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16. ABSTRACT

There is video data for the first 2000', or 609.6m, of five passing lanes. Four of the locations are at rolling terrain. One location is at slightly mountainous terrain.

References to terrain are to the terrain at the areas, not to the profiles of the highways.

There are no steep prior grades near the passing lanes. The horizontal alignment is adequate for fast or very fast speeds at all of the locations.

The approximate average grades along the first 2000', or 609.6m, of the passing lanes were -0.05 percent, +2.02 percent, + 3.15 percent, +4.32 percent and +5.05 percent.

There was not much traffic data regarding the location where the grade was -0.05 percent.

Passing rates for passing of the first vehicles of groups of three or more vehicles along the first 2000', or 609.6m, of the passing lanes along the steeper grades were typically not more than the passing rates along the less steep grades.

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Passing Rates Along the First 2000', or 609.6m, of Passing Lanes for Groups of Three or More Vehicles

H. K. Fong
F. D. Rooney

Final Report
Report Number FHWA/CA/TO-96/29
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This research was done in cooperation with the Federal Highway Administration.

16. Abstract

There is video data for the first 2000', or 609.6m, of five passing lanes. Four of the locations are at rolling terrain. One location is at slightly mountainous terrain.

References to terrain are to the terrain at the areas, not to the profiles of the highways.

There are no steep prior grades near the passing lanes. The horizontal alignment is adequate for fast or very fast speeds at all of the locations.

The approximate average grades along the first 2000', or 609.6m, of the passing lanes were -0.05 percent, +2.02 percent, +3.15 percent, +4.32 percent and +5.05 percent.

There was not much traffic data regarding the location where the grade was -0.05 percent.

Passing rates for passing of the first vehicles of groups of three or more vehicles along the first 2000', or 609.6m, of the passing lanes along the steeper grades were typically not more than the passing rates along the less steep grades.

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CONTENTS

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the State of California or the Federal Highway Administration. This report does not constitute a standard, specification or regulation.

Some metric units are slightly different than would be calculated from the distance units of this report. For example, one approximate distance of 1314' was theoretically approximately 1313.88889'. Therefore, the metric distance was approximately 400m, not approximately 401m.

References to terrain are to the terrain at the areas, not to the profiles of highways.

The Caltrans data upon which this research project relies is traffic operational data. This research project did not utilize Caltrans safety data or Caltrans accident data. If any of the contents of this report is used for the planning, design, striping or signing of passing lanes the user must be aware that this research project did not consider or rely on Caltrans traffic safety or accident data.

Implementation

A report regarding passing lanes at rolling and slightly mountainous areas has been prepared.

Summary

The purpose of this project was to provide data regarding passing rates at passing lanes along grades of 0 percent to +7 percent.

There is video data for five locations. Four of the locations are at rolling terrain. One location is at slightly mountainous terrain. The horizontal alignment at all of the locations is adequate for fast or very fast speeds.

The grades prior to and near the passing lanes were not steep. Average prior grades were -1.52 percent to +0.42 percent at four of the areas and +2.11 percent at one area.

The approximate average grades along the first 2000', or 609.6m, of the passing lanes were -0.05 percent, +2.02 percent, +3.15 percent, +4.32 percent and +5.05 percent.

There was not much traffic data regarding the location where the grade was -0.05 percent.

The passing rates for passing of the first vehicles of groups of three or more vehicles along the first 2000', or 609.6m, of the passing lanes along the steeper grades were typically not more than the passing rates along the less steep grades. This is very significant.

The following data is only for passing of the first vehicles of groups of three or more vehicles.

At three of the four passing lanes where there is adequate traffic data the first vehicles of the groups, when the first vehicles were cars, were passed by at least one other vehicle within the first 2000', or 609.6m, for about 50 percent to about 52 percent of the groups. At one location the number was 65 percent.

The average distances for the first passes within the first 2000', or 609.6m, were 854' to 1130', or 260m to 344m. The average distances for the second passes within the first 2000', or 609.6m, were 1204' to 1449', or 367m to 442m. There were usually no such second passes.

The steepest grade is at the Route 101 location. For the first passes of trucks which were the first vehicles of groups of three or more vehicles the 50th percentile distance was about 900' and the average was 1050'. For the first passes of truck combinations the 50th percentile distance was about 1350' and the average distance was 1334'. These distances were about 274m, 320m, 411m and 407m.

For the first passes of truck combinations at the Route 126 location the average distance was 870', or 265m.

The 50th percentile distances for the first passes of the first vehicles, first vehicles cars, varied much more than average distances varied. The 50th percentile distances at the four locations where there was adequate traffic data varied from 600' to more than 1100' or from 183m to more than 335m. The 50th percentile distances along the two less steep grades were less than the distances along the two steeper grades.

The 85th percentile distances for the first pass within the first 2000', or 609.6m, with the first vehicles cars, were about 1500'-1700', or about 457m-518m, at four of the locations.

There was restrictive striping at the diverge area at one location. This probably decreased passing rates.

LOCATIONS AND OTHER FACTORS

Areas

The video data for this report is for five rural locations.

One location is along Route 101 at Mendocino County. It is more than 90 miles, or more than about 145 km, northwest of San Francisco. The terrain is rolling. Many of the trips at this area are probably to rural resort areas.

Another location is along Route 41 at Madera County. It is north of Fresno. The terrain is slightly mountainous. This route is one of the routes to Yosemite National Park. Many of the trips at this area are probably to rural resort areas.

There is a location along Route 119 and there is also a location along Route 33 at Kern County southwest of Bakersfield. The terrain is rolling. Oil wells are near the Route 33 location. No significant resort areas are near these locations.

Another location is along Route 126 at Ventura County. It is northwest of and near the Los Angeles urban area. The terrain is rolling.

Days

Traffic characteristics may be different on Friday afternoons, Saturdays and Sundays than at some other times.

All except about two hours of data for the Route 101 location was for Fridays after 1103 and for Saturdays.

All of the data for the Route 41 location was for a Friday after 1148 and for a Saturday.

The data for the Route 119 location was for a Monday and a Tuesday.

The data for the Route 33 location was for a Wednesday.

The data for the Route 126 location was for a Wednesday.

Factors Which Can Affect Traffic Operations

The speed limits were 55 mph at all locations.

