

# Comparison of Travel Behavior Before and After the Opening of HOV Lanes in a Suburban Travel Corridor

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Budgetary constraints coupled with the rapidly evolving urban infrastructure of southern California have created major problems for local transportation agencies in maintaining up-to-date travel data bases. In an effort to rectify data base deficiencies, local agencies have sought more innovative and cost-effective approaches to collect needed data. The Orange County Transit District and the California Department of Transportation have applied a survey methodology of corridor travel levels in Orange County that uses video cameras to photograph license plate numbers of travelers. The owners of the vehicles are then sent mailback postcard surveys to obtain information on their trip making. Responses are analyzed anonymously for use in commuter market studies, transit service plans, and travel demand models. Three corridors in Orange County have been surveyed to date using this technique. A follow-up survey was performed in one of the travel corridors 2 years later at the same location to allow for a detailed time series study of changes in travel behavior before and after the opening of carpool lanes in that corridor. The 1987 follow-up survey recorded some significant changes in corridor travel characteristics from the 1985 statistics for the morning peak period. The analysis of the results of the before and after surveys indicated that the facility with the median carpool lanes in operation had become more heavily used by home-to-work commuters during the morning peak period and more efficient at moving people rather than just vehicles. The data bases collected using this approach have been sizable (6,200 or more records), ensuring high statistical reliability in comparing the characteristics of small subsets of respondents, such as carpoolers commuting to work during the morning peak. The technique affords a high degree of control by location and time thereby allowing for detailed analyses of travel patterns. The four video postcard surveys conducted to date have not been disruptive to traffic, have experienced a high return rate, and have proved to be cost-effective at obtaining large-scale and accurate travel data.

Over the past 20 years, Los Angeles and Orange counties consistently have been among the fastest growing counties in the United States in terms of both population and employment. For example, over one-half million additional persons took up residence in Orange County between 1970 and 1980, a 36 percent increase in population. In addition, nearby Riverside and San Bernardino counties recently have experienced rapid residential growth as southern Californians search for more affordable housing and living space.

The rapidly evolving southern California urban infrastructure has not only created an overall increase in travel demand, but progressively more complex travel patterns as a result of the rapid rise of intercounty commuting from Riverside and San Bernardino counties to Los Angeles and to numerous emerging suburban activity/employment centers in Orange County.

The rapidly evolving travel demands in southern California coupled with budgetary constraints have created major problems for local transportation agencies in terms of maintaining up-to-date travel data bases suitable for analyzing commuter markets, developing commuter service plans, and validating travel demand models. For example, transportation agencies have developed programs to build facilities to meet increased demand, such as Orange County's program for the construction of a 70-mi system of transitways and commuter (carpool) lanes in five major freeway corridors. (Transitways [busways] are barrier-separated, limited-access facilities reserved for buses, vanpools, and carpools located in the median of freeways. Carpool lanes are high-occupancy-vehicle [HOV] lanes with no physical barrier from general purpose freeway lanes.) However, little empirical data exist in southern California to validate travel models used to forecast changes in travel behavior related to the opening of exclusive HOV facilities. Therefore, local agencies lack the ability to predict facility use and effectiveness.

In an effort to rectify these data base deficiencies, local transportation agencies have begun to dedicate more resources to collecting travel data and have sought more innovative and cost-effective approaches to collect needed data. One approach that the California Department of Transportation (Caltrans) and the Orange County Transit District (OCTD) have developed to conduct corridor travel surveys incorporates the latest video technology to record license plate numbers of vehicles at a given freeway cutline location. The plate numbers are then entered on computer tape and transmitted to the California Department of Motor Vehicles (DMV), which, in turn, provides the names and addresses that correspond to the plate numbers. Participating agencies then have a comprehensive list of travelers who have passed a particular location in a given travel corridor during a specific time period. A sample of corridor users is then surveyed anonymously by means of a postcard mailback technique or by telephone, or both.

This survey technique was first applied successfully in 1984 when Caltrans conducted a postcard mailback survey of users of the San Diego Freeway in Orange County and the San

Bernardino Freeway/El Monte Busway in Los Angeles County. Since that time, the survey technique has been refined and applied on four separate occasions in Orange County travel corridors that are programmed for future transitways or commuter lanes (see Figure 1). Three additional corridor travel surveys are planned for 1988 and beyond to provide additional data bases to achieve the following objectives:

- To examine the effects of commuter lanes on corridor level and systemwide origin/destination patterns, vehicle occupancy, and overall travel behavior for use in conducting commuter market studies, developing transit service plans, and validating travel demand models;
- To examine the potential for shared ride modes on selected travel corridors to major destinations in the Los Angeles and Orange counties region; and
- To conduct time series studies of changes in travel patterns and characteristics both on a corridor level and systemwide level, particularly before and after the introduction of facility upgrades, such as the opening of new HOV facilities or additional general purpose freeway lanes.

The first opportunity to conduct a time series before-and-after study occurred when commuter lanes were opened in the median of the Costa Mesa Freeway (CA-55) in November 1985. CA-55 is a heavily congested, undersized facility running north-south in Orange County that carries a high percentage of long-distance intercounty commute trips that originate in Riverside and San Bernardino counties and terminate at various Orange County activity/employment centers. The commuter lanes are approximately 12 mi in length and save carpoolers 15 to 20 min in their commute to work on a normal weekday. Within 6 months of opening, the volumes of two-person-plus carpools per lane on the lanes had grown to 1,200 to 1,400 carpools per lane per hour during the peak periods of the day.

In May 1985, before the construction and opening of the CA-55 commuter lanes, a video camera cutline survey was conducted on the southbound lanes of CA-55 to examine commuter travel characteristics before the introduction of the commuter lanes. This study, which included a postcard mailback survey and a follow-up telephone survey, was a cooperative technical effort by OCTD, Caltrans, the Orange County Transportation Commission (OCTC), the Southern California Association of Governments (SCAG), and the Orange County Environmental Management Agency and involved collecting, analyzing, and reporting information on current users' travel paths and attitudes toward commuter lanes.

In May 1987, 18 months after the opening of the commuter lanes, the agencies conducted a follow-up study consisting of both a postcard mailback and a telephone survey. The CA-55 postcard mailback survey collected data on basic travel characteristics, whereas the telephone survey (not covered in this paper) sought more in-depth information on travel behavior and daily trip making.

