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16. Abstract

Limited capital investment for major transportation improvements and growth in metropolitan areas require the most efficient use of the existing transportation system. Provisions of the Clean Air Act Amendments and TEA-21 further intensify these concerns. One means to improve mobility is high-occupancy vehicle (HOV) lanes. HOV lanes have been shown to be very successful in Texas, however, they have been met with scepticism in several areas across the country. HOV lanes in two corridors in New Jersey (I-287 and I-80) were recently closed as a result of public criticism. In the wake of the actions of New Jersey, legislation has been introduced in California to limit the implementation of new HOV lanes and to potentially remove existing HOV lanes. Inappropriate data, such as vehicle volumes, is used as a basis for removing the facilities. The states of Colorado, Virginia, and Georgia have also proposed legislation to either eliminate HOV lanes or convert them to high-occupancy toll (HOT) lanes. While some of the claims against HOV lanes may be justified, a need exists to evaluate new HOV lanes implemented in the Dallas area as well as to continue an evaluation of existing HOV lanes.

While an extensive system of permanent HOV lanes is planned for the Dallas-Fort Worth urbanized area, the Texas Department of Transportation (TxDOT) and Dallas Area Rapid Transit (DART) have pursued and continue to pursue short-term or interim HOV lane projects that would enhance public transportation and overall mobility. There are currently 35.4 miles of interim HOV lanes operational in the Dallas area, including a barrier-separated contraflow lane on IH-30 (East R.L. Thornton Freeway) and buffer-separated concurrent flow HOV lanes on IH-35E North (Stemmons Freeway) and IH-635 (Lyndon B. Johnson Freeway). There have been several highly successful concurrent flow HOV lane projects and several that have not been as successful across the country. The objective of this research is to investigate the operational effectiveness of the Dallas area HOV lanes. Issues such as person movement, carpool formation, travel time savings, violation rates, safety, and project cost effectiveness are addressed. By understanding the operational performance and issues of both concurrent flow (buffer-separated) and contraflow (barrier-separated) HOV lanes, recommendations can be made on suggested HOV lane policies to be implemented in the Dallas area.

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INVESTIGATION OF HOV LANE OPERATIONS IN THE DALLAS, TEXAS AREA

by

Douglas A. Skowronek, P.E.
Research Engineer
Texas Transportation Institute

Stephen E. Ranft
Engineering Research Associate
Texas Transportation Institute

and

Joseph D. Slack
Technician II
Texas Transportation Institute

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The Texas A&M University System
College Station, Texas 77843-3135

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TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF FIGURES

LIST OF FIGURES (CONTINUED)

FIGURE **Page**

LIST OF FIGURES (CONTINUED)

LIST OF FIGURES (CONTINUED)

LIST OF FIGURES (CONTINUED)

LIST OF TABLES

I. INTRODUCTION

Limited capital investment for major transportation improvements and growth in metropolitan require the most efficient use of the existing transportation system. Provisions of the Clean Air Act Amendments and TEA-21 further intensify these concerns. One means to improve mobility is high-occupancy vehicle (HOV) lanes. The concept of an HOV lane is to increase the person-carrying capacity of freeways by providing dedicated lanes for multi-occupant vehicles. By doing so, one HOV lane can serve the travel needs of more people than a freeway lane, thereby increasing the efficiency of the entire system. While a variety of types of HOV lanes have been designed and implemented, there are a number of issues that must be considered for an efficient and effective HOV facility.

Additionally, HOV lanes are receiving negative publicity in several areas across the country. Concurrent flow HOV lanes in two corridors in New Jersey (I-287 and I-80) closed in November 1998 as a result of public criticism. The I-80 HOV lane, which opened in 1994, exceeded ridership projections and received generally favorable coverage in the news media. The I-287 HOV lane however, which opened in January 1998, did not perform as expected and as a result of public and news media criticism, both facilities were closed. Several factors contributed to the lack of success for the I-287 lane including changes in the policy and regulatory environment and the lack of supporting facilities, services, and programs. In the wake of the actions of New Jersey, legislation has been introduced in California to limit the implementation of new HOV lanes and to potentially remove existing HOV lanes. Inappropriate data, such as vehicle volumes, is used as a basis for removing the facilities. The states of Colorado, Virginia, and Georgia have also proposed legislation to either eliminate HOV lanes or convert them to high-occupancy toll (HOT) lanes. While some of the claims against HOV lanes may be justified, a need exists to evaluate new HOV lanes implemented in the Dallas area as well as to continue an evaluation of existing HOV lanes.

