The Effectiveness of the Katy Freeway HOV Lane Pricing Project:
A Preliminary Assessment

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ABSTRACT

This paper describes the current use of the QuickRide program that is implementing priority lane pricing on the Katy high-occupancy vehicle (HOV) lane in Houston, Texas. The QuickRide program allows two-person carpools to use the HOV lane during peak periods for $2 when the lane has a three or more person restriction. This paper describes the use of QuickRide during its first six months, and presents an analysis of the effectiveness of the program. QuickRide usage and before-and-after implementation data are used to analyze user travel patterns, observed travel time savings, and changes in person throughput in the Katy Freeway corridor. The results of this analysis show that the participation in the QuickRide program is too low to observe significant impacts on travel speeds and person-throughput on both the general purpose lanes and the Katy HOV lane. Also, the analysis indicates that the use of QuickRide program has reached a plateau since mid-March, about two months into the program. Participants seem to be using QuickRide on an occasional or infrequent basis, and a majority of the participants are not using the program in any given week. Most of the QuickRide users appear to be previous two-person carpool commuters, with a substantial minority of single-occupant vehicle drivers now forming carpools to participate in QuickRide. Fortunately, higher vehicle occupancy modes are not losing many patrons to the QuickRide program. An analysis of travel time savings shows that travel time savings for participants are substantial, and are worthwhile for two-person carpools with a value of time exceeding about $6.50/hr. However, the analysis of person-throughput indicates that, at this initial stage, the observed changes in vehicle- and person-throughput are not statistically meaningful. To improve the participation in the program, a lower fee is recommended, and marketing efforts should be enhanced, especially to single-occupant vehicle drivers.
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INTRODUCTION

High occupancy vehicle (HOV) lanes have been implemented in many areas over the past twenty years as a means of supplying needed capacity to congested freeway corridors. Especially during peak periods, these HOV lanes can increase the overall person-throughput of congested freeway corridors, while providing an incentive for HOV use by providing a higher level of service to these vehicles.

One of the most important tasks in operating an HOV lane is efficiently managing the available capacity. An HOV lane should allow the freeway corridor to have greater person-throughput; however, this need must be balanced by the desire to maintain acceptable operating speeds in the HOV lane, usually with a distinctly higher level of service than the adjacent general purpose lanes. In managing this capacity, problems arise either: (1) when the demand for the HOV lane exceeds the capacity, resulting in a degraded level of service; or, (2) when the demand for the HOV lane is too low to maximize person throughput in the corridor. This latter case, with excess capacity in the HOV lane, occurs in some urban freeway corridors. In response, HOV lane pricing (or “value pricing”) has been investigated as a tool to attract more travel demand to the HOV lanes, thereby increasing corridor throughput and, perhaps, relieving congestion in the main lanes. This paper outlines the preliminary results of one ongoing HOV lane pricing project, the QuickRide program on the Katy HOV lane in Houston, Texas.

Facility History

Since the Katy HOV lane opened in 1984, vehicle eligibility for the HOV lane has ranged from only transit and vanpools, to all vehicles with two or more occupants. However, with eligibility at two or more persons per vehicle (HOV2+), growing travel demand led to high volumes, and degraded service levels, on the HOV lane during peak periods. Thus, to maintain a higher level of service for transit and vanpools, the Katy HOV lane was restricted to vehicles with three or more occupants during the “peak of the peak,” from 6:45–8:00 am and 5:00–6:00 pm. However, this resulted in significant excess capacity in the HOV lane during these peak periods. At the same time, the congestion level in the adjacent mixed flow lanes has continued to grow (1).

In January 1998, an HOV lane pricing demonstration began on the Katy Freeway in Houston. The primary goal of this project, called QuickRide, was to increase the person-throughput on the Katy HOV lane and in the Katy freeway corridor. To this end, two-person carpools (HOV2's) could “buy into” the HOV lane during these morning and evening peak periods, for a charge of $2. In effect, the QuickRide program uses pricing as the means of managing available capacity in the HOV lane. By selecting an appropriate price, demand for the HOV lane can be managed.
In this program, as a primary motivation, HOV2's can reduce their travel time by paying a toll – hence the name “QuickRide”. One might suggest that travelers are making a trade-off between the cost of the toll and expected travel time savings from using the HOV lane. Hence, travelers' value of time is an important concept to determine how many HOV2's might use the facility, and thereby to manage the capacity of the HOV lane.

