Effects of Ramp Metering with HOV Bypass Lanes on Vehicle Occupancy

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ABSTRACT

The concept of providing preferential treatment for high occupancy vehicles on metered freeway on-ramps is being tested for the first time in northern California, as a cost-effective means of reducing freeway congestion. The purpose of this research project was to evaluate the impacts of ramp meter bypass lanes on the traffic system, and on vehicle occupancy in particular. A comparison of before and after project mean occupancy rates and an analysis of covariance revealed a 0.015 person per vehicle increase in automobile occupancy for the ramps with bypass lanes, and a 0.014 person per vehicle decrease for the ramps without bypass lanes. However, it is suspected that these results are mostly explained by a shift of existing carpools from the nonbypass ramps to the ramps with carpool bypass lanes. Another important discovery revealed that bypass lanes and ramp metering can actually be counterproductive to one another. Ramp metering smooths out the congestion, which decreases the carpool incentive, and unless the geometrics of the project are carefully planned, the vehicles that use the bypass lanes can interfere with the ability of the ramp meters to reduce mainline congestion. Although new carpool information was negligible, the tendency for automobile occupancy to increase where the carpool bypass lane incentive is implemented cannot be ignored. The possibility for greater reductions in vehicle miles traveled as a result of the bypass lanes in the future is quite strong if increased traffic congestion enhances the time savings incentive.

Ramp metering is a transportation system management (TSM) technique whereby vehicles that are in the process of entering a freeway during periods of high use are spaced so as to reduce freeway congestion and allow traffic to move faster and more smoothly. Metering makes it possible for more vehicles per hour to use a freeway corridor with an overall shorter commute time. Bypass lanes for high occupancy vehicles (HOVs) at metered ramps allow carpools, vanpools, buses, and other HOVs to bypass single occupancy vehicles that are waiting at ramp meter signals to enter the freeway. They therefore also allow for increased efficiency (i.e., reduced congestion) of the exiting freeway system in terms of people-carrying capabilities by providing an incentivé for more people to rideshare (that is, carpool, vanpool, buspool, or use public transit).

Although preferential lanes for HOVs at metered ramps had been in operation for a decade in Southern California, ramp metering was new to the Sacramento area when this first ramp meter project was installed in 1983. Before the project was implemented, congestion had increased on Route 50 to the point where traffic frequently slowed and occasionally came to a standstill. The California Department of Transportation (Caltrans) proposed ramp metering as a cost-effective method for reducing freeway congestion.

Through ramp metering with bypass lanes, several specific traffic issues can be addressed, such as maintaining free flow of traffic, increasing vehicle occupancy, and reducing parking needs in high employment areas. However, the Sacramento Highway 50 Ramp Meter Auto Occupancy Study focuses on the incentive to shift to an HOV mode of travel that this type of project provides. The study was initiated to evaluate the concept of preferential treatment of HOVs at metered ramps in a medium-sized metropolitan area. This paper contains the results of the study, in which the impact of the bypass lanes on vehicle occupancy was evaluated and a discussion on some of the other impacts of the bypass lanes on other aspects of the traffic system.

RELATED LITERATURE

The amount of literature in the general subject area of preferential treatment of HOVs is growing rapidly; however, this paper is not intended to be an exhaustive literature review. The literature discussed here is that which is most pertinent to this study.

Relatively few ramp meter projects with bypass lanes have been rigorously evaluated. Most of the studies that have been conducted conclude that the HOV bypass lanes on metered ramps do not lead to significantly increased vehicle occupancy rates. Goodell, in his evaluation of carpool bypass lanes in the Los Angeles area, indicated that the increase (or decrease) in carpools after installation of the ramp meters with bypass lanes varied from ramp to ramp (1). The time savings for carpoolers who used the ramps with carpool reductions was very short and hardly an incentive to form carpools from existing ramp traffic.

In Goodell's study, two ramps were surveyed to determine the number of additional carpools that had been formed since installation of the carpool bypass lanes. Based on these two surveys, 50 percent of the additional carpools were formed since the installation of the carpool lane. Goodell assumed that all (575) of these new carpools were formed as a result of the project.