BENEFITS OF HIGH-OCCUPANCY VEHICLE LANES

There are many benefits of implementing an HOV lane in a corridor. Some of the HOV lane benefits are described below.

Travel time savings for eligible vehicles. Multi-occupant vehicles in the HOV lane are able to bypass the congested "stop-and-go" traffic in the general-purpose lanes during peak periods.

Trip time reliability for eligible vehicles. The travel speed in an HOV lane is generally near free-flow, which does not cause much variation in the day-to-day travel times on an HOV lane. The travel time, however, in congested conditions on general-purpose lanes can vary greatly from day-to-day, particularly when incidents occur on the freeway.

Increased person throughput. HOV lanes are an incentive for motorists to form carpools or ride transit buses to utilize the HOV lane benefits. With more occupants in fewer vehicles, the number of people commuting in a freeway corridor can increase.

Reduced fuel consumption and decreased vehicle emissions. The addition of an HOV lane in a corridor allows for free-flow travel for buses and other eligible vehicles who use the lane. In general, with an increase in vehicle speeds from the stop-and-go congested conditions, there is a reduction in fuel consumption and vehicle emissions.

Reduced bus operating costs. Transit service convenience can be measured in terms of adherence to a predetermined schedule and the time between buses (bus headways). If buses must travel in congested corridors, the time between consecutive buses can vary greatly from day-to-day. HOV lanes reduce the daily variance in time between consecutive buses and may even reduce the number of buses that are needed on a particular route because of a reduction in trip time.

Increased efficiency for the entire system. As commuters from the general-purpose lanes form carpools or ride buses to obtain the benefits of the HOV lane, excess capacity may become available on the general-purpose lanes. Vehicles that had diverted to arterial streets to avoid the congestion on the freeway may divert back to the freeway. The transfer of vehicles from the general-purpose lanes to the HOV lane and from the arterial streets to the freeway (general-purpose lanes and HOV lane) increases the efficiency of the road system.

IMPLEMENTATION OF HOV LANES IN THE DALLAS AREA

An extensive system of permanent HOV lanes is planned for the Dallas-Fort Worth urbanized area. The North Central Texas Council of Governments (NCTCOG) Mobility 2020 Plan, the long-range transportation plan for the Dallas-Fort Worth area, recommends 225 center line miles of HOV lanes. Until these permanent treatments can be implemented, the Texas Department of

Transportation (TxDOT) and Dallas Area Rapid Transit (DART) have been and continue to pursue short-term or interim HOV lane projects that would enhance public transportation and overall mobility. These projects are considered interim projects by the Federal Highway Administration (FHWA) because they have been retrofitted into the existing freeway facilities resulting in design exceptions from normally required standards.

There are currently 35.4 mi of interim HOV lanes operational in the Dallas area (Figure 1), consisting of HOV lanes on IH-30, IH-35E North, and IH-635 (Table 1). A 5.2 mi interim barrier-separated contraflow HOV lane on IH-30 (East R.L. Thornton Freeway) opened in September 1991 (Figure 2). Interim buffer-separated concurrent flow HOV lanes were opened on IH-35E North (Stemmons Freeway) in September 1996 (Figure 3). The northbound HOV lane is 5.5 mi in length, and the southbound HOV lane is 6.8 mi in length. The IH-35E North HOV lane includes a reversible barrier-separated at-grade HOV ramp through the IH-635 interchange. Interim buffer-separated concurrent flow HOV lanes also opened on IH-635 (Lyndon B. Johnson Freeway) in March 1997 (Figure 4). The eastbound HOV lane is 6.5 mi in length, and the westbound HOV lane is 6.2 mi in length.