**The Objectives of QuickRide Program**

The overall objectives of the QuickRide program are to:

- Increase overall person throughput in the Katy Freeway corridor during peak periods;
- Increase travel speeds on mixed flow lanes during peak periods, assuming a number of vehicles currently using the general purpose lane lanes will divert to the HOV lane; and,
- Efficiently manage demand without adverse operating impacts on both the HOV lane and the general purpose lanes.

This paper describes some of the motivation behind the QuickRide program and presents an analysis of the program's effectiveness to date. In the next section, the QuickRide project is described in the context of other pricing concepts and demonstration projects. The third section describes the evaluation methods, and the fourth section gives initial results on the usage, travel patterns, travel time savings, and corridor throughput for the QuickRide program. The final section presents some conclusions on the project performance to date.

**LITERATURE REVIEW**

**The Concept of HOV Lane Pricing**

The QuickRide program is based on several concepts from HOV lane “value pricing.” Value pricing differs considerably from the more general notion of congestion pricing, which involves the use of pricing mechanisms to manage, i.e. to reduce, roadway congestion (2, 3). Instead, the value pricing concept, as applied in QuickRide, a toll is charged to allow access to restricted facilities (the HOV lane), thereby reducing congestion on the unrestricted facilities (the general purpose lanes). Road users have a choice whether to remain in the general purpose lanes or pay a price to access the largely uncongested HOV lane.

Fielding and Klein (4, 5) introduced the concept of value pricing for underutilized HOV lanes. They suggest that HOV lane pricing will both increase the access to HOV lanes as well as increase public acceptance of pricing schemes for general purpose lanes. Also, based on a study of HOV lane pricing in Southern California, they argue that simultaneously pricing and expanding HOV lanes will provide additional motivation for ridesharing.

Since the early 1995, several value pricing projects have been initiated, and these are well summarized in a recent article in the ITE Journal (6). The first HOV lane pricing project, the State Route 91(SR91) Express Lanes in Orange County, opened on December 27, 1995. Intended as a means of providing additional capacity to all personal vehicles in the corridor, the Express Lanes charge a toll that varies by the time of day. Initially, vehicles with 3 or more occupants...
could use the facility free of charge; however, now these vehicles pay half of the toll (6). The evaluation of the SR-91 Express Lanes indicates that this project has successfully attracted travelers to pay tolls to avoid congestion in the general purpose lanes. However, the complete project impacts on traffic conditions and traveler behavior in the corridor have not yet been published (7, 8).

Second, the I-15 HOV lane pricing project (FasTrak) in San Diego opened in December 1996. Initially, for a flat monthly fee, single-occupant vehicles were allowed unlimited use of the HOV lane. After 15 months in operation, the pricing mechanism was changed; currently, the toll charged fluctuates, from $0.50 to $4 per trip, based on real-time traffic volumes and speeds (6). There is an ongoing evaluation of the FasTrak program, with some limited results to date.

The QuickRide program, in contrast to these two projects, focuses exclusively on HOV pricing, as only HOV2’s (and not single-occupant vehicles) are eligible. Also, the price for QuickRide does not vary in any way; the fee is $2 per trip. Finally, the time period for the HOV2 pricing is limited to 6:45 – 8:00 am and 5:00 – 6:00 pm; HOV2’s may use the facility free of charge outside of these periods.

The Value of Travel Time

One important element in HOV lane value pricing is determining the toll at which the desired HOV lane demand is reached. In the QuickRide program, a toll that is too low will result in high HOV2 demand, degrading the level of service in the HOV lane. On the other hand, a toll that is too high will not result in greater person throughput. Because the primary motivation for using the HOV lane is time savings, travelers’ value of time can be used to determine a toll, and to measure the benefits of the QuickRide program. The value of travel time can be expressed as the money value that people place on saving various forms of travel time (9).

