09	2.86						66.196	71.519	-5.323
13	C		X	2.6	3.3						78.671	61.983	16.688
14	C	X		3	2.76	X					68.182	74.111	-5.929
15	C	X		2.72	3.75						75.201	54.545	20.655
16	RV	X		3.35	3.05						61.058	67.064	-6.006
17	C		X	3.18	2.97						64.322	68.871	-4.548
18	C	X		3.25	3.2			X			62.937	63.920	-0.983
19	T	X		3.28	3.48						62.361	58.777	3.584
20	C	X		3.13	3.2	X					65.350	63.920	1.430
21	RV	X		3.65	3.56						56.040	57.457	-1.417
22	T	X		3.59	4.11	X					56.976	49.768	7.209
23	C		X	2.97	2.95	X					68.871	69.337	-0.467
24	T	X		3.38	3.45						60.516	59.289	1.228
25	C	X		3.22	3.09						63.523	66.196	-2.673
26	C	X		3.21	3.38						63.721	60.516	3.205
27	C + Trailer	X		3.84	3.71	X					53.267	55.134	-1.867
28	C		X	2.78	2.93						73.578	69.811	3.767
29	T	X		3.53	3.68	X					57.945	55.583	2.362
30	RV	X		3.84	3.98						53.267	51.393	1.874
31	C	X		3.03	3.05						67.507	67.064	0.443
32	C		X	2.62	2.6						78.071	78.671	-0.601
33	C	X		3.4	3.29						60.160	62.172	-2.011
34	C		X	2.5	2.92						81.818	70.050	11.768
35	C	X		2.91	3.09						70.291	66.196	4.095
36	T	X		3.53	4.01						57.945	51.009	6.936
37	C	X		3.59	3.53						56.976	57.945	-0.968
38	C	X		3.19	2.91						64.121	70.291	-6.170
39	C	X		4.15	3.88	X					49.288	52.718	-3.430
40	T	X		4.5	4.41	X					45.455	46.382	-0.928
41	C	X		3.34	3.24	X					61.241	63.131	-1.890
42	C		X	2.68	3.09						76.323	66.196	10.127
43	C		X	2.94	3.09						69.573	66.196	3.377
44	C	X		3.16	3.08						64.730	66.411	-1.681
45	C	X		3.03	2.95						67.507	69.337	-1.831
46	C		X	2.84	3.2						72.023	63.920	8.103
47	C		X	2.81	2.91						72.792	70.291	2.501
48	C	X		3.31	3.31						61.796	61.796	0.000
49	T	X		3.44	3.66						59.461	55.887	3.574
50	C		X	2.94	2.7	X					69.573	75.758	-6.184
51	C	X		3.06	3.06						66.845	66.845	0.000
52	T	X		3.25	3.34						62.937	61.241	1.696
53	C	X		2.91	2.96						70.291	69.103	1.187
54	C	X		3.25	3.27					X	62.937	62.552	0.385
55	C	X		2.97	3.04					X	68.871	67.285	1.586
56	C	X		2.94	3.1						69.573	65.982	3.591
57	C	X		3.25	3.41						62.937	59.984	2.953
58	C	X		3.09	3.12						66.196	65.559	0.636
59	C	X		3.44	3.49						59.461	58.609	0.852