The horizontal alignment was adequate for fast or very fast speeds at all of the locations.

Pavement conditions probably did not significantly affect speeds at any of the locations.

There was no rain or other weather conditions which significantly affected speeds at any of the locations.

The elevations of the passing lanes were all less than 1500', or 457.2m. The power of motorized vehicles is not significantly affected at such elevations.

Annual Average Daily Traffic

Routes	1991 Annual Average Daily Traffic
101	11,500
41	6,800
119	10,200
33	8,100
126	16,600

Stripes at Diverge Areas

There was no striping within the diverge areas at the Route 101, 119, 33 and 126 locations.

There was a double barrier stripe to guide vehicles to lane 2 at the Route 41 location. This was because of a driveway. Approximately 397 vehicles illegally traveled over the stripe during about 12 hours.

Diverge Areas

The diverge area distances were from the beginning of the diverge areas to the beginning of the dash stripe between lanes 1 and 2.

Routes	Approximate Distances
101	370' 113m
41	600' 183m
119	420' 128m
33	200' 61m
126	655' 200m

Distances

For this report all distances along the passing lanes were from where the dash stripe separating lane 1, the left lane, and lane 2, the right lane, began.

Recreational Vehicles

There are many types of vehicles and vehicle combination designated as recreational vehicles. Many of the vehicles and vehicle combinations are used for other

purposes, such as pickup trucks and trailers used for commercial purposes. Therefore, the data in this report regarding recreational vehicles should not be used for planning passing lanes.

Groups of Vehicles

The data is only for groups of three or more vehicles which were traveling within five seconds or less of another vehicle near the beginning of a passing lane.

The data regarding where passing occurred is also only for groups of vehicles when the first vehicle traveled to lane 2 near the beginning of a passing lane and did not leave lane 2 until at least the 2000', or 609.6m, location. It also does not include data for groups of vehicles which traveled along the passing lane when unusual events occurred. It also does not include data for groups of vehicles which probably included a convoy of two or more vehicles or which included very unusual vehicles such as vehicles which cannot legally travel without a permit.

This report includes passing data for most of the groups of three or more vehicles. For example, during 11 of the 12 video tapes along Route 101 only 165 of the 1657 groups of three or more vehicles were not included because the first vehicle did not travel to lane 2 and so forth.

First Vehicles of Groups of Three or More Vehicles

There were locations where passing was legal prior to and near all of the passing lanes except the Route 126 location. Therefore, some of the first vehicles of groups of three or more vehicles had recently passed one or more of the following vehicles and were not slow vehicles. Some of the first vehicles were traveling very fast.

Prior Grades

The grades prior to the passing lanes were not steep. The only significant prior grade was along Route 41. Prior grades may affect the speeds of vehicles.

Routes	Approximate Prior Distances	Approximate Elevation Differences	Average Prior Grades, Percent
101	3500' 1067m	+5' +1.5m	+0.14
41	1852' 564m	+39' +11.9m	+2.11
119	1923' 586m	+8' +2.4m	+0.42
33	986' 301m	-15' -4.6m	-1.52
126	1324' 404m	+5.5' +1.7m	+0.42

Grades

The approximate grades are from the beginning of the dash stripe between lane 1 and lane 2 to locations 1500', or 457.2m, and 2000', or 609.6m, further.

Routes	Approximate Grades, Percent, for 1500', or 457.2m	Approximate Grades, Percent, for 2000', or 609.6m
101	+4.80	+5.05
41	+3.78	+4.32
119	+1.89	+2.02
33	-0.08	-0.05
126	+2.58	+3.15

Preceding Passing Lanes

There is a NB passing lane from about Postmile 13.40 to about Postmile 13.99 prior to the Route 101 location. These postmiles were the approximate limits of the dash stripe between lanes 1 and 2. The dash stripe at the Route 101 location began at about Postmile 14.73.

There is a SB passing lane of about 0.5 mile, or about 0.8km, prior to the Route 33 location. There was about 0.84 mile or about 1.4km, from the beginning of the merge area of the that passing lane to the beginning of the dash stripe at this location.

Towns

There are two SB lanes at a town for about 1.06 mile, about 3.75 miles to about 2.69 miles prior to the Route 33 location. These distances are 1.71km, 6.04km and 4.33km.

There are two EB lanes at a town for about 1.44 miles, about 2.72 miles to about 1.28 mile prior to the Route 126 location. These distances are 2.32km, 4.38km and 2.06km.

Preceding Two-Lane Passing Zones

Passing was legal at one or more areas prior to and near the passing lanes along Routes 101, 41, 119 and 33. Along Route 126 passing was not legal from the town to the beginning of the passing lane.

RESULTS

Factors

There are many factors which could possibly affect the speeds of the first vehicles of groups of three or more vehicles at passing lanes and which could possibly affect where passing occurs at passing lanes at rolling and slightly mountainous terrain. Some of these factors include whether many of the trips are possibly to rural resort areas, distances from an urban area, day of a week, stripes at diverge areas, diverge area distances, prior grades, grades at passing lanes, preceding passing lanes, towns prior to passing lanes and preceding two-lane passing zones. However, there is no data for these locations to prove that most of these factors markedly affected the speeds of the first vehicles of groups of three or more vehicles or where passing occurred. This is very significant. Most, though not all, of the many factors which could have markedly affected traffic operations probably did not markedly affect traffic operations.

Data

Summaries of most of the data for this research are in the attachments. Some of the data is for less than 50 vehicles or less than 50 groups of vehicles. This affects the accuracy of the results.

Most of the data on this page and the following several pages is only for at least 50 vehicles or at least 50 groups of vehicles.

The average speeds are time mean speeds.

The passing data is for passes of the first vehicles of groups of three or more vehicles within 2000', or 609.6m, of the beginning of the dash stripes. The passing distances were for approximately where the passing vehicles were just clear of the vehicles which were passed.

Speeds of cars which were the first vehicles of groups of three or more vehicles.

Location	Vehicles	Average Speeds, mph
101	1046	58
41	470	57
119	86	58
126	122	58

Speeds of truck combinations which were the first vehicles of groups of three or more vehicles.

Location	Vehicles	Average Speeds, mph
101	80	56
126	52	53

The prior grades of +0.14 percent to +2.11 percent did not markedly affect these speeds. Sustained prior grades would, of course, affect speeds.