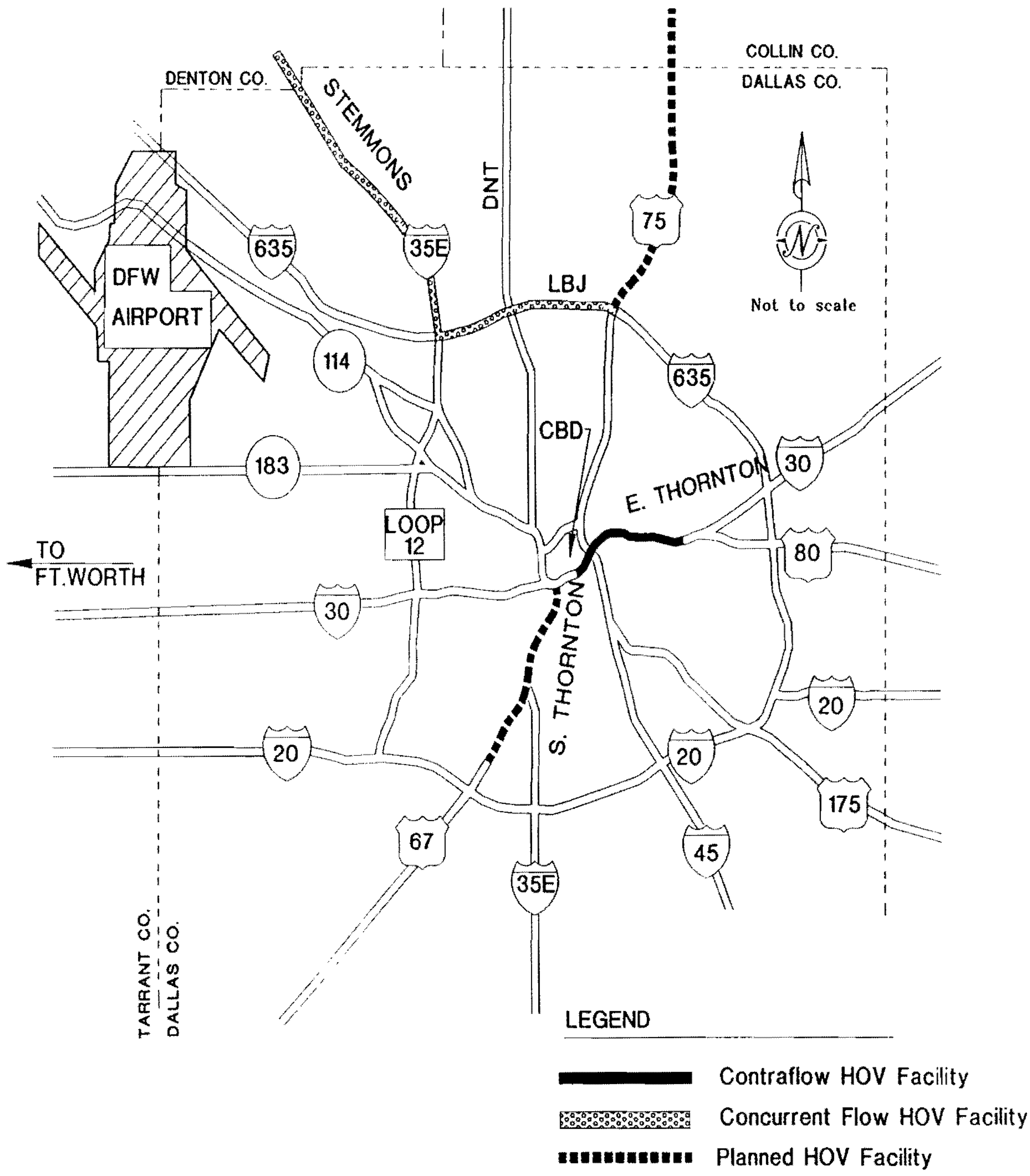
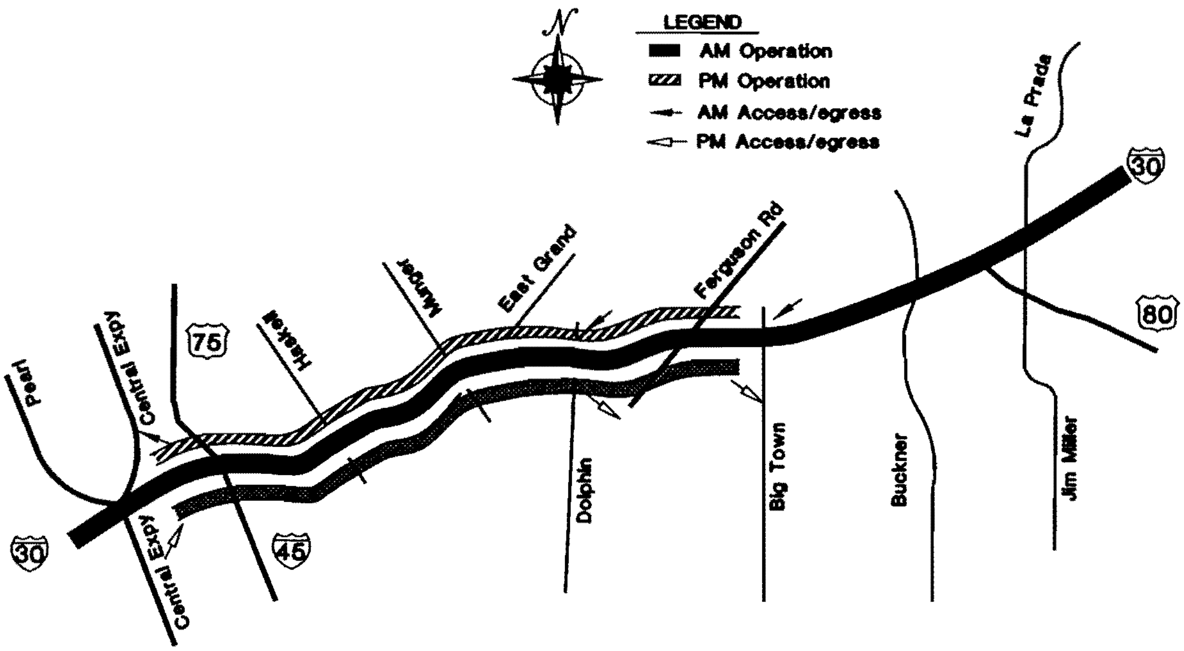