Location:	LA MOINE												
Date:	1/3/00	(Trip 4)											
Speed Trap 1 Distance (FT):			300										
Speed Trap 2 Distance (FT):			300										
						Brake Lights	**Encroachment**				**Speed**		**Speed**
	veh type	**Vehicle Lane**		**Trap 1**	**Trap 2**	**In Curve**	**Inside**	**Center**	**Outside**	**Lane**	**Trap 1**	**Trap 2**	**Reduction**
Veh ID	Track Trail	Drive Ln (x)	Pass Ln (x)	Time	Time	**(x) for yes**	**Edge**	**Laneline**	**Edge**	**Change**	**mph**	**mph**	**mph**
1	C	X		2.63	2.6						77.774	78.671	-0.897
2	C	X		3.56	3.8						57.457	53.828	3.629
3	C	X		3.44	3.5						59.461	58.442	1.019
4	C	X		3.15	3.06						64.935	66.845	-1.910
5	RV		X	3.19	3.07						64.121	66.627	-2.506
6	C	X		3.72	3.65						54.985	56.040	-1.055
7	C	X		2.78	2.9						73.578	70.533	3.045
8	C	X		3.38	3.3						60.516	61.983	-1.467
9	C	X		3.03	3.19						67.507	64.121	3.386
10	C	X		3.69	3.09						55.432	66.196	-10.764
11	C		X	3	3						68.182	68.182	0.000
12	C		X	2.72	2.8						75.201	73.052	2.149
13	T		X	3.31	3.13						61.796	65.350	-3.554
14	C	X		3.37	3.09						60.696	66.196	-5.500
15	C		X	3.47	3.24						58.947	63.131	-4.184
16	RV	X		3.1	3	X					65.982	68.182	-2.199
17	C		X	2.97	2.96					X	68.871	69.103	-0.233
18	C	X		3.19	3.08						64.121	66.411	-2.290
19	C	X		3.09	3.24						66.196	63.131	3.065
20	T	X		3.66	3.45						55.887	59.289	-3.402
21	C	X		3.16	3.07						64.730	66.627	-1.898
22	C	X		3.25	3.21						62.937	63.721	-0.784
23	C	X		3.25	3.41						62.937	59.984	2.953
24	C	X		3.46	3.4						59.117	60.160	-1.043
25	C + Tr	X		3.66	3.77						55.887	54.256	1.631
26	C		X	2.97	2.89						68.871	70.777	-1.906
27	T	X		3.63	3.42						56.349	59.809	-3.460
28	C	X		3.12	3.16						65.559	64.730	0.830
29	RV	X		3.07	3.26	X					66.627	62.744	3.883
30	C	X		3.19	3.22						64.121	63.523	0.597
31	C	X		3.12	2.93						65.559	69.811	-4.251
32	C + Tr	X		3.87	3.75						52.854	54.545	-1.691
33	C	X		3.18	3						64.322	68.182	-3.859
34	C	X		3.22	3.52	X					63.523	58.110	5.414
35	C	X		3.18	3.4						64.322	60.160	4.162
36	RV	X		3.59	3.57						56.976	57.296	-0.319
37	C		X	3.82	2.81						53.546	72.792	-19.246
38	C		X	2.81	2.74						72.792	74.652	-1.860
39	C		X	3.09	3.04						66.196	67.285	-1.089
40	C	X		3.16	3.16						64.730	64.730	0.000
41	C		X	2.75	2.8	X					74.380	73.052	1.328
42	C		X	3.06	3.31						66.845	61.796	5.049
43	RV	X		3.68	3.49						55.583	58.609	-3.026
44	C	X		3.5	3.49						58.442	58.609	-0.167
45	C		X	3.15	3.17						64.935	64.525	0.410
46	T	X		3.5	3.27						58.442	62.552	-4.111
47	C		X	2.85	2.73						71.770	74.925	-3.155
48	C + Tr	X		3.47	3.38						58.947	60.516	-1.570
49	C	X		3.69	3.53						55.432	57.945	-2.513
50	C	X		3.44	3.46						59.461	59.117	0.344
51	C		X	2.81	2.73						72.792	74.925	-2.133
52	C + Tr	X		3.53	3.39						57.945	60.338	-2.393
53	T	X		3.25	3.32	X					62.937	61.610	1.327
54	C		X	2.88	2.87						71.023	71.270	-0.247
55	C	X		2.87	2.98						71.270	68.639	2.631
56	Uhaul	X		3.22	3.02					X	63.523	67.730	-4.207
57	C		X	3.19	3.23						64.121	63.327	0.794
58	C		X	2.96	2.88	X					69.103	71.023	-1.920
59	C	X		3.13	3.26						65.350	62.744	2.606
60	C	X		3.16	3.1	X					64.730	65.982	-1.253
61	C		X	2.84	2.73						72.023	74.925	-2.902
62	C	X		3.46	2.99						59.117	68.410	-9.293
63	C	X		3.09	2.98						66.196	68.639	-2.443
64	C	X		3.59	3.64						56.976	56.194	0.783
65	C		X	2.56	2.66						79.901	76.897	3.004
66	C	X		2.96	3.05						69.103	67.064	2.039