Uematsu's report, Evaluation of Preferential

Lanes for High Occupancy Vehicles at Metered Ramps, is an evaluation of the preferential treat- ment of HOVs at metered ramps along the Golden State Freeway (I-5) corridor between Route I-10 and State Route 170 in the Los Angeles area (2). Included in the study were analyses of before, after, and control section data to determine the effectiveness of the preferential bypass lanes. On 13 of the 47 metered freeway on-ramps, bypass lanes were provided for buses and carpools with two or more occupants. The time saving was small, and Uematsu concluded that although the number of carpools had increased, the increase that was attributable to the meter bypass lanes was not considered significant.

Rothenberg's Project Status Report contains a discussion on the current status of 14 preferential treatment projects for buses and carpools in the United States (3). A range of projects is covered, including bypasses of metered freeway ramps. Rothenberg concluded that the increases in carpool use of the Los Angeles area metered ramps was more a result of a route shift by existing carpools than the formation of new carpools.

Rothenberg also documented the status of the I-35 corridor ramp meter project in Minneapolis. He stated that the project is operationally sound; however, the limited travel time savings has resulted in a negligible modal shift to HOVs.

Benke wrote that the provision of preferential treatment for carpool vehicles that use the TH 65 route from downtown Minneapolis did not result in a measurable increase in the number of carpools (4). The delays encountered at the metered entrance ramps were not great enough to induce many carpoolers to divert to the bypass, nor to form new carpools so that they could use the ramp. Primary use of the bypass ramp was by previously existing carpoolers who found it convenient to divert.

In the San Francisco Bay area, carpools (three or more persons per vehicle) and buses are given priority and toll-free access to the Bay Bridge. The metering system and relatively quick response to incidents provides a generally delay-free ride on the bridge. Currently, about 20 percent of the westbound vehicles that use the bridge between 6:00 and 9:00 a.m. are HOVs. The time savings provided by the HOV lanes at the toll plaza has caused a large increase in the total number of carpools. However, a significant portion of this increase is a result of "casual" carpools formed by drivers picking up passengers at transit bus stops so they can proceed through the toll plaza without delay. These carpools do not reduce vehicular demand for the bridge (5).

PROJECT DESCRIPTION

In the spring of 1982, the $727,000 project was initiated to install ramp meters along the 5-mile Route 50 transportation corridor at westbound on-ramps from Watt Avenue westbound to the Business Route 80 interchange just west of Stockton Boulevard. There are nine metered ramps, four of which have bypass lanes. Figure 1 shows the location of the metered ramps and bypass lanes.

Along with the installation of computer-operated traffic signals at these ramps, a fifth westbound freeway lane was constructed between 59th Street and Stockton Boulevard. The southbound Watt Avenue on-ramp has two metered lanes plus a bypass lane. The bypass lane on the Hornet Drive on-ramp is for buses only. In general, there are four lanes in the westbound direction along the project corridor, but there are portions where there are five--between Stockton Boulevard and 59th Street, and between 65th Street and Howe Avenue. The morning peak commute period usually lasts from 20 to 30 min and occurs between 7:00 and 8:00 a.m.

The speed of the traffic during the morning commute varies. If traffic is running smoothly, it