The average grades along the first 1500', or 457.2m of the four passing lanes were +1.89 percent to + 4.80 percent. These various grades did not markedly affect these speeds.

There is speed data for 2332 vehicles which were the first vehicles of groups of three or more vehicles. Only 41 were traveling at average speeds of less than 45 mph along about the first 1500' or 457.2m, of the passing lanes. This was about 1.8 percent.

All groups, average distances for first passes within 2000', or 609.6m, of the beginning of the passing lanes, excluding groups with no passing.

Location	Number of Groups	Distances
101	869	1044' 318m
41	334	1130' 344m
119	100	977' 298m
126	178	854' 260m

There was not much data for the Route 33 location. However, the average distance was about 1067', or about 325m.

The steepest grade was at the Route 101 location. However, at this location, for the first passes of trucks which were the first vehicles of groups of three or more vehicles the 50th percentile distance was about 900' and the average distance was 1050'. For truck combinations which were the first vehicles of groups of three or more vehicles the 50th percentile distance was about 1350' and the average distance was 1334'. These distances were about 274m, 320m, 411m and 407m.

The average distance for the first passes of truck combinations was 870', or 265m, at the Route 126 location.

All groups, average distances for second passes within 2000', or 609.6m, of the beginning of the passing lanes, excluding groups with no second passes.

Location	Number of Groups	Distances
101	381	1423' 434m
41	160	1449' 442m
119	66	1356' 413m
126	106	1204' 367m

Groups, first vehicle a car, average distances for first passes within 2000', or 609.6m, of the beginning of the passing lanes, excluding groups with no passing.

Location	Number of Groups	Distances
101	588	986' 300m
41	246	1104' 337m
119	56	880' 268m
126	78	877' 267m

Groups, first vehicle a car, average distances for second passes within 2000', or 609.6m, of the beginning of the passing lanes, excluding groups with no second passes.

Location	Number of Groups	Distances
101	241	1379' 420m
41	105	1447' 441m

The average distances for these first passes at the Route 41 location were more than at the other locations. These average distances could have been affected by various factors, including the approach grade of +2.11 percent and the restrictive striping at the diverge area. Research at New Jersey proved that restrictive striping decreased passing efficiency at a 0.4 mile location and slightly increased passing efficiency at a 0.9 mile location. The article is included in Transportation Research Record 1239.

Approximately 397 vehicles illegally traveled over the restrictive striping at the Route 41 area during about 12 hours.

The average distances for these first passes at the other three locations were generally similar. Therefore, the various factors including grades along the first 1500' and the first 2000', or 457.2m and 609.6m, of the passing lanes did not have much of an effect regarding these average passing distances. However, the 50th percentile passing distances at two of the locations did vary significantly. This data and additional data included in the attachments could be used for planning many proposed passing lanes. If groups of enough vehicles were present and if passing did occur, the average distance for the first pass of the first vehicle of groups of three or more vehicles within the first 2000', or 609.6m, would probably be about ±1000'. The average distance for the second pass of

the first vehicle of groups of three or more vehicles within 2000', or 609.6m, would probably be about ±350' - ±400' further. However, there are usually no such second passes. These distances are about ±305m, and ±107m - ±122m.

Percentile data regarding locations where the first passes of the first vehicles of groups of three or more vehicles occurred, first vehicles cars, passes beyond 2000', or 609.6m, not included.

	Routes			
Distances	101	41	119	126
0' 0m	0	0	0	3
500' 152.4m	10	6	29	21
1000' 304.8m	30	23	45	31
1500' 457.2m	43	38	55	39
2000' 609.6m	50	52	65	51
First Passes	588	246	56	78
Total Number of Groups	1179	470	86	154

Percentile data regarding locations where the second passes of the first vehicles of groups of three or more vehicles occurred, first vehicles cars, passes beyond 2000', or 609.6m, not included.

	Routes	
Distances	101	41
0' 0m	0	0
500' 152.4m	0	1
1000' 304.8m	6	4
1500' 457.2m	13	13
2000' 609.6m	20	22
Second Passes	241	105
Total Number of Groups	1179	470

At the four locations there were passes of the first vehicles of groups of three or more vehicles when the first vehicles were cars for about 50 percent to about 52 percent at three locations and about 65 percent at the other location for these groups within about 2000', or 609.6m.

First passes of the first vehicles of groups of three or more vehicles, first vehicles cars, passes beyond 2000', or 609.6m, not included.

Routes	101	41	119	126
First Passes	588	246	56	78
Approximate 50th	900'	1100'	600'	600'
Percentile Distances	274m	335m	183m	183m
Approximate 85th	1500'	1700'	1700'	1600'
Percentile Distances	457m	518m	518m	488m

This 85th percentile data could be used for planning minimum distances for proposed passing lanes along routes where there is not much traffic and where typical speeds are about 55 mph or faster.

First passes of the first vehicles of groups of three or more vehicles.

	Routes				
Distances	101	41	119	33	126
0'-500' 0-152.4m	145	36	34	3	64
600'-1000' 182.88-304.8m	335	104	28	4	51
1100'-1500' 335.28-457.2m	247	106	20	8	32
1600'-2000' 487.68-609.6m	142	89	18	0	28
Totals	869	235	100	15	175

The numbers of first passes of the first vehicles decreased prior to the 2000', or 609.6m, distances.

Total passes of the first vehicles of groups of three or more vehicles.

	Routes				
Distances	101	41	119	33	126
0'-500',0-152.4m	147	41	35	3	70
600'-1000',182.88-304.8m	437	128	55	7	77
1100'-1500', 335.28-457.2m	443	197	48	10	86
1600'-2000', 487.68-609.6m	377	218	69	7	74
Totals	1404	584	207	27	307

The total passes of these first vehicles did not decrease much within the first 2000', or about 609.6m. Whether this would occur at proposed passing lanes would depend on traffic volumes.

Types of vehicles, first vehicles of groups of three or more vehicles.

	Routes			
	101	41	119	126
Cars	1046	470	86	122
Trucks	47	20	22	34
Truck Combinations	80	10	16	52
RV's	239	77	11	No data
Totals	1412	577	135	208

RV's included many vehicles which were not actually recreational vehicles, such as pickup trucks and utility trailers used for commercial purposes.

Cars should probably be used as typical vehicles for planning most passing lanes.