Fundamentally, drivers with a high value of travel time should be interested in paying money to save travel time because the HOV lane can provide shorter travel time than the general purpose lanes. Estimating the value of time at which travelers will choose the HOV lane, however, is not an easy task, a priori. The value of travel time is known to vary based on: (1) the variety of attributes of travel alternatives; (2) the socioeconomic attributes of traveler, such as income, wage rate, age, sex and car ownership; and, (3) the trip purpose (9, 10, 11). For this reason, estimates of travelers’ value of time vary widely.

Nonetheless, in the feasibility study for QuickRide (1), a value of travel time savings of $7.50 per hour per vehicle was investigated. With additional assumptions on the number of potential HOV2’s and the distribution of the value of time among travelers, a toll of $2 was recommended. It was believed that this would manage the new HOV2 demand to under 600 vehicles per hour, which was the excess capacity of the HOV lane at that time (1). However, the recommended toll depended heavily on both the assumed value of time, and the potential number of HOV2’s in the corridor.
EVALUATION OF QUICKRIDE

There are several dimensions of the QuickRide program that can be used for evaluation. In this study, we explore the overall impact of the QuickRide program on travel in the freeway corridor. The investigation looked at changes in person throughput in the corridor, vehicle occupancy, patronage of buses and vanpools, sources of QuickRide trips before and after the program, and the frequency of use of QuickRide by participants.

From these topics, the following four analyses were performed and are reported below. First, the use of QuickRide was analyzed. Total patronage, and travel by time of day and day of week, is investigated. Also, the frequency of use of the QuickRide program is analyzed. The second part of the analysis investigates QuickRide users’ changes in commuting mode and facility (HOV vs. general purpose lanes). Third, for the purpose of evaluating the impacts of the QuickRide program on traffic characteristics in both the general purpose lanes and the HOV lane, travel speeds and travel times are calculated. Also, the travel time savings for HOV2’s is quantified by comparing the travel time data for the HOV lane and the main lanes. Finally, as the primary goal of the QuickRide program, person throughput in the Katy Freeway corridor during the peak hour is quantified. Together, these analyses provide an initial report on the effectiveness of the QuickRide program. A more detailed final evaluation report for the first year of operation is pending.

The data for these analyses come from several sources. QuickRide counts from Houston METRO were used to quantify the overall QuickRide usage. The data used for analysis of QuickRide by time of day, by peak hour, and by day of week were collected manually by direct observation on a sample of days before and after the program implementation. Travel time and travel speed data were collected by an Automatic Vehicle Identification (AVI) system run jointly by Houston TranStar and TTI’s Houston office. For this study, data were collected for two days in the before period and for seven days after implementation of QuickRide. In addition to these aggregate data, the AVI system was used to create a complete data base containing the date and time of travel of each enrolled QuickRide participant. These data are used to quantify the frequency of use of QuickRide, and to investigate specific before-and-after travel patterns of the QuickRide participants. Finally, traffic volumes and vehicle occupancies were counted manually on the freeway main lanes for every 15-minute period during peak hours on a small number of days (two days before and one day after implementation of QuickRide). HOV lane traffic volumes were counted on a larger sample of days, including five days before and eight days after the project implementation.

ANALYSIS AND RESULTS

The analysis of QuickRide performance is divided into the four areas described previously.

QuickRide Usage

The first analysis examines the daily use of QuickRide, and includes the measures of daily total use, daily peak hour use, use by day of week, and use by time of day. It also describes the typical weekly frequency of use of QuickRide.
**Daily Usage Trends**

Figure 1 shows the daily total use of QuickRide. The average daily use in the first six months is approximately 115 vehicles, covering both the morning and evening restricted periods. Observing general trends, QuickRide usage increased during the first two months of the program, and has since reached a “plateau” since the beginning of March. Also, Figure 1 illustrates that the daily use appears to be increasing, although there is also significant day-to-day variation in use. One may also note that the total daily use has decreased slightly since the end of May. One potential reason for this trend might be the end of school, resulting in fewer family-based HOV2’s during peak hours in the corridor.

![Figure 1: Daily QuickRide Usage](image)

The total enrolled tags as of June 30, 1998, were 468. Originally, there were concerns that too many persons would be interested, so the number of potential participants was capped at 600. Clearly, the original cap has not been reached, indicating either that the service only has a limited demand, or that the marketing of the program has been limited and ineffective.