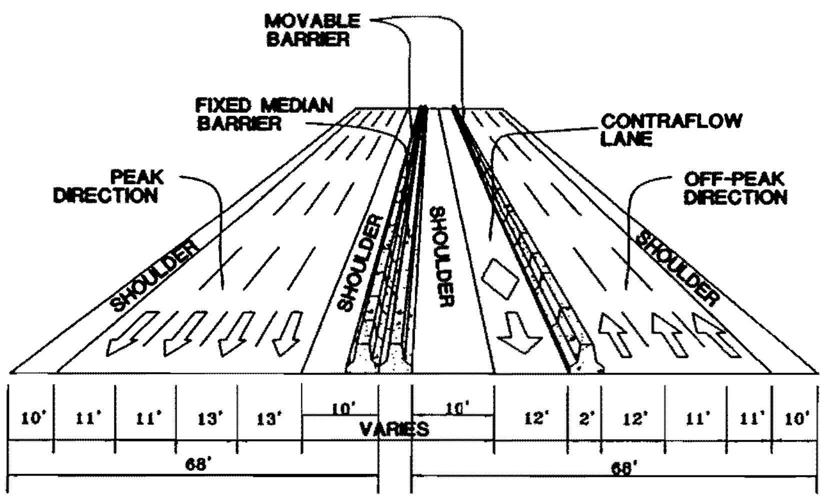