Routes	Approximate Diverge Area Distances
101	370' 113m
41	600' 183m
119	420' 128m
33	200' 61m
126	655' 200m

There is no data regarding which diverge area distances would be appropriate. There should be paved shoulders at and near the beginning of diverge areas to reduce the possibility of the right tires of vehicles traveling off of the pavement.

Other Research

Dr. A. D. May of the University of California at Berkeley prepared a report regarding traffic performance and the design of passing lanes. The speeds were typical speeds.

		Typical Speeds, mph		
Route	Terrain	Opposing Lane	Lane 1	Lane 2
70	Level	57	62	58
41	Rolling	59	57	54
49	Rolling	-	58	55
140	Rolling	-	58	56
299	Mountainous	54	59	53

One recommendation was that passing lanes on the order of 0.25 to 0.75 miles appeared to be the most effective and spacing between such passing lanes on the order of 2 to 5 miles appeared appropriate depending on downstream roadway and traffic conditions. This recommendation was also included in the article by Dr. May which was published in Transportation Research Record 1303.

D. W. Harwood and C. J. Hoban prepared a report regarding low-cost methods for improving traffic operations on two-lane roads. One recommendation was that passing lanes should usually be about 0.5-1.0 mile depending on volumes. The spacing of passing lanes will depend primarily on the magnitude of improvements needed to achieve satisfactory traffic operations.

ATTACHMENTS

Passing Lane Locations and Other Factors

Locations

The data for this report is for five locations.

District	County	Route	Approximate Postmile	Direction
1	Mendocino	101	14.73	NB
6	Madera	41	21.03	NB
6	Kern	119	R11.64	EB
6	Kern	33	15.6	SB
7	Ventura	126	23.86	EB

There is also video for several other locations. However, it is not practical to obtain research data for these locations from the video because of the horizontal and vertical alignment.

Durations of the Data

Most of the video data was for approximately two hour increments.

Route	Date	Approximate Times of Beginning
101	April 18, 1991	1557
	May 24, 1991	1116, 1318, 1519
	May 25, 1991	0830, 1032, 1233
	August 16, 1991	1103, 1311, 1513
	August 17, 1991	0815, 1017
41	August 30, 1991	1148, 1350, 1552
	August 31, 1991	0823, 1023, 1225
119	May 4, 1992	1315
	May 5, 1992	0752
33	November 20, 1991	0855, 1057, 1258
126	May 6, 1992	0831, 1033, 1235

Days

Route	Date	Day
101	April 18, 1991	Thursday
	May 24, 1991	Friday
	May 25, 1991	Saturday
	August 16, 1991	Friday
	August 17, 1991	Saturday
41	August 30, 1991	Friday
	August 31, 1991	Saturday
119	May 4, 1992	Monday
	May 5, 1992	Tuesday
33	November 20, 1991	Wednesday
126	May 6, 1992	Wednesday

Horizontal Alignment

The horizontal alignment along at least the first 2000', or 609.6m, was adequate for fast or very fast speeds at all of the locations. The horizontal alignment at the passing lanes did not significantly affect passing rates at any of the locations.

Speed Limits

The speed limits were 55 mph at all of the locations. A speed of 55 mph is about 88.5 kph.

Pavement

Pavement conditions probably did not significantly affect speeds.

Weather

There was no rain or other weather conditions which significantly affected speeds.

Elevations

The five passing lanes are all at elevations of less than 1500', or 457.2m. The power of motor vehicles is not significantly affected at such elevations.

Terrain

The terrain at the Route 101, 119, 33 and 126 areas is rolling. The terrain at the Route 41 area is slightly mountainous.

Areas

The five passing lanes are all at rural areas.

The passing lane along Route 101 is more than 90 miles, or more than about 145 km, northwest of San Francisco. It is probable that many of the trips at this area are to rural resort areas.

The passing lane along Route 41 is at the mountains north of Fresno. Route 41 is one of the routes to Yosemite National Park. It is probable that many of the trips at this area are to rural resort areas.

The passing lanes along Routes 119 and 33 are southwest of Bakersfield. There are oil wells near the Route 33 location. There are no significant resort areas near these locations.

The passing lane along Route 126 is northwest of and near the Los Angeles urban area.

Lane Numbers

For this report lane 1 is the lane nearest the lane for the opposite direction of travel. Lane 2 is the outer lane at the passing lane areas.

Pavement Stripes at Diverge Areas

At the diverge areas at the Route 101, 119, 33 and 126 locations there were double barrier stripes between the lanes for the different directions of travel and there were edgestripes.

At the Route 41 location there was a double barrier stripe between the NB and the SB lanes. There was edgestripe. However, there was also a double barrier stripe at the diverge area because of a driveway so that vehicles were legally required to travel to the outer lane. A total of approximately 397 vehicles illegally traveled over this double barrier stripe during approximately twelve hours.

Distances

All distances along the passing lanes for this report were from where the dash stripe separating lanes 1 and 2 began.

Types of Vehicles

This report includes data for four general types of vehicles. The types are cars, trucks, truck combinations and recreational vehicles.

Cars included sedans, pickup trucks, pickup trucks with canopies, vans and so forth.

Trucks and truck combinations did not include pickup trucks.

Recreational vehicle included pickup trucks with campers, motorhomes, all motorized vehicles, except trucks, with a trailer of any type and so forth.

Groups of Vehicles

The data is only for groups of three or more vehicles. Groups of vehicles included only vehicles which were traveling within five seconds or less of another vehicle near the beginning of a passing lane.

The data regarding where passing occurred is also only for groups of vehicles which traveled along the passing lane when there were no unusual events. It does not include data for groups if the first vehicle did not travel to lane 2 near the beginning of a passing lane and stay at lane 2 until at least the 2000', or 609.6m, location. It also does not include groups of vehicles which probably included a convoy of two or more vehicles or which included very unusual vehicles such as vehicles which cannot legally travel without a permit. It also does not include data for when significant incidents were occurring. It also does not include data for when vehicles which were turning significantly affected a group of three or more vehicles.

During 11 of the 12 video tapes along Route 101 at Mendocino County passing data regarding only 165 of the 1657 groups of three or more vehicles was not included because the first vehicle did not travel to lane 2 and so forth.