Considering the total number of enrolled AVI tags, the ratio of daily users to the potential enrolled users is 25%. We have also noticed that, up to June 30, approximately 25% (114) of the registered AVI tags had not been used at all. Approximately 40% of these unused tags are second tags owned by the same household, but the remainder represents a substantial minority (about 15%) of enrolled participants who have never used QuickRide. Both the total enrollment and the number of daily users are significantly lower than expected. While we are still evaluating the reasons for this, it is generally believed that the difficulty of creating and maintaining a two-person carpool has been a significant deterrent.

Figure 2 illustrates the peak period usage for morning and evening peak. Perhaps the most striking feature of these data is the much heavier use of QuickRide in the morning peak versus the evening peak. Morning use is about 33% higher than the evening use, even after accounting...
for the longer time period in the morning (75 minutes) versus the evening peak (60 minutes). While we do not know the exact cause, we suspect this is due to travelers' greater flexibility in the time of travel in the evening peak.

![Figure 2: AM and PM Peak Period Use](image)

**Figure 2: AM and PM Peak Period Use**

Day of Week

To examine sources of day-to-day variation in use, the patronage of QuickRide by day of week was also investigated. Figure 3 illustrates the use of QuickRide program by day of week (Monday through Friday), showing the mean for each day for a limited sample of travel days. For every day, the use during the morning peak is greater than the use during the evening peak. For the morning peak, use seems to grow during the week up to Thursday (the maximum) and then decreases slightly on Friday. In the evening peak, the highest use occurs on Friday, probably due to travelers' eagerness to begin the weekend. Interestingly, the use of QuickRide is smallest on Mondays for both peaks. These results seem to comply with the results from the SR-91 Express Lanes (7, 8). However, the reasons for these observed use patterns are unknown at this time and require further study.

![Figure 3: Use by Day of Week](image)
Time of Day

Both the morning and evening peak periods were divided into 15-minute intervals for further analysis of time-of-day trip patterns. Figure 4 shows the statistics for use of QuickRide during the morning peak (6:45 – 8:00 am). Generally, the use of QuickRide increases from the first 15-minute period to the third 15-minute period, and then it decreases to the last 15-minute period. During the morning peak, the third 15-minute period (7:15 – 7:30 am) has the highest average value. On the contrary, the first 15-minute period (6:45-7 am) has the smallest average value. We believe this trend is related to the concentration of work start times between 7:30 and 8:00 am, but other factors may also contribute to this travel pattern.

Figure 5 shows the statistics for use of QuickRide during the evening peak hour (5:00 – 6:00 pm). During the evening peak hour, the second 15-minute period (5:15 – 5:30) has the highest average use. Like the morning peak hour, the first 15-minute period has the smallest average value. It is again difficult to interpret this trend, but the high use from 5:15 – 5:30 may be related to a concentration of work end times at Houston’s major activity centers at 5:00.

For both the morning and evening peak periods, we have examined the variability in individual vehicles’ travel times. The point of this investigation was to see how people’s time of travel varies from day to day. In general, it was found that the standard deviation of the time of travel for QuickRide users in the morning is about 10 minutes, and is about 11 minutes for the evening. Together, these results suggest a pretty wide spread in the time of travel, and indicate much more flexibility in the time of travel than expected. It is also noteworthy that the variation is similar in both the morning and evening peaks. This suggests people are equally flexible on their time of travel in both the morning and evening.
Frequency of Use

As noted above, only about 25% of the registered QuickRide participants use their tag on a given day. To compensate for daily variations, we examined the use of QuickRide during the week. The frequency distribution of uses per week, for a representative week in June 1998, is given in Figure 6. As can be seen, about 60% of the users do not use the tag during a given week, and of the remainder, most of the participants use QuickRide relatively infrequently, from one to three times per week. A very small number of users could be considered daily users (at least five times per week). The average number of uses per week is approximately 1.1, including the zero-use tags, and about 2.8 among tags used in a given week.