## SURVEY METHODOLOGY

The 1985 and 1987 video camera surveys were performed in an identical manner, at the same location on CA-55, on the

same day of the week (Tuesday), and over the same time period to ensure consistency for comparison of data bases. The 1985 and 1987 postcard mailback surveys were identical in methodology and scope. The follow-up survey in 1987 was expanded to differentiate between users of the three southbound general traffic freeway lanes and of the parallel commuter lane. Also, the 1987 survey included a second group of cameras shooting from a more southerly overpass on CA-55 to better analyze traffic flow south of an interchange with the Santa Ana Freeway (I-5), the major north-south freeway in Orange County. The sequence of survey steps was as follows:

1. The videotaping of license plates took place on May 5, 1987, between the hours of 6:30 a.m. and 7:30 p.m., the envelope of daylight hours suitable for photography. Five high-speed video cameras were positioned on the La Veta Avenue overpass and were focused to pick up the rear plate numbers of southbound traffic in each of the three general traffic lanes, the commuter lane, and one of the transition lanes from southbound CA-55 to westbound CA-22. To provide total traffic counts for determining the overall survey sample size, one wide-angle-lens camera recorded all activity at this location and 24-hr traffic counts were recorded at a Caltrans count station north of La Veta Avenue.

2. Two cameras were placed on the more southerly McFadden Street overpass, one viewing the southbound CA-55 commuter lane, while a second camera was rotated on an hourly basis among the three southbound general traffic lanes at this location. These provided a sample of freeway users for the follow-up telephone survey to be conducted by the OCTC.

3. License plate numbers were read from the videotapes and entered onto computer tape, with out-of-state and heavy-duty commercial-vehicle license plate numbers deleted from the survey. Only a 50 percent sample of plate numbers was entered during the midday hours (9:00 a.m. to 3:00 p.m.).

4. By using the license plate data, addresses of registered owners of passenger vehicles recorded on the southbound CA-55 freeway and commuter lane were obtained from the California DMV and printed on labels, which were then affixed to postcard surveys.

5. Postcard surveys requesting the origin, destination, purpose, frequency, and vehicle occupancy for the trip observed were mailed to the registered vehicle owners. There were two versions of the survey, with users of the CA-55 commuter lane asked additional questions on travel mode and trip start time used before the opening of the commuter lanes. A sample of the mailback postcard survey form sent to commuter lane users is shown in Figure 2.

6. The survey returns were coded and key-entered, and tabulations and cross-tabulations of travel data were produced using the Statistical Package for Social Science (SPSS X), Release 2.1.

7. Travel data were analyzed to determine travel characteristics and these were compared to the data base from the 1985 postcard survey to determine changes in travel behavior associated with the different travel conditions before and after the opening of the CA-55 commuter lanes.

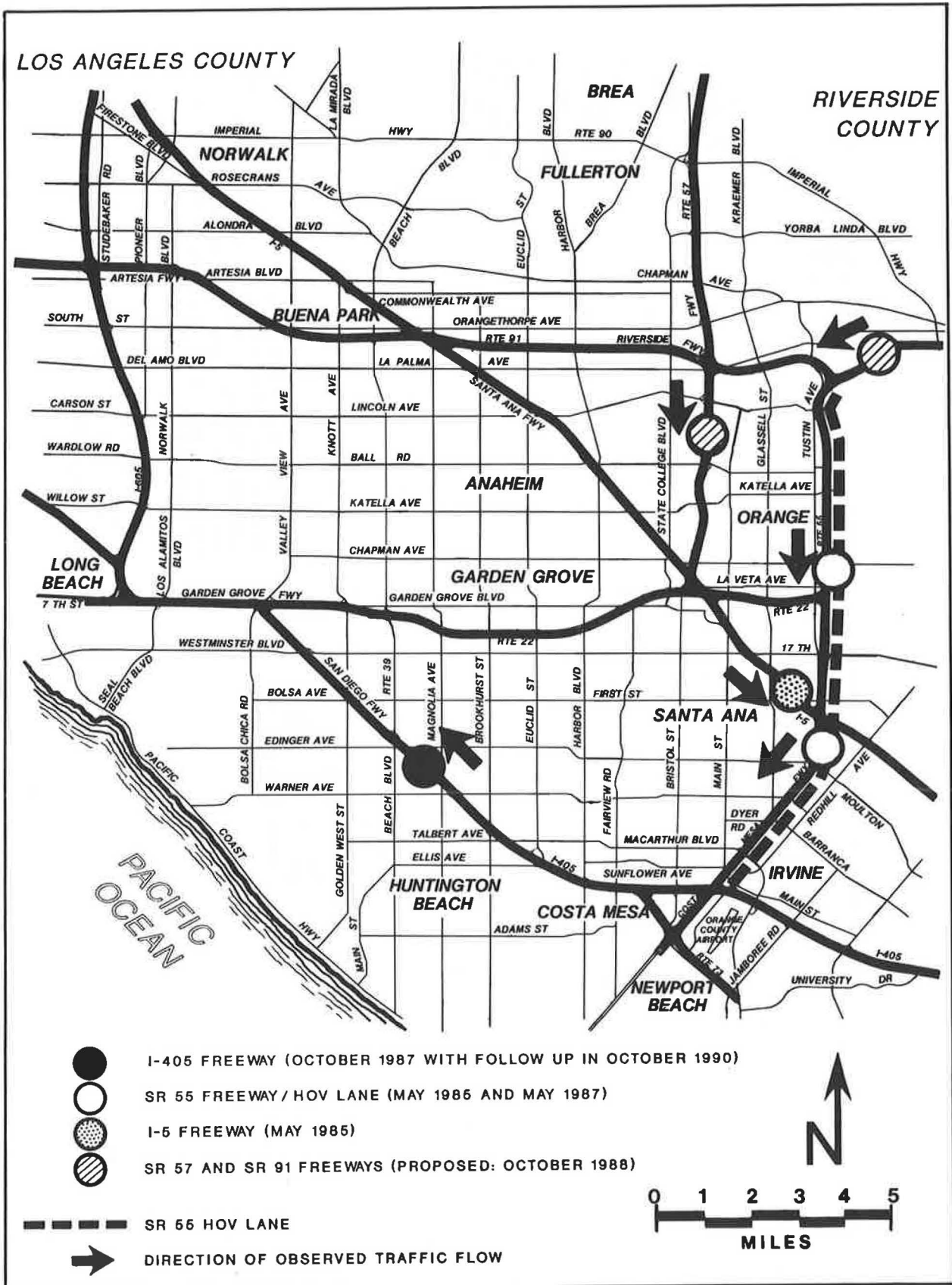

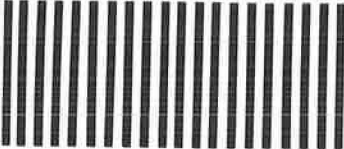


FIGURE 1 Cutline survey sites.