Location: SIMS ROAD
Date: 1/3/00 (Trip 4)
Speed Trap 1 Distance (FT): 300
Speed Trap 2 Distance (FT): 300

	veh type	Vehicle Lane		Trap 1	Trap 2	Brake Lights In Curve	Encroachment				Speed		Speed Reduction
Veh ID	Track Trail	Drive Ln (x)	Pass Ln (x)	Time	Time	(x) for yes	Inside Edge	Center Laneline	Outside Edge	Lane Change	Trap 1 mph	Trap 2 mph	mph
1	C	X		3.56	3.56						57.457	57.457	0.000
2	C		X	2.57	3.14	X					79.590	65.142	14.448
3	T	X		3.91	4.06						52.313	50.381	1.933
4	C	X		3.38	3.41						60.516	59.984	0.532
5	C	X		3.63	3.59						56.349	56.976	-0.628
6	C		X	3.03	3.58						67.507	57.136	10.371
7	C	X		3.12	3						65.559	68.182	-2.622
8	C		X	3.25	3.32						62.937	61.610	1.327
9	T	X		3.75	3.7						54.545	55.283	-0.737
10	C	X		2.9	2.98						70.533	68.639	1.894
11	T	X		3.38	3.38						60.516	60.516	0.000
12	C	X		2.94	3.13		X				69.573	65.350	4.223
13	C	X		2.78	3						73.578	68.182	5.396
14	T	X		3.78	3.85						54.113	53.129	0.984
15	C		X	3.06	3.34						66.845	61.241	5.604
16	C		X	3.03	3.47						67.507	58.947	8.560
17	C	X		4.41	4.58						46.382	44.661	1.722
18	C	X		3.13	3.34						65.350	61.241	4.109
19	T	X		3.57	3.65						57.296	56.040	1.256
20	C		X	3.41	3.44						59.984	59.461	0.523
21	C		X	3.47	3.5						58.947	58.442	0.505
22	C + Trailer	X		3.88	3.96						52.718	51.653	1.065
23	C	X		4.22	4.7						48.470	43.520	4.950
24	C		X	2.81	2.84						72.792	72.023	0.769
25	C	X		3.1	3.28						65.982	62.361	3.621
26	C		X	2.88	3.19						71.023	64.121	6.902
27	T	X		4.62	4.27						44.274	47.903	-3.629
28	T	X		3.81	3.78	X					53.686	54.113	-0.426
29	C		X	2.97	3.23						68.871	63.327	5.544
30	C	X		3.06	3.42						66.845	59.809	7.036
31	C	X		3.38	3.22						60.516	63.523	-3.007
32	T	X		3.66	3.66						55.887	55.887	0.000
33	C		X	3.34	3.67						61.241	55.734	5.507
34	C		X	3.1	3.2						65.982	63.920	2.062
35	C	X		3.41	3.34		X				59.984	61.241	-1.257
36	C	X		3.18	3.44	X					64.322	59.461	4.862
37	C	X		3.35	3.55		X				61.058	57.618	3.440
38	C		X	3.41	3.44						59.984	59.461	0.523
39	C	X		3.84	4.07						53.267	50.257	3.010
40	C	X		3.35	3.34						61.058	61.241	-0.183
41	C	X		3.16	3.12						64.730	65.559	-0.830
42	C	X		3.15	3.24						64.935	63.131	1.804
43	T	X		3.47	3.59						58.947	56.976	1.970
44	T	X		3.34	3.41						61.241	59.984	1.257
45	C	X		3.12	3.25						65.559	62.937	2.622
46	C	X		3.35	3.45						61.058	59.289	1.770
47	C	X		2.94	3.34						69.573	61.241	8.332
48	C	X		3.19	3.4						64.121	60.160	3.960
49	C	X		3.25	3.24						62.937	63.131	-0.194
50	C	X		3.25	3.37						62.937	60.696	2.241
51	C	X		3.79	3.97						53.970	51.523	2.447
52	C	X		3.13	3.49						65.350	58.609	6.741
53	T	X		3.31	3.42		X				61.796	59.809	1.988
54	C	X		3.47	4.08						58.947	50.134	8.813
55	C		X	2.91	2.96						70.291	69.103	1.187
56	C	X		3.22	3.3						63.523	61.983	1.540
57	T	X		3.72	3.79						54.985	53.970	1.016
58	T	X		3.19	3.38		X				64.121	60.516	3.604
59	C		X	2.75	2.89						74.380	70.777	3.603
60	C	X		3.68	3.59						55.583	56.976	-1.393
61	C	X		3.25	3.41						62.937	59.984	2.953
62	C	X		3.44	3.71						59.461	55.134	4.327
63	C		X	3.22	3.09						63.523	66.196	-2.673
64	T	X		3.75	3.56						54.545	57.457	-2.911
65	C	X		4.22	3.84						48.470	53.267	-4.797
66	C		X	3.09	3.12						66.196	65.559	0.636