Figure 1. Dallas Area HOV Lanes.



HOV LANE LIMITS



TYPICAL CROSS SECTION

Figure 2. IH-30 East R.L. Thornton Freeway HOV Lane.

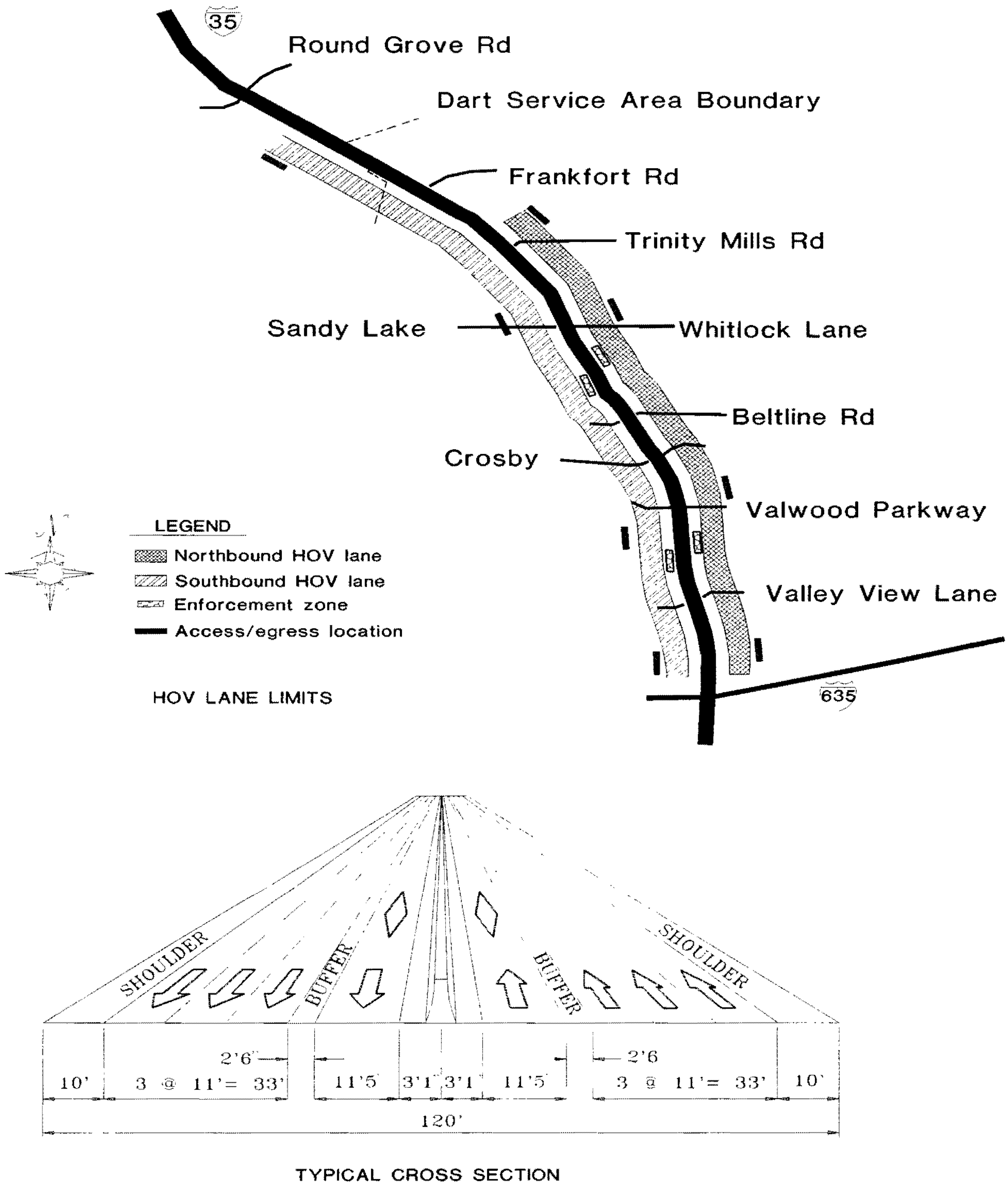
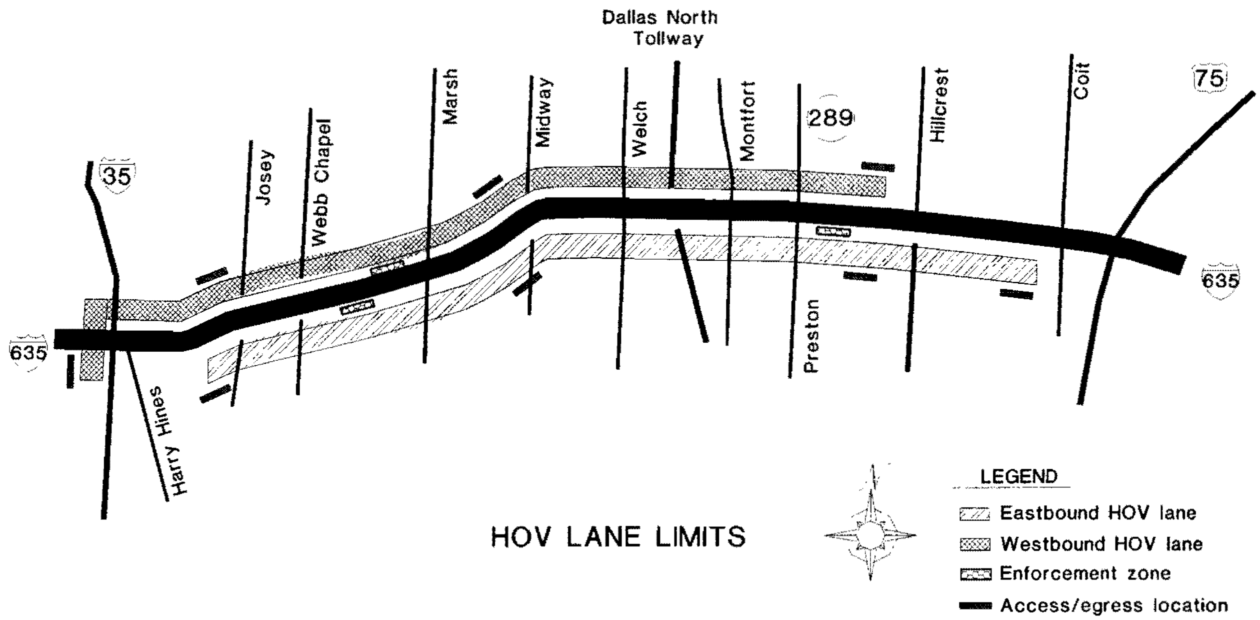