NO POSTAGE  
NECESSARY  
IF MAILED  
IN THE  
UNITED STATES





**BUSINESS REPLY CARD**  
FIRST CLASS PERMIT NO. 41955 LOS ANGELES, CA  
POSTAGE WILL BE PAID BY ADDRESSEE

**STATE DEPARTMENT OF TRANSPORTATION**  
BOX 2304, TERMINAL ANNEX  
LOS ANGELES, CALIFORNIA 90051

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**Cut along dotted line**

**Dear Motorist:**

The California Department of Transportation (Caltrans) is conducting a survey of travelers on Route 55, the Newport-Costa Mesa Freeway, to determine ways to improve travel conditions. If you were traveling on the southbound Route 55 on Tuesday, May 5 would you please take a moment to answer the following questions about that southbound trip and then mail the prepaid postcard to us.

Your response is anonymous; only the general information you provide will be used to assist us in improving service to the traveling public. Your cooperation in participating in the survey is greatly appreciated.

**Thank You.**

(FRONT)

**CALTRANS TRAVEL SURVEY (Route 55)**  
Thank you for completing and returning this postcard.

1. I was driving from: (please check one only)

Home     Work Place  
 Shopping     Work Related (Deliveries, sales, etc.)  
 School     Other (Recreation, personal, etc.)

The place I was driving from is located at:  
City \_\_\_\_\_  
Nearest major cross streets \_\_\_\_\_ & \_\_\_\_\_

1. I started my trip at \_\_\_\_\_ a.m./p.m.

2. I was driving to: (Please check one only)

Home     Work Place  
 Shopping     Work related (Deliveries, sales, etc.)  
 School     Other (Recreation, personal, etc.)

The place I was driving to is located at:  
City \_\_\_\_\_  
Nearest major cross streets \_\_\_\_\_ & \_\_\_\_\_

I arrived at this location at \_\_\_\_\_ a.m./p.m.

3. Including the driver, how many persons were in the vehicle?  
\_\_\_\_\_

4. How often do you make this particular trip on the carpool lane?


More than 5 days a week     5 days a week  
 2-4 days a week     Less than 2 days a week

5. How did you usually make this particular trip before using the carpool lane?

Carpooled on Route 55  
 Carpooled on another route: Which route? \_\_\_\_\_  
 Drove alone on Route 55  
 Drove alone on another route: Which route? \_\_\_\_\_  
 Took public transit  
 Did not make trip

6. Before using the carpool lane, I used to start this trip at \_\_\_\_\_ a.m./p.m.

7. My home ZIP Code is: \_\_\_\_\_



**FIRST CLASS  
U.S. POSTAGE  
PAID  
LOS ANGELES, CA  
PERMIT NO. 32598  
PRE-SORTED**

STATE OF CALIFORNIA  
DEPARTMENT OF TRANSPORTATION  
P.O. Box 2304, Terminal Annex  
Los Angeles, California 90051

(BACK)

**FIGURE 2** Cutline survey form.

TABLE 1 SUMMARY OF 1985 AND 1987 TRAVEL SURVEY STATISTICS

Data Category	1985 AT LA VETA AVE. (a)	1987 AT LA VETA AVE.		1987 AT McFADDEN ST.		1987 Totals
	General Traffic Lanes	General Traffic Lanes	Comm. Lanes	General Traffic Lanes	Comm. Lanes	
Survey Forms Mailed	18,697	30,259	4,272	7,881	3,085	45,497
Survey Forms Returned	6,208	6,546	862	1,271	460	9,139
Survey Response Rate	33.2%	21.6%	20.2%	16.1%	14.9%	20.1%
ADJUSTED CONTROL COUNT (Southbound)	48,945	51,126	7,147	---	---	---
Percent Forms Returned of Control Count	12.7%	12.9%	12.1%	---	---	---

<sup>a</sup>Includes data from four southbound on-ramps (CA 22, McFadden, 17th, and 4th streets).

TABLE 2 COMPARISON OF CA-55 TRAVEL CORRIDOR CHARACTERISTICS BEFORE AND AFTER OPENING OF COMMUTER LANES, FROM RESPONSES TO 1985 AND 1987 TRAVEL SURVEYS OF SOUTHBOUND TRIPS FOR A.M. PEAK PERIOD AT LA VETA

	May 1985 Survey: 6 Months Prior to Opening	May 1987 Survey: 18 Months After Opening	Change Relative to 1985
• <b>Morning Peak Survey Returns</b>	2,103	2,504	--
• <b>Total Morning Peak Carpools</b>	332	653	--
• <b>Average Vehicle Occupancy Rate</b>	1.213	1.343	+11%
• <b>Home-to-Work Trips</b>	70%	79%	+13%
• <b>AM Peak Trip Origins</b>			
Orange County	61%	65%	--
Riverside County	29%	25%	--
Other External	10%	10%	--
• <b>Major Destination Cities For All Morning Peak Period Trips</b>			
Santa Ana	26%	20%	--
Irvine	22%	26%	--
Newport Beach	16%	11%	--
Costa Mesa	15%	13%	--
Tustin	11%	10%	--
• <b>Percent Carpools of Total Vehicles</b>	15.8%	26.1%	+65%
<b>By Origin County:</b>			
Orange County	13%	20%	+54%
Riverside County	23%	35%	+52%
San Bernardino County	17%	39%	+129%
Los Angeles County	16%	45%	+181%

## SURVEY STATISTICS

Table 1 summarizes the basic statistics of the 1985 and 1987 cutline travel surveys on southbound CA-55. The overall response rate for the 1985 survey, which was conducted only during the morning and afternoon peak periods, was 33.2 percent versus 20.1 percent in 1987 for a 13-hr period from 6:30 a.m. to 7:30 p.m. In each case, the survey responses represented slightly over 12 percent of the total southbound traffic flow during survey hours at the La Veta Avenue overpass.