First Vehicles of Groups of Three or More Vehicles

There were locations for passing prior to and near all of the passing lanes except the passing lane along Route 126. Therefore, the first vehicles of groups of three or more vehicles may have recently passed one or more following vehicles and were not slow vehicles. For example, during about two hours at the Route 101 location beginning at about 1116 on May 24, 1991, there is speed data for 88 cars which were the first vehicles of groups of three or more vehicles. Four of these cars were traveling faster than about 65 mph, or about 105 kph.

Speeds of the First Vehicles of Groups of Three or More Vehicles

Data

The data was for the speeds of the first vehicles of groups of three or more vehicles.

The speeds were time mean speeds. The distances began at the beginning of the dash stripe between lane 1 and lane 2. The distances varied. However, most of the distances were approximately 1500', or about 457.2m.

Speeds of Cars Which Were the First Vehicles of Groups of Three or More Vehicles

This data was for cars which were the first vehicles of groups of three or more vehicles. There was no speed data for Route 33.

Locations	Vehicles	Time Mean Speeds mph	kph
Route 101	1046	58	94
Route 41	470	57	92
Route 119	86	58	93
Route 126	122	58	93

The speed data for Route 126 included speeds for some vehicles which did not travel to lane 2 at or near the beginning of the passing lane.

Locations	Vehicles	Cars, Speeds Less Than 45 mph, or 72 kph
Route 101	1046	10
Route 41	470	3
Route 119	86	0
Route 126	122	3
Totals	1724	16

Speeds of Trucks Which Were the First Vehicles of Groups of Three or More Vehicles

This data was for trucks which were the first vehicles of groups of three or more vehicles.

Locations	Vehicles	Time Mean Speeds mph	kph
Route 101	47	55	88
Route 41	20	55	88
Route 119	22	56	90
Route 126	34	52	83

The truck data for Route 119 included one truck with a trailer.

Locations	Vehicles	Trucks, Speeds Less Than 45 mph, or 72 kph
Route 101	47	2
Route 41	20	1
Route 119	22	1
Route 126	34	1
Totals	123	5

Speeds of Truck Combinations Which Were the First Vehicles of Groups of Three or More Vehicles

This data was for truck combinations which were the first vehicles of groups of three or more vehicles.

Locations	Vehicles	Time Mean Speeds mph	kph
Route 101	80	56	90
Route 41	10	49	78
Route 119	16	54	87
Route 126	52	53	86

Locations	Vehicles	Truck Combinations, Speeds Less Than 45 mph, or 72 kph
Route 101	80	0
Route 41	10	2
Route 119	16	0
Route 126	52	3
Totals	158	5

Speeds of RV's Which Were the First Vehicles of Groups of Three or More Vehicles

This data was for RV's which were the first vehicles of groups of three or more vehicles.

Locations	Vehicles	Time Mean Speeds mph	kph
Route 101	239	53	85
Route 41	77	53	85
Route 119	11	56	90

There were not many RV's at the Route 126 location.

Locations	Vehicles	RV's, Speeds Less Than 45 mph, or 72 kph
Route 101	239	10
Route 41	77	5
Route 119	11	0
Totals	327	15

Passes of the First Vehicles of Groups of Three or More Vehicles

The following data was for the first passes of the first vehicles of groups of three or more vehicles. The distances were from the beginning of the dash stripes.

Route 101

0'-500'	0-152.4m	145
600'-1000'	182.88-304.8m	335
1100'-1500'	335.28-457.2m	247
1600'-2000'	487.68-609.6m	142
Total		869

Route 41

0'-500'	0-152.4m	36
600'-1000'	182.88-304.8m	104
1100'-1500'	335.28-457.2m	106
1600'-2000'	487.68-609.6m	89
Total		235

Route 119

0'-500'	0-152.4m	34
600'-1000'	182.88-304.8m	28
1100'-1500'	335.28-457.2m	20
1600'-2000'	487.68-609.6m	18
Total		100

Route 33

0'-500'	0-152.4m	3
600'-1000'	182.88-304.8m	4
1100'-1500'	335.28-457.2m	8
1600'-2000'	487.68-609.6m	0
Total		15

Route 126

0'-500'	0-152.4m	64
600'-1000'	182.88-304.8m	51
1100'-1500'	335.28-457.2m	32
1600'-2000'	487.68-609.6m	28
Total		175

The following data was for the total passes of the first vehicles of groups of three or more vehicles.

Route 101

0'-500'	0-152.4m	147
600'-1000'	182.88-304.8m	437
1100'-1500'	335.28-457.2m	443
1600'-2000'	487.68-609.6m	377
Total		1404

Route 41

0'-500'	0-152.4m	41
600'-1000'	182.88-304.8m	128
1100'-1500'	335.28-457.2m	197
1600'-2000'	487.68-609.6m	218
Total		584

Route 119

0'-500'	0-152.4m	35
600'-1000'	182.88-304.8m	55
1100'-1500'	335.28-457.2m	48
1600'-2000'	487.68-609.6m	69
Total		207

Route 33

0'-500'	0-152.4m	3
600'-1000'	182.88-304.8m	7
1100'-1500'	335.28-457.2m	10
1600'-2000'	487.68-609.6m	7
Total		27

Route 126

0'-500'	0-152.4m	70
600'-1000'	182.88-304.8m	77
1100'-1500'	335.28-457.2m	86
1600'-2000'	487.68-609.6m	74
Total		307

Average Distances for Certain Passes

The data was for the average distances for certain passes. The groups were groups of three or more vehicles.

All groups, average distances for first passes within 2000', or 609.6m, of the beginning of the passing lanes, excluding groups with no passing.

Route	Numbers of Groups	Distances
101	869	1044' 318m
41	334	1130' 344m
119	100	977' 298m
33	15	1067' 325m
126	178	854' 260m

At the Route 101 location the 50th percentile distance for groups with the first vehicles trucks was about 900' and the average was 1050'. There were 34 trucks which were the first vehicles of groups of three or more vehicles and which were passed. For the 51 such truck combinations the 50th percentile distance was about 1350' and the average distance was 1334'. These distances are 274m, 320m, 411m and 407m.

The average distance for the first passes of truck combinations was 870', or 265m, at the Route 126 location.

Groups, first vehicle a car, average distances for first passes within 2000', or 609.6m, of the beginning of the passing lanes, excluding groups with no passing.