Appendix D: Radar Speed Data by Vehicle Type and Site

To reiterate:

- Location 1 was 1000 feet upstream of the CMS
- Location 2 was middle of the first stopwatch speed measurement section (150 feet upstream of the CMS)
- Location 3 was middle of second stopwatch speed measurement section (150 feet upstream of the beginning of the curve)

Table D1: Radar Speed Data for Trucks at Sidehill Viaduct

Speed Categories (mph)	Number of Vehicles	Avg. Speed Location 1 (mph)	Avg. Speed Location 2 (mph)	Avg. Speed Location 3 (mph)	Total Change in Speed (mph)
35-39	1	35.0	36.0	36.0	1.0
40-44	0	N/A	N/A	N/A	N/A
45-49	2	48.5	49.5	47.5	-1.0
50-54	16	52.1	50.9	49.7	-2.4
55-59	4	56.4	56.5	56.3	-0.1
60-64	5	61.8	56.8	55.3	-6.5
65-69	1	66.0	58.0	59.0	-7.0

Table D2: Radar Speed Data for Cars with Trailers and RV's at Sidehill Viaduct

Speed Categories (mph)	Number of Vehicles	Avg. Speed Location 1 (mph)	Avg. Speed Location 2 (mph)	Avg. Speed Location 3 (mph)	Total Change in Speed (mph)
55-59	7	57.4	55.9	53.9	-3.6
60-64	2	60.5	53.0	52.0	-8.5
65-69	1	66.0	N/A	60.0	-6.0

Table D3: Radar Speed Data for Passenger Cars at Sidehill Viaduct

Speed Categories (mph)	Number of Vehicles	Avg. Speed Location 1 (mph)	Avg. Speed Location 2 (mph)	Avg. Speed Location 3 (mph)	Total Change in Speed (mph)
45-49	1	48.0	51.0	50.0	2.0
50-54	1	52.0	56.0	55.0	3.0
55-59	6	58.0	54.0	55.3	-2.7
60-64	28	62.1	59.6	57.7	-4.4
65-69	17	66.9	59.3	59.6	-7.4
70-74	5	71.4	68.8	67.6	-3.8
75-79	1	75.0	67.0	66.0	-9.0

Table D4: Radar Speed Data for Trucks at O'Brien

Speed Categories (mph)	Number of Vehicles	Avg. Speed Location 1 (mph)	Avg. Speed Location 2 (mph)	Avg. Speed Location 3 (mph)	Total Change in Speed (mph)
50-54	1	54.0	46.0	47.0	-7.0
55-59	11	57.5	51.0	49.2	-8.3
60-64	14	61.6	57.4	52.7	-8.9
65-69	2	66.0	53.0	51.0	-15.0

Table D5: Radar Speed Data for Cars with Trailers and RV's at O'Brien

Speed Categories (mph)	Number of Vehicles	Avg. Speed Location 1 (mph)	Avg. Speed Location 2 (mph)	Avg. Speed Location 3 (mph)	Total Change in Speed (mph)
50-54	2	53.0	50.0	46.0	-7.0
55-59	4	58.8	55.3	53.8	-5.0
60-64	6	61.2	56.5	51.8	-9.3
65-69	0				0.0
70-74	1	72.0	58.0	55.0	-17.0