## COMPARISON OF 1985 AND 1987 SURVEY DATA

Table 2 contains a comparison of significant findings from the 1985 and 1987 mailback surveys at the La Veta Avenue location on the southbound CA-55 for the morning peak period (6:30 a.m. to 9:00 a.m.). The 1985 survey recorded 2,103 returns in the morning peak period as compared to 2,504 from the 1987 survey.

As shown in the table, the 1987 survey recorded some significant changes in corridor travel characteristics from 1985 for the morning peak period. The analysis of the results of the before and after surveys indicates that the CA-55 facility with the median commuter lanes in operation is now more heavily used by home-to-work commuters during the morning peak period and is more efficient at moving people rather than just vehicles (i.e., the average vehicle occupancy rate has increased 11 percent). Significant findings from the 1985 and 1987 surveys are described in the following paragraphs.

- *More capacity on freeway lanes is available for Orange County commuters because of the high percentage of external origin carpools in the commuter lane in the morning peak.* Because of a large-scale shift of trips with external origins into carpools that use the commuter lane, an estimated 1,300 more vehicles from Orange County origins are traveling southbound on the CA-55 general traffic freeway lanes in 1987 versus 1985 during the morning peak period. The results of the 1987 survey indicate that the commuter lane has captured a high percentage of the long-distance intercounty commute trips that take up the most miles of freeway lane capacity. Fifty-one percent of the morning peak period commuter lane users surveyed at La Veta Avenue in May 1987 indicated that they began their trips outside of Orange County. This translates into approximately 5,600 persons with external origins being carried in 2,400 carpools on the southbound CA-55 commuter lane during the morning peak period in 1987.

Although these intercounty carpoolers certainly benefit from the travel time savings they gain by using the commuter lane, the shift of these trips into carpools on the commuter lane also greatly benefits Orange County commuters because vehicles are removed from traffic that would otherwise take up capacity over many miles of both CA-55 and CA-91 (Riverside Freeway) during the morning peak period. Survey statistics indicate that the percentage of peak period users on the southbound CA-55 general traffic lanes that reported external origins dropped from 39 to 31 percent from 1985 to 1987.

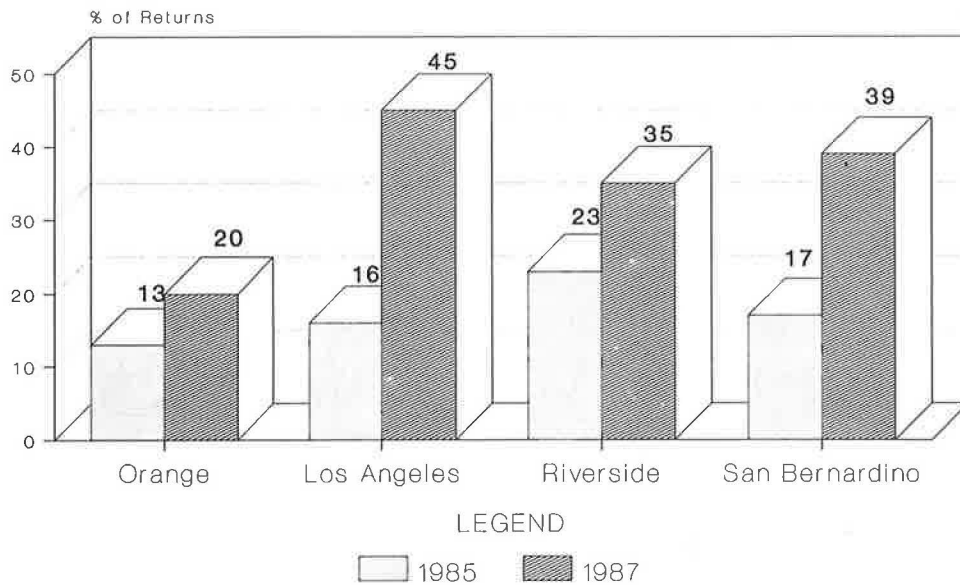
- *More 1987 morning peak period CA-55 commuters with external origins were in carpools than drove alone.* One of the most dramatic changes in travel in the CA-55 corridor between 1985 and 1987 was the 76 percent rate of growth in long-distance intercounty carpools from Riverside, San Bernardino, and Los Angeles counties during the morning peak period. Based on the survey responses, the percentage of total vehicles reported as carpools from these counties grew from 21 to 37 percent from 1985 to 1987.

As shown in Figure 3, carpools as a percent of total vehicles increased from 16 to 45 percent for Los Angeles County, 23 to 35 percent for Riverside County, and from 17 to 39 percent for San Bernardino County, from 1985 to 1987. Carpools from internal origins in Orange County grew from 13 to 20 percent over the same time period. Based on an average occupancy of 2.32 persons per carpool (from the survey responses) in 1987, 58 percent of person-trips with external origins on southbound CA-55 during the morning peak period were carried in carpools, versus 42 percent who drove alone. This compares to only 37 percent of person-trips from Orange County origins traveling in carpools in 1987 on CA-55 during the same time period.

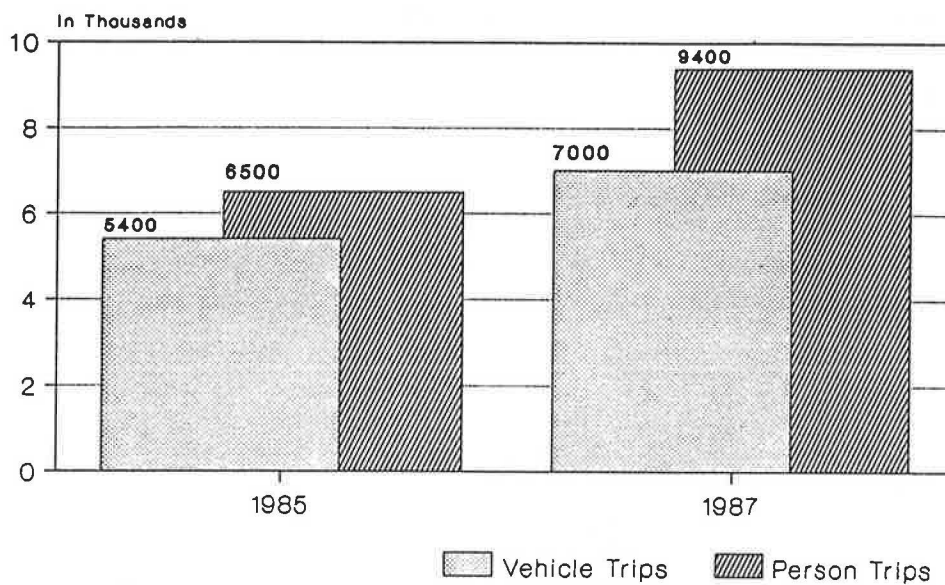
- *Person-trips carried in the CA-55 corridor increased by 45 percent from 1985 to 1987.* The vehicle-carrying capacity of the southbound CA-55 was expanded from three to four lanes with the addition of the commuter lane in late 1985. As shown in Figure 4, the peak usage of the southbound CA-55 grew from 5,400 vehicles per hour to 7,000 vehicles per hour (assuming 1,800 vehicles per hour per lane for a freeway lane and 1,600 for the commuter lane). Based on the survey responses, the average number of people carried per vehicle in the southbound CA-55 corridor during the morning peak period increased from 1.213 persons per vehicle in 1985 before the opening of the commuter lanes to 1.343 in 1987 after the lanes were in operation for 18 months. This 11 percent increase in average corridor vehicle occupancy, coupled with the 30 percent increase in vehicle volumes translates into a 45 percent increase in persons being carried in the corridor during the morning peak hour.