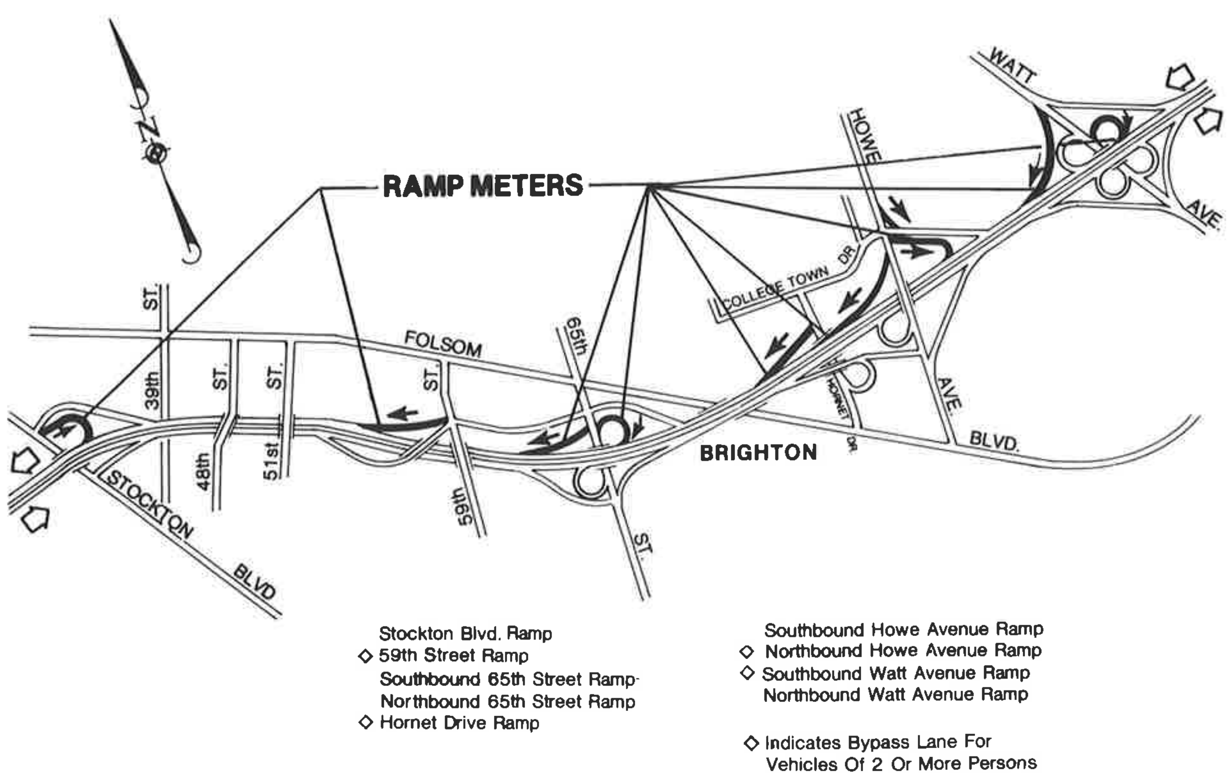

FIGURE 1 Highway 50 transportation corridor—westbound on-ramps.

flows at about 40 mph. If there is an accident, stalled car, or other special problem, speeds drop to around 15 to 20 mph. The most congestion occurs around Watt Avenue where the ramps merge into the mainline and in the outside lane (lane No. 4) near Stockton Boulevard. Just east of the Stockton Boulevard on-ramp, vehicles start moving over to the outside lane to get on Business Route 80 East, which is immediately west of the study area. The weaving of these vehicles with vehicles that are merging onto Highway 50 from the on-ramp causes the bottleneck.

The system monitors operate only from 7:00 to 9:00 a.m. on weekdays. The meters are traffic-actuated, meaning that the traffic is monitored between 7:00 and 9:00 a.m., and the meters turn on and off as indicated by the traffic volume. The meters are usually activated from 7:15 to 8:00 a.m. The carpool requirement for use of the bypass lanes is two or more persons per vehicle.

DATA COLLECTION

All "before" traffic count data were collected between April 20, 1982 and May 25, 1982, approximately 1 year before the ramp meters became operational. The "after" counts were made from March 27, 1984 through April 25, 1984, approximately 1 year after the ramp meters became operational. No data were collected on Mondays, Fridays, weekends, holidays, or days of inclement weather. All westbound access ramps on Route 50 from Watt Avenue to Stockton Boulevard were sampled. Counts were also made of the westbound mainline traffic at locations both east and west of the project.

A field crew was trained to make vehicle occupancy counts, both of the ramps and the mainline traffic. Vehicle occupancies were observed and tabulated vocally using portable cassette tape recorders. Ramp counts were made in 10-min intervals from 7:10 to 8:20 a.m. (seven time periods). Mainline lanes were counted for six, 5-min time periods from 7:15 to 7:30 a.m. and from 7:40 to 7:55 a.m. One-hundred percent of the vehicles were counted within each time period. Seven vehicle type categories were defined: automobile, van, motorcycle, recreational vehicle, pickup, truck, and bus. For each vehicle observed, the vehicle type and number of occupants were recorded. For buses, the number of occupants was recorded as either empty (driver only), quarter-full, half-full, full, or standing room only. Altogether, 62,195 observations were recorded.