Route	Numbers of Groups	Distances
101	588	986' 300m
41	246	1104' 337m
119	56	880' 268m
33	10	1090' 332m
126	78	877' 267m

All groups, average distances for second passes within 2000', or 609.6m, of the beginning of the passing lanes, excluding groups with no second passes.

Route	Numbers of Groups	Distances
101	381	1423' 434m
41	160	1449' 442m
119	66	1356' 413m
33	10	1550' 472m
126	106	1204' 367m

Groups, first vehicle a car, average distances for second passes within 2000', or 609.6m, of the beginning of the passing lanes, excluding groups with no second passes.

Route	Numbers of Groups	Distances
101	241	1379' 420m
41	105	1447' 441m
119	36	1264' 385m
33	7	1586' 483m
126	36	1314' 400m

Percentile Data Regarding Locations Where Passes Occurred

The following data regarding where passing occurred was only for when there were a total of at least 15 groups. However, it does not include all data for when there were a total of at least 15 groups. For example, it does not include data regarding the fourth passes of the first vehicles.

Percentile data regarding locations where the first passes of the first vehicles of groups of three or more vehicles occurred, first vehicles cars, passes beyond 2000', or 609.6m, not included.

	Routes				
Distances	101	41	119	33	126
0' 0m	0	0	0	0	3
500' 152.4m	10	6	29	12	21
1000' 304.8m	30	23	45	29	31
1500' 457.2m	43	38	55	59	39
2000' 609.6m	50	52	65	59	51
First Passes	588	246	56	10	78
Total Number of Groups	1179	470	86	17	154

Percentile data regarding locations where the second passes of the first vehicles of groups of three or more vehicles occurred, first vehicles cars, passes beyond 2000', or 609.6m, not included.

	Routes				
Distances	101	41	119	33	126
0' 0m	0	0	0	0	0
500' 152.4m	0	1	2	0	2
1000' 304.8m	6	4	20	6	8
1500' 457.2m	13	13	28	18	16
2000' 609.6m	20	22	42	41	23
Second Passes	241	105	36	7	36
Total Number of Groups	1179	470	86	17	154

Percentile data regarding locations where the third passes of the first vehicles of groups of four or more vehicles occurred, first vehicles cars, passes beyond 2000', or 609.6m, not included.

	Routes			
Distances	101	41	119	126
0' 0m	0	0	0	0
500' 152.4m	0	0	0	0
1000' 304.8m	1	0	9	2
1500' 457.2m	4	4	17	2
2000' 609.6m	7	12	34	8
Third Passes	58	35	16	7
Total Number of Groups	838	296	47	84

Percentile data regarding locations where the first passes of the first vehicles of groups of three or more vehicles occurred, first vehicles trucks, passes beyond 2000', or 609.6m, not included.

	Routes			
Distances	101	41	119	126
0' 0m	0	0	0	2
500' 152.4m	12	5	23	33
1000' 304.8m	40	10	45	65
1500' 457.2m	56	35	64	81
2000' 609.6m	68	60	82	88
First Passes	34	12	18	38
Total Number of Groups	50	20	22	43

Percentile data regarding locations where the second passes of the first vehicles of groups of three or more vehicles occurred, first vehicles trucks, passes beyond 2000', or 609.6m, not included.

	Routes			
Distances	101	41	119	126
0' 0m	0	0	0	0
500' 152.4m	0	0	0	5
1000' 304.8m	10	5	9	26
1500' 457.2m	26	25	36	56
2000' 609.6m	44	30	64	65
Second Passes	22	6	14	28
Total Number of Groups	50	20	22	43

Percentile data regarding locations where the first passes of the first vehicles of groups of three or more vehicles occurred, first vehicles truck combinations, passes beyond 2000', or 609.6m, not included.

		Routes	
Distances	101	119	126
0' 0m	0	0	0
500' 152.4m	1	6	18
1000' 304.8m	20	38	50
1500' 457.2m	39	69	64
2000' 609.6m	61	94	71
First Passes	53	15	47
Total Number of Groups	87	16	66

Percentile data regarding locations where the second passes of the first vehicles of groups of three or more vehicles occurred, first vehicles truck combinations, passes beyond 2000', or 609.6m, not included.

		Routes	
Distances	101	119	126
0' 0m	0	0	0
500' 152.4m	0	0	0
1000' 304.8m	3	19	5
1500' 457.2m	14	44	32
2000' 609.6m	29	50	42
Second Passes	25	8	28
Total Number of Groups	87	16	66

Percentile data regarding locations where the first passes of the first vehicles of groups of three or more vehicles occurred, first vehicles RV's, passes beyond 2000', or 609.6m, not included.

		Routes	
Distances	101	41	126
0' 0m	0	0	7
500' 152.4m	6	8	27
1000' 304.8m	35	38	47
1500' 457.2m	60	66	73
2000' 609.6m	74	87	87
First Passes	194	67	13
Total Number of Groups	262	77	15

Percentile data regarding locations where the second passes of the first vehicles of groups of three or more vehicles occurred, first vehicles RV's, passes beyond 2000', or 609.6m, not included.

	Routes		
Distances	101	41	126
0' 0m	0	0	0
500' 152.4m	0	1	0
1000' 304.8m	7	9	7
1500' 457.2m	19	30	27
2000' 609.6m	35	57	47
Second Passes	92	44	7
Total Number of Groups	262	77	15

Percentile data regarding locations where the third passes of the first vehicles of groups of four or more vehicles occurred, first vehicles RV's, passes beyond 2000', or 609.6m, not included.

	Routes	
Distances	101	41
0' 0m	0	0
500' 152.4m	0	0
1000' 304.8m	0	5
1500' 457.2m	8	11
2000' 609.6m	15	31
Third Passes	32	20
Total Number of Groups	207	65

First passes of the first vehicles of groups of three or more vehicles, first vehicles cars, passes beyond 2000', or 609.6m, not included.