Table 3 shows vehicle occupancy breakdowns and person-trips by mode for a.m. peak period users of the southbound CA-55 freeway and commuter lane for 1985 and 1987. It is interesting to note that although carpools grew by a sizable percentage from 1985 to 1987, the average vehicle occupancy rate for carpools dropped slightly from 1985 to 1987 (2.35 persons per vehicle to 2.32) in the morning peak period. With the CA-55 commuter lanes open to all vehicles with two or more persons, no extra impetus exists for the formation of higher-occupancy carpools in the travel corridor.

- *Morning peak period carpools have more than doubled from 1985 to 1987.* The percent of CA-55 survey respondents reporting that they were in carpools of two or more persons increased dramatically from May 1985 to May 1987. The percent of carpools to total vehicles (general traffic lanes and commuter lane combined) southbound in the morning peak increased from 15.8 percent in 1985 to 26.1 percent in 1987,



**FIGURE 3** Carpools as a percentage of total vehicles for 1985 and 1987, by origin county.



1985 OCCUPANCY RATE: 1.21 1987: 1.34

**FIGURE 4** Comparison of 1985 and 1987 peak-hour vehicle and person-trip throughput on CA-55, southbound at La Veta.

a 65 percent increase. As shown in Figure 5, when growth in peak-period volumes on CA-55 from 1985 to 1987 resulting from the added lane is factored into the calculations, carpool volumes have more than doubled in the morning period (114 percent increase from 1985 to 1987). In addition, the 1987 survey indicated that 45 percent of morning-peak-period person-trips on southbound CA-55 were in carpools versus only 30 percent in 1985.

- *Morning peak period trips originating in Orange County increased from 61 to 65 percent from 1985 to 1987.* Although the CA-55 travel corridor continued to carry a high percentage of intercounty trips in 1987 (31 percent southbound in the

morning peak period), the survey indicated that the percent of trips from Orange County origins grew from 61 to 65 percent from 1985 to 1987 for the freeway lanes and commuter lane combined. The percentage of respondents from Riverside County who indicated that they travel in the morning peak period declined from 29 to 25 percent from 1985 to 1987. However, in absolute numbers, this commuting group actually grew, because the level of overall traffic carried on CA-55 grew by an estimated 30 percent from 1985 to 1987 with the addition of another travel lane in the southbound direction.

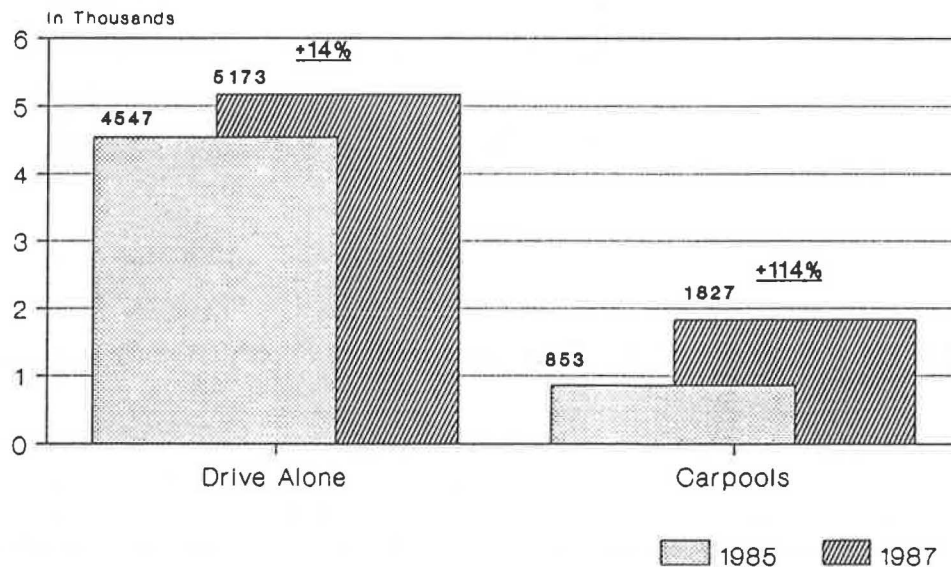
- *Morning peak period person-trips originating in Orange County grew by 49 percent compared to a 35 percent growth*

TABLE 3 COMPARISON OF CARPOOLING IN CA-55 FREEWAY CORRIDOR BEFORE AND AFTER OPENING OF COMMUTER LANES, FROM RESPONSES TO 1985 AND 1987 TRAVEL SURVEYS OF SOUTHBOUND TRIPS FOR A.M. PEAK PERIOD AT LA VETA

	MAY 1985 SURVEY: 6 MONTHS PRIOR TO OPENING				MAY 1987 SURVEY: 18 MONTHS AFTER OPENING			
	Vehicles	%	Persons	%	Vehicles	%	Persons	%
Drove Alone	1,771	84	1,771	70	1,851	74	1,851	55
2 Person Carpools	259	12	518	20	508	20	1,016	30
3+ Person Carpools	73	4	261	10	145	6	497	15
<u>Total Carpools</u>	<u>332</u>	<u>16</u>	<u>779</u>	<u>30</u>	<u>653</u>	<u>26</u>	<u>1,513</u>	<u>45</u>
Total Responses	2,103	100	2,550	100	2,504	100	3,364	100