DATA ANALYSIS

For each observation, the location, date, day of the week, time period, vehicle type, number of occupants, and the name of the data collection crew member who made the observation were documented. Then the average vehicle occupancy was computed for each location before and after the ramp metering project.

The data were analyzed to determine:

1. The difference in before and after project vehicle occupancy rates for each location,
2. The change in the proportion of HOVs for each location observed, and
3. How important an incentive the carpool bypass lanes are to carpool formation.

Changes in Vehicle Occupancy Rates

To more directly address the home-to-work commute during the morning peak period, occupancy rates for vehicle type 1 (automobile) only were compared. The data in Tables 1 and 2 summarize the automobile occupancy rates in descending order by location. The differences in those occupancy rates were calculated, and are summarized in Table 3. The overall increase in the automobile occupancy rate for the ramps with carpool bypass lanes was 0.015 persons per vehicle. That is a 1.3 percent increase for these ramps. This represents an overall small change in automobile occupancy. However, separate examination of each bypass ramp indicates that persons per vehicle increased more significantly for the high traffic volume ramps (northbound Howe Avenue and southbound Watt Avenue). The rate on the low-volume 59th Street ramp was the only carpool bypass ramp where automobile occupancy decreased. The automobile occupancy rate decreased 0.014 persons per vehicle on the nonbypass ramps. This represents an overall 1.2 percent decrease for these ramps.

Although changes in the automobile occupancy rates were very small, these results must be examined in terms of other, exogenous factors that affect the level of carpool participation along the corridor. The price of gasoline declined steadily for 8 months before the "after" data collection

TABLE 1 Locations in Descending Order by Average Automobile Occupancy Rate for Before Project Data

Ramp to Westbound Highway 50	Occupancy Rate (persons/vehicle)	Mainline	Occupancy Rate (persons/vehicle)
Northbound 65th Street	1.281		
Northbound Watt Avenue	1.280		
		East Lane 3	1.259
		West Lane 2	1.248
		West Lane 1	1.243
		West (overall)	1.237
		West Lane 3	1.232
		East Lane 2	1.221
		East Lane 1	1.215
Hornet Drive	1.209		
Northbound Howe Avenue	1.209		
		West Lane 4	1.204
		East (overall)	1.198
59th Street	1.186		
Southbound Watt Avenue	1.180		
Southbound Howe Avenue	1.173		
Southbound 65th Street	1.161		
Stockton Boulevard	1.138		
		East Lane 4	1.116

TABLE 2 Locations in Descending Order by Average Automobile Occupancy Rate for After Project Data

Ramp to Westbound Highway 50	Occupancy Rate (persons/vehicle)	Mainline	Occupancy Rate (persons/vehicle)
Northbound 65th Street	1.247		
Northbound Howe Avenue	1.239		
Northbound Watt Avenue	1.234		
		East Lane 2	1.210
Southbound Watt Avenue	1.205		
		West Lane 2	1.191
		East Lane 3	1.180
Hornet Drive	1.180		
Stockton Boulevard	1.175		
Southbound 65th Street	1.172		
		East (overall)	1.170
		West Lane 1	1.169
		West Lane 3	1.168
		East Lane 1	1.168
		West (overall)	1.165
Southbound Howe Avenue	1.162		
59th Street	1.142		
		West Lane 4	1.117
		East Lane 4	1.114

TABLE 3 Change in Automobile Occupancy Rate on Carpool Bypass Ramps, Noncarpool Bypass Ramps, and Mainline