Distances	Number of First Passes Route 101	Route 41	Route 119	Route 126
0' 0m	0	0	0	5
100' 30m	1	0	0	13
200' 61m	6	0	7	17
300' 91m	21	5	11	21
400' 122m	50	12	17	28
500' 152m	123	29	25	33
600' 183m	195	42	28	38
700' 213m	224	57	29	42
800' 244m	265	76	31	43
900' 274m	307	86	33	45
1000' 305m	352	107	39	47
1100' 335m	388	117	39	50
1200' 366m	410	136	40	50
1300' 396m	438	158	44	53
1400' 427m	476	164	45	54
1500' 457m	509	179	47	60
1600' 488m	526	186	47	65
1700' 518m	539	210	48	69
1800' 549m	554	227	48	69
1900' 579m	580	236	49	74
2000' 610m	588	246	56	78

Percentiles, first passes of the first vehicles of groups of three or more vehicles, first vehicles cars, passes beyond 2000', or 609.6m, not included.

Distances	Route 101	Route 41	Route 119	Route 126
0' 0m	0	0	0	6
100' 30m	0	0	0	17
200' 61m	1	0	13	22
300' 91m	4	2	20	27
400' 122m	9	5	30	36
500' 152m	21	12	45	42
600' 183m	33	17	50	49
700' 213m	38	23	52	54
800' 244m	45	31	55	55
900' 274m	52	35	59	58
1000' 305m	60	43	70	60
1100' 335m	66	48	70	64

1200' 366m	70	55	71	64
1300' 396m	74	64	79	68
1400' 427m	81	67	80	69
1500' 457m	87	73	84	77
1600' 488m	89	76	84	83
1700' 518m	92	85	86	88
1800' 549m	94	92	86	88
1900' 579m	99	96	88	95
2000' 610m	100	100	100	100
Approximate 85th Percentile Distances	1500'	1700'	1700'	1600'

Data Regarding the Passing Lane Areas

Profiles

The profile elevations are from the plans. Actual elevations would, of course, vary slightly.

Profile, Route 101

The plans do not include exact vertical and horizontal profile data.

Postmile 14.619 is at 206 +19. This was approximately photolog mile 14.60.

Postmile 15.937 is at 275 + 78. This was approximately photolog mile 15.975.

Approximate Location		Approximate Elevation
177 + 00		523'
	+ 0.134%	
196 + 10, BVC		526'
202 + 10, EVC		526'
	0.00%	
209 + 70, BVC		526'
219 + 70, EVC		556'
	+ 6.00%	
231 + 20, BVC		625'
242 + 20, EVC		627.5'
	- 5.641%	

The elevation of the summit is approximately 642'.

Grades, Route 101

The total profile elevation difference along 3500', or about 1067m, prior to the beginning of the dash stripe between lanes 1 and 2 is about +5', or about +1.5m.

The distances are from the beginning of the dash stripe between lanes 1 and 2.

Approximate Distances	Approximate Grades	Approximate Elevations
0' 0m		528'
	+2.8%	
500' 152.4m		542'
	+5.6%	
1000' 304.8m		570'
	+6.0%	
1500' 457.2m		600'
	+5.8%	
2000' 609.6m		629'

The average grade from the beginning of the dash stripe to the 1500', or 457.2m, location is approximately +4.80 percent.

The average grade along the 2000', or 609.6m, is approximately +5.05 percent.

Geometrics, Route 101

The diverge taper was about 370', or about 113m.

The dash stripe between lanes 1 and 2 was from approximately Postmile 14.73 to approximately Postmile 15.60. Postmile 14.73 is at approximately 212 + 00.

Passing locations prior to the passing lane, Route 101

There is a NB passing lane prior to this location. The approximate limits of the dash stripe between lanes 1 and 2 were photolog mile 13.38 to photolog mile 13.97.

Passing was legal NB from approximately photolog mile 14.02 to approximately pholoog mile 14.60.

Profile, Route 41

The photolog miles were approximately the same as the postmiles. However, the Postmile 21.00 marker is approximately 0.03 mile norh of the actual location of Postmile 21.00. This data is for actual postmiles, not the locations of the markers.

Postmile 21.95 is at approximately 124 + 70. This is probably accurate to about 1' to about 17'.

Postmile 21.03 is at approximately 76 + 12.

Approximate Location		Elevation
57 + 60		1259.03
	+2.12%	
76 + 12		1298.29
78 + 70, BVC		1303.76
81 + 12		1309.84
86 + 12		1328.39
90 + 70, EVC		1352.48
	+6.00%	
91 + 12		1355.00
95 + 00, BVC		1378.28
96 + 12		1384.60
103 + 00, EVC		1405.76
	+0.87%	

Grades, Route 41

The total profile elevation difference along approximately 1852', or about 564m, prior to the beginning of the dash stripe between lanes 1 and 2 is about +39', or about +11.9m.

The distances are from the beginning of the dash stripe between lanes 1 and 2.

Approximate Distances	Approximate Grades	Elevations
0' 0m		1298.29
	+2.3%	
500' 152.4m		1309.84
	+3.7%	
1000' 304.8m		1328.39
	+5.3%	
1500' 457.2m		1355.00
	+5.9%	
2000' 609.6m		1384.60

The average grade from the beginning of the dash stripe to the 1500', or 457.2m, location an approximately +3.78 percent.

The average grade along the 2000', or 609.6m, is approximately +4.32 percent.

Geometrics, Route 41

The diverge taper was about 600', or about 183m.

The dash stripe between lanes 1 and 2 was from approximately Postmile 21.03 to approximately Postmile 21.45. Postmile 21.03 is at approximately 76 + 12.

Passing locations prior to the passing lane, Route 41

There is one NB through lane along the three miles, or about 4.8km, prior to this location. There are many areas where vehicles may pass.

Profile, Route 119

Photolog mile 11.00 was very near Postmile Marker R11.00. The postmile data on the plans is different than the postmile markers. The approximate location of the center of an intersection is about R11.93 on the plans. However, it is about 0.975 mile beyond Postmile Marker R11.00.

For this report photolog mile 11.975 is equal to Postmile R11.975 which is at approximately 673 + 30.

Location		Elevation
651 + 39, EVC		522.91
	+0.12%	
657 + 00, BVC		523.58
665 + 00, EVC		535.58
	+2.88%	
671 + 26.3, BVC		553.62
702 + 26.3, EVC		523.86
	-4.80%	

The elevation of the summit is approximately 570'.

Grades, Route 119

The total profile elevation difference along approximately 1923', or 586m, prior to the beginning of the dash stripe between lanes 1 and 2 is about +8', or about +2.4m.

The distances are from the beginning of the dash stripe between lanes 1 and 2.