AVERAGE VEHICLE OCCUPANCY RATE	$\frac{2,550}{2,103} = 1.213$ persons per vehicle	$\frac{3,364}{2,504} = 1.343$ persons per vehicle
AVERAGE VEHICLE OCCUPANCY RATE FOR CARPOOLS	$\frac{518 + 261}{259 + 73} = \frac{779}{332} = 2.35$ persons per carpool	$\frac{1016 + 497}{508 + 145} = \frac{1513}{653} = 2.32$ persons per carpool
PERCENT CARPOOLS OF TOTAL VEHICLES	$\frac{332 \text{ Carpools}}{2,103 \text{ Vehicles}} = 15.8\%$	$\frac{643 \text{ Carpools}}{2,504 \text{ Vehicles}} = 26.1\%$
PERCENTAGE INCREASE IN CARPOOLS OF TOTAL VEHICLES FROM 1985 TO 1987	$\frac{1987 \text{ carpools/vehicles}}{1985 \text{ carpools/vehicles}} = \frac{26.1\%}{15.8\%} = +65\%$	



PERCENT CARPOOLS OF TOTAL VEHICLES  
1985: 15.8% 1987: 26.1%

FIGURE 5 Growth in a.m. peak-hour carpools 1985 to 1987 on CA-55, southbound at La Veta.



for external trips from 1985 to 1987. Based on survey responses, the 45 percent rate of growth in person trips carried on CA-55 southbound in the morning peak from 1985 to 1987 was more heavily oriented toward Orange County residents than residents of Riverside, San Bernardino, and Los Angeles counties, although trips from these counties also grew. The survey indicated that morning peak period trips originating in Orange County grew by 49 percent compared to a 35 percent growth for trips with external origins. Person-trips originating in Riverside County and traveling southbound on CA-55 in the morning peak period were estimated to have grown by 25 percent from 1985 to 1987, even though the relative percentage of survey responses from Riverside declined from 29 to 25 percent. These seemingly contradictory trends for Riverside exist because overall vehicle trips on CA-55 grew by an estimated 30 percent from 1985 to 1987 with the added lane, and survey respondents from Riverside County who indicated they were in carpools increased from 23 to 35 percent in 2 years.

the lanes, and another 5 percent indicated that they carpooled on another route. At first glance, it would appear that the opening of the commuter lanes has had a dramatic impact on travel behavior by influencing many persons who formerly drove alone to carpool. However, caution must be used in interpreting these survey results because 18 months had elapsed since the commuter lanes were opened and some degree of natural turnover in trips occurred during that time. Studies of the duration of individual carpools from around the country indicate that as much as a 50 percent turnover in carpools may occur over an 18-month period.

As the following data show, a slightly higher percentage of journey-to-work CA-55 carpools named carpooling and driving alone as prior modes than did nonwork peak period carpools. Conversely, a much-lower-than-average percentage of morning peak period users of the lanes traveling to work indicated they did not make their trip before the opening of the carpool lanes in November 1985.

Trip Purpose of CA-55 Carpool Lane Users	Formerly Carpooled (%)	Formerly Drove Alone (%)	Did Not Make Trip (%)
Morning peak period—work	35	58	7
Morning peak period—nonwork	31	49	20
Total daily composite	33	56	11

- Morning peak period home-to-work trips increased from 70 to 79 percent. Seventy-nine percent of the morning peak period respondents to the 1987 travel survey reported that they were journeying from home to work versus 70 percent from the 1985 survey. When the 30 percent increase in peak volumes associated with the extra southbound lane is factored into the calculations along with the 11 percent increase in average vehicle occupancy, the CA-55 is now carrying 65 percent more home-to-work person-trips during the morning peak period than in 1985.

**COMPARISON OF USERS OF GENERAL TRAFFIC AND CARPOOL LANES IN 1987**

Table 4 contains some of the significant characteristics of the users of the southbound CA-55 freeway lanes and commuter lane from the 1987 postcard travel survey. Many of these statistics, such as the percentage of work trips in the morning peak and destination cities, closely mirror the overall corridor characteristics presented in the previous section. However, some significant findings about the formation of carpools and differences between users of the commuter lane and the general traffic lanes in areas such as trip origin and trip frequency are discussed in the following paragraphs.

- Sixty-seven percent of carpools in CA-55 corridor did not exist before the opening of the commuter lanes. CA-55 commuter lane users were asked to indicate which mode of travel they used before using the commuter lanes. Fifty-six percent indicated that they previously drove alone, whereas 11 percent reported that they did not make the trip before November 1985. Twenty-eight percent of the commuter-lane users said that they were carpooling on CA-55 before the opening of

- Forty-five percent of commuter-lane users responding to the 1987 survey started their trip outside of Orange County in morning peak period. The southbound CA-55 commuter lanes are carrying a large number of intercounty carpool trips in the morning peak period. Fifty-one percent of the commuter lane users in the morning peak period at the La Veta cutline originated outside of Orange County, compared to 31 percent of the users of the general traffic lanes at La Veta. The more southerly McFadden Street location picked up 32 percent external origins in the commuter lane in the morning peak; however, the percentage of externals passing McFadden might be higher because trips picked up at La Veta were deleted from the McFadden data base. The percentage of morning peak period commuter lane trips with external origins for both locations combined is 45 percent.

- In 1987, the CA-55 commuter lane and general traffic lanes carried approximately the same percent of work trips in the morning peak period. Eighty percent of the CA-55 commuter lane users (La Veta and McFadden locations combined) for the morning peak period indicated that they were traveling to work versus 82 percent of the respondents using the general traffic lanes.

- Eighty-five percent of users of the general traffic lanes in morning peak period commute 5 days per week versus 74 percent on the commuter lane. Respondents on the southbound commuter lane in the morning peak period indicated a lower frequency of use than the respondents using the general traffic lanes. It should be noted that when part-time users of CA-55 (2 to 4 days per week) are added to everyday users, the difference narrows (87 percent commuter lane versus 94 percent for the general traffic lanes).