Locations	Before (persons/ vehicle)	After (persons/ vehicle)	Difference (persons/ vehicle)
With carpool bypass			
Northbound Howe Avenue	1.209	1.239	+0.030
Southbound Watt Avenue	1.180	1.205	+0.025
59th Street	1.186	1.142	−0.044
Overall	1.186	1.201	+0.015
Without carpool bypass			
Hornet Drive	1.209	1.180	−0.029
Southbound Howe Avenue	1.173	1.162	−0.011
Stockton Boulevard	1.138	1.175	+0.038
Northbound Watt Avenue	1.280	1.234	−0.046
Northbound 65th Street	1.281	1.247	−0.034
Southbound 65th Street	1.161	1.172	+0.011
Overall	1.210	1.196	−0.014
Mainline westbound			
East of project	1.198	1.170	−0.028
West of project	1.237	1.165	−0.072
Overall	1.225	1.168	−0.057

period (6). This decline in gasoline prices, plus the fact that the ramp metering increased flow on the mainline (reduced congestion), would suggest decreased occupancy rates, and mainline automobile occupancy rates did decrease. But automobile occupancy actually increased slightly overall for the on-ramps with the carpool bypass lane incentive. Rates on the ramps without this incentive decreased as expected, even on the high-volume ramps.

The results of t-tests are not given for the differences reported in Table 3. Because of the large number of observations in the sample, the changes in automobile occupancy are assumed to be real, and not a result of sampling variation. Statistical tests of significance would not be meaningful to this analysis, as they would account for only a very small portion of the variation.

Preferential treatment for buses is provided on each of the three ramps that have carpool bypass lanes. In addition, there is a "buses only" lane on the Hornet Drive ramp. No measurable effect of the bypass lanes on bus ridership was discovered. In the sample, bus occupancy increased an average of one person per bus for the HOV bypass ramps as a group. However, bus occupancy decreased by nine persons per bus on the Hornet Drive ramp. Bus occupancy actually increased more on the ramps where no HOV lane exists. Ridership counts conducted by the local transit agency indicated that transit bus ridership decreased during the study period (Sacramento Regional Transit, unpublished data). This decrease was largely attributed to a fare increase that was implemented in July 1983. These results are consistent with the analysis of the mainline data, which show that bus occupancy decreased an average of eight persons per bus. Although these results are inconclusive, it is clear that the HOV bypass lanes did not provide enough of an incentive to induce a significant increase in transit ridership. On the other hand, it cannot be determined if, as a result of the bypass lanes, fewer people quit using public transit in response to the fare increase.

HOV Volume Changes

Another approach taken to measure the level of ridesharing participation along the corridor was to compute the percentage of HOVs that were observed in the sample for each location. The figures were computed by using the automobile, van, pickup, and bus vehicle types. The results are summarized in Table 4. The northbound Howe Avenue, southbound Watt Avenue, and southbound 65th Street ramps exhibited the greatest proportional increases. The three ramps with carpool bypass lanes showed a greater overall increase in the proportion of HOVs entering the freeway than the other six ramps. These results are consistent with the results from the analysis of the change in automobile occupancy rates. The increase in the proportion of HOVs occurred despite an increase in freeway volume between the before and after traffic counts.

TABLE 4 Ridesharing Participation Along Highway 50 Corridor Before and After Ramp Meter Project

Location	High Occupancy Vehicles	
	Before (%)	After (%)
Ramps with carpool bypass		
Northbound Howe Avenue	10.9	18.1
Southbound Watt Avenue	14.4	16.5
59th Street	17.5	15.0
Total	14.4	16.6
Ramps without carpool bypass		
Hornet Drive	17.5	14.6
Southbound Howe Avenue	15.4	14.8
Stockton Boulevard	15.1	15.1
Northbound Watt Avenue	20.4	21.6
Northbound 65th Street	23.2	20.3
Southbound 65th Street	11.8	14.7
Total	17.4	17.5

Importance of the Bypass Lanes

At this time, the preferential lanes do not provide enough of an incentive to induce more people to use public transit, according to the data collected for this survey. However, it is difficult to conclude whether the changes in automobile occupancy on the freeway on-ramps are a result of the presence or absence of carpool bypass lanes. There certainly are other factors that influence a person's decision to carpool. Following is a list of some of these factors:

1. Gas prices;
2. Parking costs and availability;
3. Energy conservation attitudes;
4. Work hours;
5. Availability, cost, and convenience of alternate forms of transportation;
6. Economic conditions of individuals;
7. Type and size of automobile driven;
8. Commute distance;
9. Human behavioral effects such as privacy, independence, and status;
10. Residence and work locations; and
11. Before and after work use of automobile for pleasure, child care, shopping, and so forth.