Table D6: Radar Speed Data for Passenger Cars at O'Brien

Speed Categories (mph)	Number of Vehicles	Avg. Speed Location 1 (mph)	Avg. Speed Location 2 (mph)	Avg. Speed Location 3 (mph)	Total Change in Speed (mph)
55-59	1	59.0	55.0	53.0	-6.0
60-64	22	62.1	58.0	55.4	-6.7
65-69	24	67.1	60.8	57.9	-9.2
70-74	9	70.9	63.9	58.7	-12.2

Table D7: Radar Speed Data for Trucks at Salt Creek

Speed Categories (mph)	Number of Vehicles	Avg. Speed Location 1 (mph)	Avg. Speed Location 2 (mph)	Avg. Speed Location 3 (mph)	Total Change in Speed (mph)
50-54	6	52.0	50.3	49.7	-2.3
55-59	14	56.6	54.9	54.1	-2.5
60-64	8	61.0	59.0	59.3	-1.8
65-69	3	65.3	58.0	52.7	-12.7

Table D8: Radar Speed Data for Cars with Trailers and RV's at Salt Creek

Speed Categories (mph)	Number of Vehicles	Avg. Speed Location 1 (mph)	Avg. Speed Location 2 (mph)	Avg. Speed Location 3 (mph)	Total Change in Speed (mph)
50-54	3	53.3	52.3	49.3	-4.0
55-59	3	57.0	53.3	54.0	-3.0
60-64	3	63.0	58.0	57.0	-6.0
65-69	2	65.5	61.0	59.0	-6.5

Table D9: Radar Speed Data for Passenger Cars at Salt Creek

Speed Categories (mph)	Number of Vehicles	Avg. Speed Location 1 (mph)	Avg. Speed Location 2 (mph)	Avg. Speed Location 3 (mph)	total change in speed (mph)
50-54	1	53.0	51.0	56.0	3.0
55-59	8	57.0	56.3	55.5	-1.5
60-64	11	62.1	60.5	58.0	-4.1
65-69	20	66.7	60.8	62.2	-4.6
70-74	15	70.8	67.7	63.7	-7.1
75-79	3	76.7	72.0	63.0	-13.7

Table D10: Radar Speed Data for Trucks at La Moine

Speed Categories (mph)	Number of Vehicles	Avg. Speed Location 1 (mph)	Avg. Speed Location 2 (mph)	Avg. Speed Location 3 (mph)	Total Change in Speed (mph)
55-59	20	57.3	57.1	57.8	0.5
60-64	15	60.8	60.3	58.1	-2.7
65-69	3	65.0	60.0	56.3	-8.7

Table D11: Radar Speed Data for Cars with Trailers and RV's at La Moine

Speed Categories (mph)	Number of Vehicles	Avg. Speed Location 1 (mph)	Avg. Speed Location 2 (mph)	Avg. Speed Location 3 (mph)	Total Change in Speed (mph)
55-59	5	57.6	58.4	57.5	-0.1
60-64	8	61.3	61.1	59.4	-1.9

Table D12: Radar Speed Data for Passenger Cars at La Moine

Speed Categories (mph)	Number of Vehicles	Avg. Speed Location 1 (mph)	Avg. Speed Location 2 (mph)	Avg. Speed Location 3 (mph)	Total Change in Speed (mph)
50-54	1	54.0	56.0	52.0	-2.0
55-59	2	59.0	58.0	62.5	3.5
60-64	10	62.1	64.4	61.9	-0.2
65-69	19	66.3	66.0	62.8	-3.4
70-74	13	71.5	68.5	65.2	-6.2
75+	3	79.3	74.0	69.7	-9.7

Table D13: Radar Speed Data for Trucks at Sims Road

Speed Categories (mph)	Number of Vehicles	Avg. Speed Location 1 (mph)	Avg. Speed Location 2 (mph)	Avg. Speed Location 3 (mph)	Total Change in Speed (mph)
50-54	5	52.8	50.4	49.0	-3.8
55-59	24	57.3	53.1	51.7	-5.6
60-64	15	61.0	56.7	54.1	-6.9