Figure 3. IH-35E North Stemmons Freeway HOV Lane.



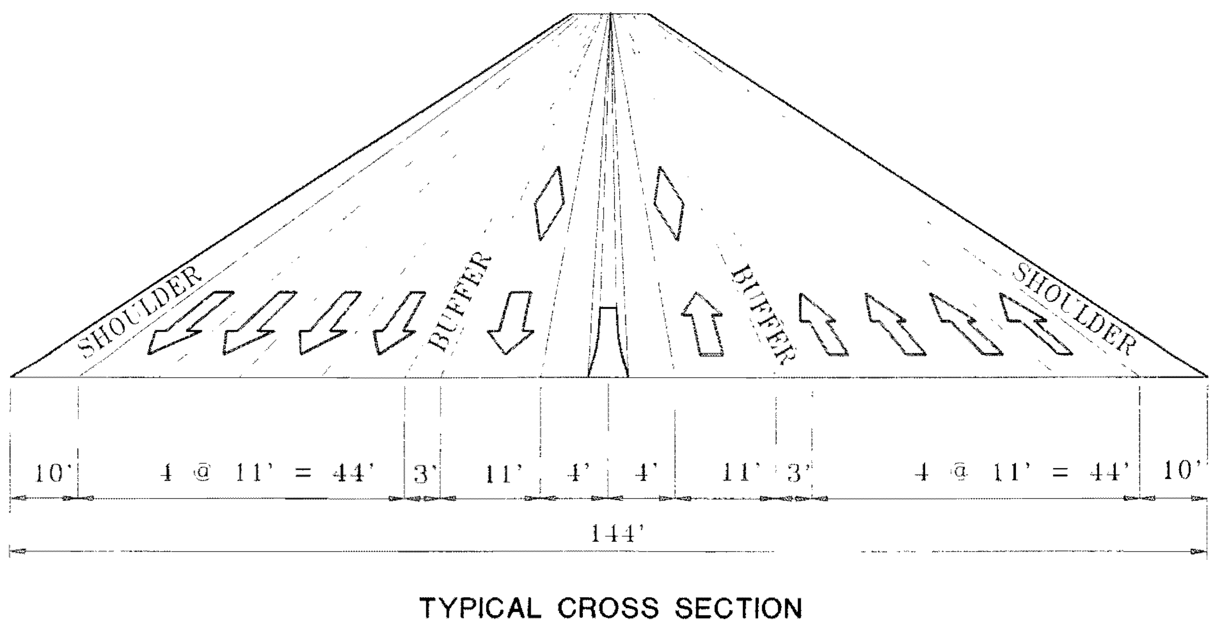


Figure 4. IH-635 Lyndon B. Johnson Freeway HOV Lane.