Many of these influences are known to have changed during the study period, and it is expected that these changes would affect the level of ridesharing participation. However, it is reasonable to assume that the commuters on all the ramps were exposed to these other changing factors equally, so it would be expected that the automobile occupancies for each ramp would be affected in the same way. Occupancy rates, in fact, did not even change in the same direction for each ramp. Because increases in automobile occupancy were shown for some ramps and decreases were shown for others, there must be some characteristic(s) specific to each ramp that influences commuters' mode choice.

To investigate the importance of the carpool bypass lanes as having a significant effect on automobile occupancy rates, the method of least squares was used to fit a general linear model. The model formulated for the analysis is given in Equation 1.

$$\#OCCUP = \beta_0 + \beta_1 VEHFLO + \beta_2 METER + \beta_3 HOV + \beta_4 V{*}M + \beta_5 V{*}H + \beta_6 M{*}H + \epsilon \quad (1)$$

where

#OCCUP = the dependent variable, number of occupants per automobile;
VEHFLO = continuous independent variable, a measure of congestion (vehicle flow) on the ramp;
METER = discrete independent variable that represents the presence or absence of ramp metering;
HOV = discrete independent variable that represents the presence or absence of a carpool bypass lane on the ramp;
V*M, V*H, M*H = the interaction effects between vehicle flow and metering, vehicle flow and HOV bypass lanes, and metering and HOV bypass lanes, respectively.
β_0 = the intercept;
$\beta_1, \beta_2, \ldots, \beta_6$ = the regression coefficients of the independent variables; and
ϵ = the error term.

T-tests for significance of the estimates for the coefficients fail to reject the hypothesis that $\beta_i = 0$, where $i = 1,2,\ldots,6$. In other words, the independent variable for each test has no influence on the mean number of occupants. These independent variables are not separately relevant factors in the prediction of average automobile occupancy for each ramp. However, the F test rejects the hypothesis that $\beta_i = \beta_j = 0$ for $i = 2$, $j = 3$ and $i = 1$, $j = 2$. The separate contributions of ramp metering, bypass lanes, and congestion to the explanation of the variation of automobile occupancy are weak, whereas their joint contributions are quite strong. According to the sample, ramp metering alone did not affect automobile occupancy. Further, increases in automobile occupancy were not observed even when carpool bypass lanes were used in conjunction with ramp metering unless congestion was also a significant factor. Unless congestion causes traffic to back up in the metering queue, there is no time savings incentive for use of the bypass lane. Even with a preferential lane for carpools, if a vehicle can gain access to the freeway just as quickly by using the nonbypass lane, then the advantage of the bypass lane disappears.

The analysis of the changes in automobile occupancy and number of HOVs showed increases for the ramps with HOV bypass lanes where traffic congestion was significant. This appears to indicate that the ramp meters and bypass lanes do provide an effective TSM solution for reducing freeway congestion. The regression model further supports this conclusion. But these analyses are not totally conclusive. It is not clear that there has been an incentive for new carpool formation. A shift has traditionally occurred from other nearby ramps and city streets when HOV bypass lanes are introduced, so decreases in the number of HOVs on the ramps that do not have bypass lanes are not surprising. If this shift has occurred, it could explain the increase in the number of carpools on the ramps with bypass lanes. Perhaps existing carpools have changed routes to take advantage of the bypass lanes. If this is the case, then the carpool bypass lanes cannot necessarily be credited with providing an incentive for new carpools to form.

Although a formal license plate survey was not conducted, it is strongly suspected that this type of shifting occurred from the southbound Howe Avenue ramp (no HOV bypass) to the northbound Howe Avenue ramp with a bypass lane, and possibly between other ramps too. When the ramp meters were installed, a left-turn pocket was added at the intersection of Howe Avenue and College Town Drive (Figure 1) to allow vehicles southbound on Howe Avenue access to the Howe Avenue on-ramp, which was previously accessed only by northbound traffic. It is therefore reasonable to suspect that the increase in HOVs on the northbound Howe Avenue ramp (now also accessed by southbound traffic via a left turn) and the decrease on the southbound Howe Avenue ramp is a result of previously existing carpools shifted from the use of one ramp to the other to take advantage of the bypass lane.