These results strongly suggest both an advantage and disadvantage of the QuickRide program. Clearly, for many users, the availability of the QuickRide program allows them to take advantage of the HOV lane on occasion when necessary. Such "choice" usage is of considerable benefit to these users. At the same time, the relative infrequency of use indicates that either the service is priced too high for regular use, or that two-person carpools are difficult to maintain on a consistent basis, by time of day and across days of the week.
Changes in Travel Mode and Facility

Persons registering for QuickRide were asked how many times per week they normally commuted by (a) single-occupant vehicle (SOV) on the main lanes, (b) carpool or vanpool on the main lanes, (c) carpool/vanpool on the HOV lane, (d) bus on the HOV lane, or (e) other. These responses were compared with their observed QuickRide usage to determine the origin of trips in QuickRide. From a fairly simple analysis, it appears that about 25% of the QuickRide trips on a given day were previously SOV trips on the freeway. This significant minority of trips clearly indicates that there is some incentive for SOV's to form two-person carpools. While the absolute number of SOV's is very small (25-30 vehicles per day), in percentage terms, this mode change is significant. QuickRide is indeed having some effect to encourage carpools.

Another concern was whether QuickRide was perhaps stealing bus, vanpool, or HOV3+ passengers from the HOV lane. It appears from the user registrations that no more than 5% of the QuickRide trips are taken from either bus, vanpool, or other HOV3+. Instead, the remaining QuickRide trips are coming from HOV2's that previously used the main lanes, HOV2's that previously used other routes, or HOV2's that previously traveled outside the peak hours. An analysis of the exact sources of these HOV2's has not been conducted yet, but will be reported in the final evaluation. Nonetheless, it is a reassuring result that HOV2's are the lion's share of the QuickRide participants, and that higher-occupancy modes are not losing significant numbers of patrons to QuickRide.

Travel Speed and Travel Time Savings

To examine travelers' incentive to use the HOV lane, travel speeds and travel time savings on the HOV lane were compared with those on the main (general purpose) lanes. A weighted average of travel speeds during the peak period is used to calculate the average travel speed during each peak period. Also, the full HOV lane length of 21 kilometers is used to calculate travel time savings since the participants of QuickRide can use the full length of the HOV lane instead of the main lanes.

Table 1 describes average travel speeds during the peak period for several sample days. One may note particularly higher speeds ("free flow") in the HOV lane both before and after QuickRide. Notably, the small number of QuickRide users has not adversely affected HOV lane speeds, nor has it improved the speeds on the freeway main lanes. As a result, the effect of the QuickRide program on both main lane and HOV lane congestion has been negligible. In addition to the "before" data listed in Table 1, TTI also has speed and volume data going back to 1984 for the Katy freeway corridor. In general, the speeds observed in both the main lanes and the HOV lane in Table 1 are comparable to previous observations on that facility (12). With the high variability of morning and evening speeds, and the small number of vehicles actually using QuickRide, there are no changes in HOV or main lane speeds that are attributable to the QuickRide program.
Using the same sample days, however, Table 2 and Figure 7 show estimates of travel time savings for QuickRide users. The results shown in Figure 7 imply that the travel time savings can be a strong motivation to participate in the QuickRide program. After implementing QuickRide, the weighted average time savings for HOV2's is about 18 minutes for both peak periods. This means that QuickRide participants enjoy about 18 minutes of travel time savings for a $2 toll. From this, we estimate a minimum value of travel time for participating vehicles of $6.57/hr ($2+0.304 hr.) per vehicle. This empirical observation is slightly lower than the $7.50/hr value originally used in the feasibility study (1). However, it seems more likely that the reason for the low QuickRide usage, compared with the a priori expectations, is that the feasibility study overestimated the number of potential HOV2's in the corridor. It appears that people are less willing to form new carpools than was originally expected. Also, note that a drop in toll to increase QuickRide usage would imply a smaller minimum value of time for participants.
Table 2
Travel Time Savings for HOV Lane vs. Main Lanes

<table>
<thead>
<tr>
<th>Date</th>
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<th>Evening Peak Hour</th>
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</thead>
<tbody>
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<tr>
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</tr>
<tr>
<td>03/24/98</td>
<td></td>
<td>22.0</td>
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<td>22.6</td>
<td>24.9</td>
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<td>15.9</td>
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</tr>
</tbody>
</table>