- The average vehicle occupancy rate in the morning peak period is 2.11 persons per vehicle on the commuter lane versus 1.16 for the general traffic lanes. As reported earlier, the 1987

TABLE 4 COMPARISON OF CA-55 FREEWAY AND COMMUTER LANE USERS' TRIP CHARACTERISTICS FROM MAY 1987 SURVEY OF SOUTHBOUND TRIPS

Survey Characteristics	Users of CA 55 Commuter Lane <sup>(a)</sup>			Users of CA 55 General Traffic Lanes at La Veta
	La Veta Cutline	McFadden Cutline	Total Commuter Lane Carpools	
<b>Survey Returns</b>	862	460	1,322	6,546
<b>Percent Traveling to Work in Morning Peak Period</b>	82%	78%	80%	82%
<b>Origins for Morning Peak Period</b>				
Orange County	49%	68%	55%	69%
Riverside	33%	18%	28%	23%
Los Angeles	8%	8%	8%	3%
San Bernardino	10%	6%	9%	5%
<b>Mode Used Prior to Opening of CA 55 Commuter Lanes</b>				
Carpooled on CA 55	28%	28%	28%	--
Carpooled another route	5%	5%	5%	--
Drove alone	57%	55%	56%	--
Did not make trip	10%	12%	11%	--
<b>Frequency of Usage Per Week for Morning Peak Period</b>				
5 days or more	76%	71%	74%	85%
2-4 days	13%	13%	13%	9%
<b>Vehicle Occupancy Rate in Morning Peak Period</b>	2.16	2.06	2.11	1.16
<b>Trip Duration in Minutes Morning and Afternoon Peak Periods</b>	55.8	--	--	56.0

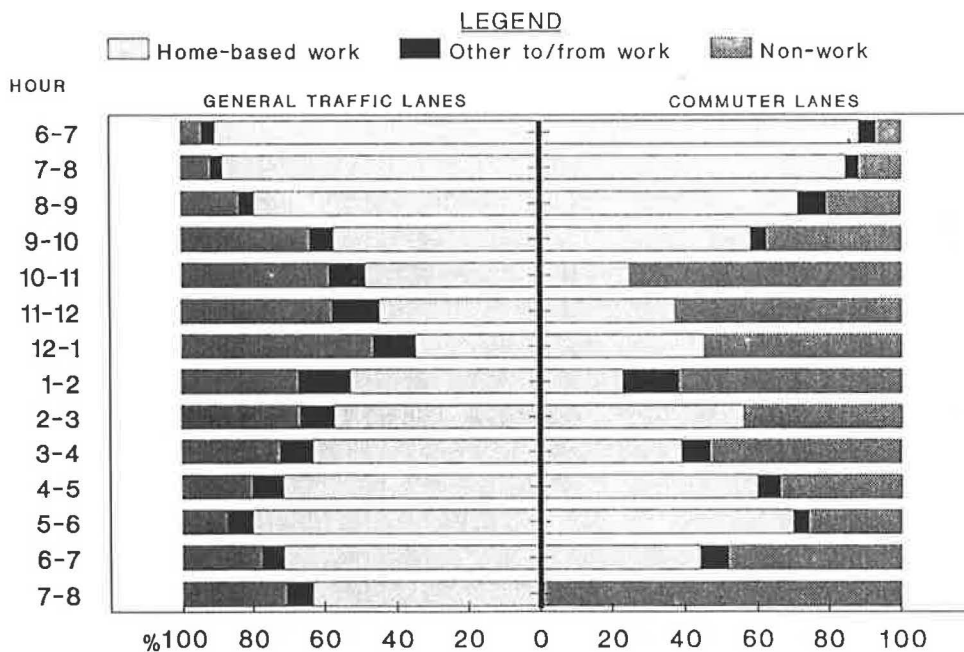
<sup>(a)</sup>License plates recorded at both locations were deleted from the McFadden database.

survey showed the CA-55 travel corridor with an average southbound morning peak period vehicle occupancy rate of 1.34 persons per vehicle. This breaks down to 2.11 persons per vehicle in the southbound CA-55 commuter lane and 1.16 for the southbound general traffic lanes.

- *Trip durations reported for southbound CA-55 commuter lane and general traffic trips were nearly identical.* Respondents to the 1987 travel survey were asked to indicate their trip start and end times. An estimate of trip duration was made from their responses. The computed morning peak period trip durations for users of the freeway and commuter lanes were nearly identical, even though CA-55 commuter lane users travel faster southbound according to Caltrans field surveys. Although analyses of trip length data have not yet been completed, they will probably show longer average trip lengths for carpool lane users, as indicated by the increase in the percent of external origins from 1985 to 1987.

- *Seventy-seven percent of CA-55 commuter-lane users indicated that they now start their trip later (by 10 min or more) than before they started using the commuter lanes.* Carpoolers using the commuter lane were asked to indicate their trip start time before using the commuter lanes as well as their present start time. A comparison of these times indicated that a vast majority—77 percent—of the commuter lane users now start their trip 10 min or more later, presumably because of a faster, less congested commute to work. Only 5 percent of the commuter lane users indicated that they now start their trip earlier, whereas 18 percent indicated little or no change in start time.

- *Home-based work trips predominate in both the a.m. and p.m. peak periods on the CA-55 freeway, but only in the a.m. peak on the southbound commuter lane.* Eighty-six percent of the morning peak period survey respondents on the southbound CA-55 freeway were making a home-based work trip,



**FIGURE 6** 1987 general traffic and commuter lane comparison of trip purpose by hour of day on CA-55.

as were 73 percent of the p.m. peak period freeway users. While 82 percent of the morning peak period carpools on the southbound CA-55 commuter lane reported a home-based work trip, only 57 percent of the p.m. peak period commuter lane users did so. Thus, the CA-55 commuter lanes appear to have a much more pronounced commute directionality than do the parallel freeway lanes. Figure 6 indicates trip purpose by hour for both the southbound freeway and commuter lane.

- *Over one-third of carpools on CA-55 used the general traffic lanes in the morning peak period.* Thirty-six percent of the morning peak period carpools responding to the 1987 CA-55 survey at the La Veta cutline were picked up using the general traffic lanes rather than the commuter lane. This corresponds closely to recent Caltrans CA-55 observations at Walnut and Santa Clara streets, which indicated that 31 to 38 percent of carpools were using the general traffic lanes in the morning peak hour. Carpools not in the commuter lane are possibly in the process of weaving in or out of the commuter lane when recorded or do not use the commuter lane for other reasons. However, short trip length does not appear to be a primary reason because 41 percent of morning peak period carpools using general traffic lanes had origins outside of Orange County as compared to 51 percent external origins for the commuter lane carpools. A lower number of morning peak period carpools in the general traffic lanes were going from home to work (64 percent) than carpools in the commuter lane (75 percent).