The main thrust of this study has been to evaluate the impact of HOV bypass lanes on automobile occupancy. But in carrying out the study, it became obvious that bypass lanes in a ramp meter project have impacts on the traffic system that extend beyond automobile occupancy. In theory, the potential benefits of providing bypass facilities on metered on-ramps are difficult to argue, but in actuality, there are some drawbacks that should be considered. Several more important observations that concern the bypass lanes were made on the Highway 50 project. They are itemized briefly.

1. Experience has not shown significant new carpool formations as a result of the bypass lanes.
2. Outside the metering period, the bypass lane is frequently used as a short passing lane. This is an unnecessary pass, as the freeway is only a few seconds away and not crowded at this time.
3. The HOV lanes create problems that interfere with the ability of the meters do their job. For ramps that have an HOV lane, the metering rate for the meter lane must be adjusted (longer cycles) to allow for vehicles that use the HOV lane. Also, the percentage of single-occupant vehicles that use the HOV lane varies from 10 to 50 percent, with the higher percentage occurring on the low-volume ramps. Law-abiding users of the metered lane are penalized with a slower metering rate to compensate for the violators. Without strict enforcement, it is anticipated that the percentage of violaters would increase quickly. Some of the single-occupant vehicles make unsafe lane changes into the HOV lane when they are approaching the signal. Some vehicles must radically adjust their speed to merge with vehicles that are leaving the signal in the metered lanes. Another problem occurs when vehicles in the bypass lane fill the gaps between metered vehicles. When this happens, it is more difficult to merge onto the mainline because a solid line of traffic from the on-ramp will be entering the already occupied outside freeway lane. This eliminates the beneficial aspect of the scattered vehicles that enter the freeway.
4. The cost is relatively high to provide a separate lane for only HOV vehicles to use for approximately 1 hour a day, 5 days a week. HOVs represent approximately 15 to 20 percent of the total number of vehicles that use a particular ramp. On a 2-lane ramp, HOVs occupy 50 percent of the lanes available, and on a 3-lane ramp, they occupy 33 percent.
5. There is a trade-off between tightening the metering rates to increase the carpool incentive,

and speeding them up to prevent backup on the local streets.

Impacts of the HOV bypass lanes are not limited to their effects on automobile occupancy. These impacts on other aspects of the ramp meter project and on traffic in general, are widespread and important. They are significant enough that they too should be considered before the decision is made to provide for the multiple-occupant vehicle.

CONCLUSIONS

The concept of providing preferential treatment for HOVs on metered freeway on-ramps is being tested for the first time in northern California. During the time frame of this study, the metering rates were set to accommodate existing demand so that the delay at ramp entrances in the queue was generally nominal. The time savings was intended to induce use of carpools, vanpools, and buses with consequent benefits to air quality and energy conservation. Because the delay was nominal, so was the time savings for carpoolers. The changes in automobile occupancy rates were very small, and although they were considered to be real changes, they could not be wholly attributed to the bypass lane incentive, according to this research. Further, some of these changes were probably a result of a shift in route of existing carpools rather than the formation of new carpools.

Although the intention of the bypass lanes is to increase vehicle occupancy, it was also found that they often interfere with the operation of the metering system. Before providing HOV bypass lanes on all new ramp meter projects several factors should be considered, including length of the metering period, time of delay in the metered lanes, mileage of where freeway on-ramps are to be metered, and cost. When the delay in metered ramps is longer, as a result of congestion or slower metering rates, HOV bypass lanes can be very effective. When the metering period is brief, however, and delay is minimal, the initial ramp meter project should not include bypass lanes. However, the design of the initial project should allow for the potential addition of bypass lanes if the future benefits outweigh the negative aspects. For now, the bypass lane strategy in Sacramento is considered a useful and effective means for visibly supporting and providing preferential treatment to carpools and buses. In the future, if congestion increases on Highway 50 as expected, the time savings incentive will be greater.

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