Table D14: Radar Speed Data for Cars with Trailers and RV's at Sims Road

Speed Categories (mph)	Number of Vehicles	Avg. Speed Location 1 (mph)	Avg. Speed Location 2 (mph)	Avg. Speed Location 3 (mph)	Total Change in Speed (mph)
60-64	1	64.0	61.0	56.0	-8.0
65-69	0				0.0
70-74	1	70.0	64.0	63.0	-7.0

Table D15: Radar Speed Data for Passenger Cars at Sims Road

Speed Categories (mph)	Number of Vehicles	Avg. Speed Location 1 (mph)	Avg. Speed Location 2 (mph)	Avg. Speed Location 3 (mph)	Total Change in Speed (mph)
40-44	1	41.0	65.0	62.0	21.0
45-49	0				0.0
50-54	2	52.0	49.5	50.5	-1.5
55-59	9	57.2	57.7	58.0	0.8
60-64	8	61.8	60.5	58.3	-3.5
65-69	23	66.5	62.1	59.8	-6.7
70-74	9	70.8	65.2	62.6	-8.2
75-79	2	76.5	67.5	65.5	-11.0

Appendix E: Crash Data

Table E1: Crashes at the Sidehill Viaduct Site (PM 29.00 - 29.88 SB only)

Accident Date	Primary Collision Factor	Party Type	Severity	
			# Killed	# Injured
4/8/94	Speeding	Pasngr. Car/Sta. Wagon	0	1
6/24/94	Other Than Driver	Pasngr. Car/Sta. Wagon	0	0
3/19/95	Speeding	Pasngr. Car/Sta. Wagon	0	2
10/6/95	Speeding	Truck/Tractor w/1 Trailer	0	1
4/12/96	Speeding	Truck/Tractor w/1 Trailer	0	2
4/20/96	Speeding	Truck/Tractor w/1 Trailer	0	1
8/7/96	Other Than Driver	Truck/Tractor w/1 Trailer	0	0
10/23/96	Fell Asleep	Pasngr. Car/Sta. Wagon	0	0
3/19/97	Speeding	Truck/Tractor w/1 Trailer	0	1
9/2/97	Speeding	Truck/Tractor w/2 Trailers	0	1
9/2/97	Other Than Driver	Truck/Tractor w/1 Trailer	0	0
11/18/97	Speeding	Truck/Tractor w/1 Trailer	0	1
12/24/97	Speeding	Truck/Tractor w/1 Trailer	0	2
5/7/98	Speeding	Pasngr. Car/Sta. Wagon	0	0
5/25/98	Improper Turn	Pasngr. Car/Sta. Wagon	0	2
9/7/98	Speeding	Pickup/Panel w/Trailer	0	0
12/12/98	Speeding	Pasngr. Car/Sta. Wagon	0	0
12/20/98	Speeding	Pasngr. Car/Sta. Wagon	0	0
2/12/99	Speeding	Truck/Tractor w/1 Trailer	0	0
2/13/99	Speeding	Truck/Tractor w/1 Trailer	0	1

Table E2: Crashes at the O'Brien Site (PM 31.77 – 32.30 SB only)

Accident Date	Primary Collision Factor	Party Type	Severity	
			# Killed	# Injured
3/21/95	Speeding	Passngr. Car/Sta. Wagon	0	0
4/27/95	Fell Sleep	Passngr. Car/Sta. Wagon	0	0
9/11/94	Speeding	Truck/Tractor w/2 Trailers	0	0
5/5/95	Improper Turn	Pickup/Panel w/Trailer	0	0
4/6/95	Other Than Driver	Truck/Tractor w/1 Trailer	0	2
1/17/96	Speeding	Passngr. Car/Sta. Wagon	0	3
12/7/98	Speeding	Pickup/Panel	0	0
2/6/99	Speeding	Passngr. Car/Sta. Wagon	0	2
3/22/96	Speeding	Truck/Tractor w/1 Trailer	0	0
10/23/96	Other Than Driver	Passngr. Car/Sta. Wagon	0	0
9/23/97	Influence of Alcohol	Truck/Tractor w/1 Trailer	0	1
7/6/94	Fell Sleep	Passngr. Car/Sta. Wagon	0	1
10/3/98	Other Than Driver	Passngr. Car/Sta. Wagon	0	0
8/14/95	Unknown	Truck/Tractor w/1 Trailer	0	0