**PROS AND CONS OF SURVEY APPROACH**

The corridor cutline survey technique employing high-speed video cameras to photograph license plate numbers has proved to be a relatively effective method for obtaining a large-scale sample of corridor traffic and detailed travel data for southern

California transportation agencies. Thus far, four video-camera/postcard-mailback surveys have been performed in Orange County, all with a relatively high response rate (19 percent or higher) and large number of responses (6,200 or more records). The large number of responses ensures a higher statistical reliability in comparing the characteristics of small subsets of respondents, such as carpools commuting to work in a given peak hour.

The video camera approach also has proven to be a rather cost-effective approach in that large field survey teams, normally required to conduct massive corridor surveys, are replaced by a group of cameras monitored by a field technician. Survey costs have averaged between \$5 and \$10 per return for all categories of costs including camera rental, manpower, postage, mail order house, printing of address labels and postcard surveys, data entry, coding, key entry, computer analysis, and so on.

In addition to cost-effectiveness and large numbers of returns, the video/postcard-mailback-survey approach has other strong points that make it useful for surveying high-volume travel corridors, such as

- *Little disruption to traffic.* When strategically placed, video cameras photographing rear license plates are invisible to the corridor traveler. This allows survey work to progress without traffic disruption, which so often occurs with manually distributed surveys on facilities that carry high volumes of traffic.
- *Sample control and tracking of data.* Videotaping of plate numbers at a specific location in a travel corridor, in a specific lane, in a given direction, during a specific time affords the surveyor a great deal of control in establishing a sample for survey purposes. For the 1987 CA-55 survey, users of the commuter lane were easily segregated from travelers in the general traffic lanes and were sent a separate survey form.
- *Focused framework for analysis.* Because of the great

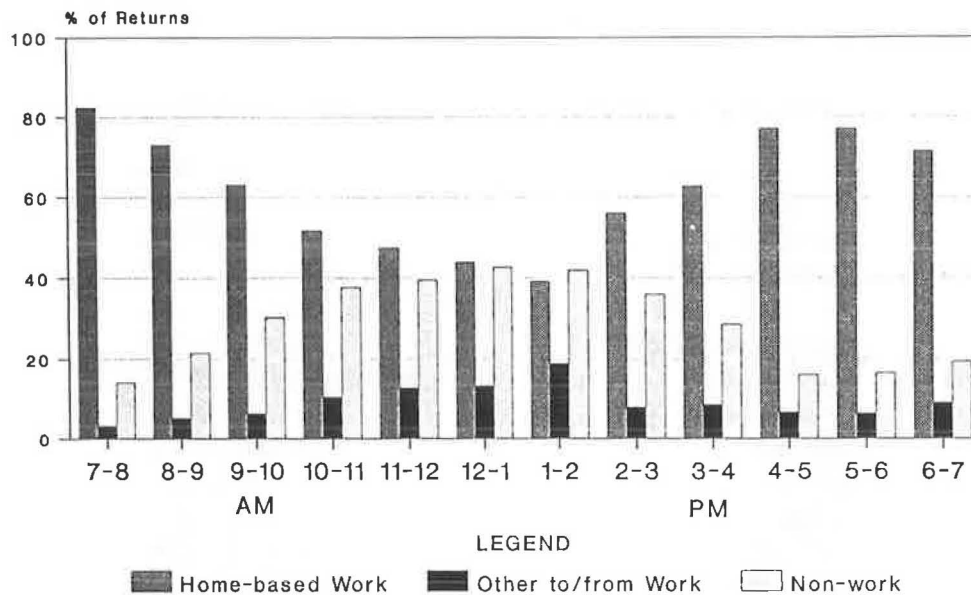


FIGURE 7 Trip purpose by hour of day on I-405 northbound at Heil cutline.

degree of control of location and time, specific travel characteristics from the returns can be analyzed within the focused framework of the travel corridor cutline. Therefore, origin-destination travel paths are known to be traveling through a specific link in the transportation network.

One of the shortcomings associated with the license plate video cutline survey approach is the potential for built-in biases in the survey population and the respondents. Although the participating agencies chose to deliberately slant the survey population by deleting out-of-state license plates and plates on heavy-duty commercial vehicles, other subsets of travelers also appear to have been lost to the survey because license plate numbers could not be easily linked to the drivers of the vehicle using DMV records. Drivers of vehicles registered to businesses, some leased vehicles, and rental cars fall into this category.

Another possible bias is associated with the lag time between the day the vehicle plate numbers are photographed and the day the households of the registered vehicles receive the postcard or telephone survey. The longer the lag time, the greater the probability that travel corridor users will not remember their trip on the day of the survey with equal accuracy. Everyday commuters may report their normal inbound trip, but occasional travelers making nonwork trips may not recall their trip if too much time has elapsed. This appears to be the case in both of the most recent video/mailback corridor surveys conducted during 1987 on CA-55 southbound and on the northbound lanes of the San Diego (I-405) Freeway in Orange County. As shown in both Figures 6 and 7, based on survey

responses, nonwork trip purposes are never predominant in either travel corridor, even during nonpeak hours. For both surveys, frequent users (5 days or more per week) constitute a high percentage of the total responses (73 percent for I-405 and 77 percent for CA-55).

## CONCLUSIONS AND FOLLOW-UP STUDIES

The cutline mailback surveys conducted to date have provided needed large-scale information on travel characteristics in three of the major travel corridors in Orange County. The 1985 and 1987 travel surveys of the CA-55 travel corridor provided comparable data bases for a detailed before and after study of the effects of the opening of exclusive commuter lanes on travel behavior within the corridor.

As shown earlier in Figure 1, OCTD and Caltrans have agreed to perform additional video/postcard surveys to document "before" travel conditions in two other travel corridors in Orange County that are programmed for future HOV facilities: CA-91 (Riverside Freeway) and CA-57 (Orange Freeway). In the future, when exclusive facilities have been opened in these travel corridors, surveys could be performed at the same cutline locations to document "after" conditions. As more "before and after" travel data bases are developed in the future in southern California, greater accuracy can be built into travel demand models used for commuter market studies, transit service planning, and facility development.

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