Approximate Distances	Approximate Grades	Elevations
0' 0m		523.42
	+0.57%	
500' 152.4m		526.27
	+2.22%	
1000' 304.8m		537.37
	+2.88%	
1500' 457.2m		551.77
	+2.41%	
2000' 609.6m		563.82

The average grade from the beginning of the dash stripe to the 1500', or 457.2m, location is approximately +1.89 percent.

The average grade along the 2000', or 609.6m, is approximately +2.02 percent.

Geometrics, Route 119

The diverge taper to the beginning of the dash stripe between lanes 1 and 2 was about 420', or about 128m.

The dash stripe between lanes 1 and 2 was from approximately Postmile R11.64 to approximately Postmile R12.39. Postmile R11.64 is at approximately 655 + 62.

Passing locations prior to the passing lane, Route 119

There is one EB through lane along the three miles, or about 4.8km, prior to this location. Passing was legal along most of the three miles, or about 4.8km.

Profile, Route 33

Photolog mile 16.49 was at approximately Postmile Marker 16.50. However, Postmile Marker 16.50 is not at the actual location of Postmile 16.50.

There is a railroad at Postmile 17.730. It is about 460' beyond 289 +77. The beginning of the dash stripe between lanes 1 and 2 was at photolog mile 15.66. This is 2.10 mile, minus approximately 15', from the railroad. The beginning of the dash stripe was at approximately 183 +64. The 2000' location from the beginning of the dash stripe was at approximately 163 +64.

Location		Elevation
	+3.07%	
155 + 50, BVC		897.57
164 + 50, EVC		911.03
	-0.08%	
175 + 50, BVC		910.15
179 + 50, EVC		910.61
	+0.31%	
186 + 50, BVC		912.78
193 + 50, EVC		926.54
	+3.62%	

There is a summit at an elevation of about 1033' near 270 + 00.

Grades, Route 33

The total profile elevation differences along approximately 986', or about 301m, prior to the beginning of the dash stripe between lanes 1 and 2 was about -15', or about -4.6m.

The distances are from the beginning of the dash stripe between lanes 1 and 2.

Approximate Distances	Approximate Grades	Elevations
0' 0m		911.89
	-0.3%	
500' 152.4m		910.38
	0.0%	
1000' 304.8m		910.30
	+0.1%	
1500' 457.2m		910.70
	+0.1%	
2000' 609.6m		910.97

The average grade from the beginning of the dash stripe to the 1500', or 457.2m, location is approximately -0.08 percent.

The average grade along the 2000', or 609.6m, is approximately -0.05 percent.

Geometrics, Route 33

The beginning of the diverge taper to the beginning of the dash stripe between lanes 1 and 2 was about 200', or about 61m.

The dash stripe between lanes 1 and 2 was from approximately photolog mile 15.66 to approximately photolog mile 15. 215.

Passing locations prior to the passing lane, Route 33

There was a SB photolog mile revision of 0.08 mile near Postmile 16.51. The sequence was 16.60, than 16.51.

There are two SB lanes at a town from about photolog miles 19.49 to 18.43. Passing was than not legal to about photolog mile 17.66, was legal to about 17.25, and was not legal to the beginning of a passing lane. The dash stripe between lanes 1 and 2 was from about photolog miles 17.06 to 16.50. Passing was then not legal to the beginning of the next passing lane at approximately photolog mile 15.66.

Profile, Route 126

There is a railroad about 15' east of photolog mile 22.46. The railroad is at about 28 + 43.

There is an equation. Location 63 + 90.62, west, is at the same location as 64 + 04.54, east.

The beginning of the dash stripe between lanes 1 and 2 was about 12' beyond photolog mile 23.78. The beginning of the dash stripe was at approximately 98 + 24. This is probably accurate to less than 25'.

The postmile markers at this area are probably not accurate. Postmile Marker 23.86 was approximately adjacent to where the stripe began. However, photolog mile 23.95 was approximately adjacent to Postmile Marker 24.00.

Location		Elevation
	-0.618%	
96 + 00, BVC		526.65
102 + 00, EVC		531.49
	+2.233%	
105 + 50, BVC		539.31
115 + 50, EVC		575.82
	+5.07%	
117 + 00, BVC		583.43
138 + 00, EVC		599.81
	-3.51%	

The profile elevation at 65 + 00 is 481.17. At 74 + 75 the profile elevation is 499.03. At 85 + 00 the profile elevation is 520.96.

The summit is at 129 + 40.91. The approximate elevation is 615'.

Grades, Route 126

The total profile elevation differences along approximately 1324', or about 404m, prior to the beginning of the dash stripe between lanes 1 and 2 is about +5.5', or about +1.7m.

The distances are from the beginning of the dash stripe between lanes 1 and 2.

Approximate Distances	Approximate Grades	Elevations
0' 0m		526.46
	+1.6%	
500' 152.4m		534.26
	+2.4%	
1000' 304.8m		546.49
	+3.7%	
1500' 457.2m		565.09
	+4.9%	
2000' 609.6m		589.40

The average grade from the beginning of the dash stripe to the 1500', or 457.2m, location is approximately +2.58 percent.

The average grade along the 2000', or 609.6m, is approximately +3.15 percent.

Geometrics, Route 126

The beginning of the diverge taper to the beginning of the dash stripe between lanes 1 and 2 was about 655', or about 200m.

The dash stripe between lanes 1 and 2 was from approximately 12' beyond photolog mile 23.78 to approximately photolog mile 24.36.

Passing location prior to the passing lane, Route 126

There are two EB lanes at a town from about photolog miles 21.06 to 22.50. Passing was not legal from there to the beginning of the passing lane.

Distances

There are postmile markers along most California state highways. The locations of the markers are usually, though not always, not accurate enough for traffic operational research. There is also published postmile data. This published data is usually adequate accurate.

Photolog miles are the mile numbers on the photolog. The distance interval is 0.01 mile.

There are plans for the routes at and near the areas when the five passing lanes are located.

The accuracy is adequate. For example, Route 126 crosses a railroad at approximately 28 + 43. This is about 15' beyond photolog mile 22.46. The distances from the plans from this railroad to three culverts, a driveway and another culvert were 8' less, 12' less, 14' more, 25' less and 5' more than the photolog distances. The last location was a culvert which is more than two miles from the railroad.