Table E3: Crashes at the Salt Creek Site (PM 36.80 – 37.53 SB only)

Accident Date	Primary Collision Factor	Party Type	Severity	
			# Killed	# Injured
3/17/97	Other Violations	Pickup/Panel Truck	0	0
1/17/98	Other Than Driver	Pasngr. Car w/Trailer	0	0
12/10/95	Speeding	Pasngr. Car/Sta. Wagon	0	0
5/6/94	Other Violations	Pasngr. Car/Sta. Wagon	0	0
2/7/96	Influence of Alcohol	Pickup/Panel Truck	0	0
5/7/96	Speeding	Pickup/Panel w/Trailer	0	0
1/21/95	Speeding	Pasngr. Car/Sta. Wagon	0	0
6/12/95	Other Than Driver	Pasngr. Car/Sta. Wagon	0	0
2/28/97	Speeding	Pasngr. Car/Sta. Wagon	0	1

Table E4: Crashes at the La Moine Site (PM 48.49 – 49.23 SB only)

Accident Date	Primary Collision Factor	Party Type	Severity	
			# Killed	# Injured
1/14/98	Speeding	Pasngr. Car/Sta. Wagon	0	1
10/4/95	Other Violations	Truck/Tractor w/Trailer	0	0
1/25/97	Speeding	Pasngr. Car/Sta. Wagon	0	0
4/6/95	Speeding	Pickup/Panel Truck	0	0
7/11/95	Other Than Driver	Pasngr. Car w/Trailer	0	0
7/19/96	Other Than Driver	Pasngr. Car/Sta. Wagon	0	0
8/16/95	Other Violations	Pasngr. Car/Sta. Wagon	0	0
2/28/98	Speeding	Truck/Tractor w/Trailer	0	1
12/8/96	Speeding	Other Motor Vehicle	0	1
10/1/98	Influence of Alcohol	Pickup/Panel Truck	0	1
6/7/94	Speeding	Truck/Tractor w/Trailer	0	0
7/27/98	Improper Turn	Pasngr. Car/Sta. Wagon	0	1
3/17/97	Improper Driving	Truck/Tractor w/Trailer	0	0
10/22/98	Speeding	Truck/Tractor w/Trailer	0	2
6/2/98	Speeding	Truck/Tractor w/Trailer	0	1
1/24/99	Other Violations	Truck/Tractor w/Trailer	0	0
10/6/94	Fell Asleep	Pickup/Panel Truck	0	1
1/27/98	Influence of Alcohol	Pasngr. Car/Sta. Wagon	0	3
12/23/98	Fell Asleep	Pasngr. Car/Sta. Wagon	0	1
11/20/96	Speeding	Truck/Tractor w/Trailer	0	0
2/11/98	Fell Asleep	Pickup/Panel Truck	0	0
11/12/95	Improper Turn	Pasngr. Car/Sta. Wagon	0	1

Table E5: Crashes at the Sims Road Site (PM 57.90 – 58.32 NB only)

Accident Date	Primary Collision Factor	Party Type	Severity	
			# Killed	# Injured
9/20/97	Fell Asleep	Pickup/Panel Truck	0	0
10/20/97	Fell Asleep	Truck/Tractor w/Trailer	0	0
7/27/97	Other Violation	Truck/Tractor w/Trailer	0	0
5/1/98	Speeding	Pasngr. Car/Sta. Wagon	0	0
8/19/94	Speeding	Truck/Tractor w/Trailer	0	2
11/11/97	Other Violation	Pickup/Panel w/Trailer	0	0
7/3/96	Speeding	Truck/Tractor w/Trailer	0	0
7/29/98	Unknown	Other Motor Vehicle	0	0
9/15/97	Speeding	Pickup/Panel Truck	0	0
9/13/96	Other Violation	Pasngr. Car/Sta. Wagon	0	3
12/11/96	Speeding	Truck/Tractor w/Trailer	0	0
1/12/97	Improper Driving	Truck/Tractor w/Trailer	0	1
3/30/98	Speeding	Pasngr. Car/Sta. Wagon	0	0