**Person Throughput**

Total person-throughput in the HOV lanes and in the general purpose lanes was calculated. As might be expected, the low QuickRide usage has not resulted in any significant changes in person-throughput. In general, person-throughput on the HOV lane during the morning peak with QuickRide has been averaging between 3500 and 3800 persons per hour. During the evening peak, person-throughput on the HOV lane has been averaging between 2800 and 3100 persons per hour. Consistent with previous research (12), the person throughput per lane on the HOV lane during both the morning peak and the evening peak is remarkably larger than that on the main lanes. However, statistically, these data are not significantly different from pre-QuickRide values (12), when one controls for the daily and monthly variation of travel in the corridor. This suggests that QuickRide has failed in its objective to improve person-throughput, and to increase the utilization, of the HOV lane.

**CONCLUSIONS**

Based on the results of this analysis, the usage of QuickRide is currently too low to demonstrate statistically significant changes in travel speeds and person throughput on both the Katy general purpose lanes and the HOV lane. The reasons for the lack of usage are many, although one might suggest that people's reluctance to form carpools, and the lack of strong marketing of the program, have been the primary factors. Also, users tend to use QuickRide only occasionally, and not on a consistent basis. The failure to improve person-throughput so far suggests that other methods must be investigated to improve the usage of the HOV lane. These might include:

- *Lowering the fee:* A toll less than $2 will result in higher patronage, although the proper value of the fee deserves more study. It is clear from the history of the Katy HOV lane that a service that is free for HOV2's will likely result in too much demand and in degraded...
operations on the HOV lane. However, a toll of $1 may be sufficient to manage demand while still finding increases in person-throughput.

• **Raising the limit on the number of participants:** The original cap of 600 participants should be increased. Given the fact that most participants use the service only occasionally, more participants can be enrolled to obtain greater HOV2 volumes in the HOV lane. At a 40% daily participation rate, doubling or tripling the number of enrolled participants will not significantly affect HOV lane operations, and will result in higher person-throughput.

• **Increased marketing of the program:** Other preliminary results suggest that commuters in the corridor are either not aware or are not adequately informed about the QuickRide program. Marketing efforts can be expanded considerably before the resulting demand exceeds the available capacity of the HOV lane.

• **Marketing of the potential time savings:** In addition to other marketing efforts, it is clear that the QuickRide program is saving travelers considerable time, and this benefit should be promoted. Specifically, targeted marketing to single occupant vehicles may result in both greater carpool formation and higher person-throughput.

In addition to these recommendations, many of the aspects of the usage to date deserve further exploration in the following areas:

• In the context of the year-long project, the QuickRide usage appears to have reached a plateau about 2 months into the program. The reasons why the program has not grown further since March deserve more investigation.

• The morning peak has about 33% higher use than the evening peak, perhaps due to increased travel flexibility in the evening peak. An investigation of the trip purpose and scheduling constraints would be useful to see why the morning is more popular than the evening.

• Most of the QuickRide users take advantage of the program less than five times per week, and over 60% do not use it at all on any given week. This suggests that, while there are occasions when using the HOV lane is helpful, people do not use the facility consistently. The reasons why people are not using the HOV lane more frequently should be explored.

• Fortunately, a solid minority of SOV users has been attracted to the QuickRide program. Targeted marketing to this group may lead to more substantial increases in QuickRide use, especially if the marketing includes information on potential time savings from the HOV lane. The potential formation of carpools from SOV’s is a market that should be exploited in this test.

• Travel time savings for QuickRide participants averages about 18 minutes per trip. This results in a minimum value of time of $6.50 per vehicle per hour, which is slightly lower than expected. If the $2 fee is lessened, the minimum value of time would drop proportionally, perhaps attracting a much larger set of travelers in the corridor. Changing the fee would
allow direct investigation of the sensitivity of demand to price, and of the variation in value of time among the Katy freeway commuters.

An additional element of the project evaluation now underway is examining (1) user acceptance of the QuickRide program, and (2) the long-term viability of the program for improving person-throughput in Houston's HOV system. These results will be documented in a separate evaluation report to be published in 1999.

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