Table 1. Interim HOV Lanes Operating in the Dallas Area.

Corridor	IH-30 (East R.L. Thornton)	IH-35E North (Stemmons)	IH-635 (LBJ)
Type of Facility	Contraflow	Concurrent Flow	Concurrent Flow
Opening Date	September 1991	September 1996	March 1997
Hours of Operation	6 - 9 AM, 4 - 7 PM	24 Hours	24 Hours
Length	5.2 mi. EB, 5.2 mi. WB	5.5 mi. NB, 6.8 mi. SB	6.5 mi. EB, 6.2 mi. WB
Construction Cost (M$)	$17.4M[1]	$9.9M[2]	$16.3M
O&M Cost (M$)	$0.6M	$0.2M	$0.2M
Eligibility	Buses, vanpools, 2+ occupant carpools, motorcycles		

[1] Includes $12.2M HOV lane construction, $0.2M AM auxiliary lane, and $5.0M PM extension.
[2] Includes a reversible HOV ramp through the IH-635 interchange.

The contraflow lane on IH-30 is created with the use of a movable barrier which "borrows" a freeway lane in the off-peak direction and allows it to be used for peak direction HOV lane eligible vehicles. The concurrent flow lanes on IH-35E North and IH-635 were created by converting the inside shoulder to an HOV lane. These interim facilities are relatively new in the field of transportation, especially in Texas, and much experimentation is underway to determine optimum operational and design characteristics. Each corridor presents unique challenges in obtaining an operational facility which will attract the formation of carpools and enhance transit ridership. The objective of this research is to investigate the operational effectiveness of the new concurrent flow HOV lanes in the Dallas area as well as to attempt to assess the effectiveness of concurrent flow (buffer-separated) and contraflow (barrier-separated) HOV lanes. Additional research concerns particular to concurrent flow lanes include safety, capacity, enforceability, magnitude of violations, appropriate ingress and egress location, impact on freeway operations, public opinion/acceptance, and effectiveness of 24-hour operation.

Contraflow HOV lanes and concurrent flow HOV lanes have both advantages and disadvantages. The concurrent flow HOV lanes on IH-35E North and IH-635 are the first concurrent flow HOV lanes in Texas; therefore, their operational performance must be monitored and documented. By understanding the operational performance and issues of both concurrent flow (buffer-separated) HOV lanes and contraflow (barrier-separated)HOV lanes, recommendations can be made on suggested HOV lane policies, including the type of permanent HOV lanes to be implemented in the Dallas area.

ORGANIZATION OF REPORT

This report is divided into six sections. The first section provides an introduction to benefits of HOV lanes and HOV lanes in the Dallas area. The background information is contained in the second section, and the data collection methodology is summarized in the third section. The fourth section summarizes the operational performance of Dallas area HOV lanes including person and vehicle volumes and occupancy, travel times and speeds, transit operation impacts, and enforcement and violations. Additional barrier- and buffer-separated HOV lane issues, including toll applications, design requirements, implementation time, capacity, and flexibility are discussed in the fifth section. A summary is included in the sixth section.

II. BACKGROUND

There are approximately 980 centerline miles of freeway HOV lanes currently operating in the United States and Canada, and more than three-quarters of these lanes are concurrent flow facilities. Other than the Dallas area, Houston is the only other city in Texas that currently has HOV lanes in operation. The first HOV lane in Texas, which opened in August 1979, was the IH-45 (North Freeway) contraflow HOV lane in Houston. Currently there are five Houston facilities with barrier-separated HOV lanes in operation: IH-10W (Katy Freeway), IH-45N (North Freeway), IH-45S (Gulf Freeway), U.S. 290 (Northwest Freeway), and U.S. 59S (Southwest Freeway). In addition to HOV lanes in the planning stage in the Dallas area and Houston, HOV lanes are also proposed in Austin and San Antonio.

The topic of priority treatment in Texas has been addressed in several previous major TxDOT research studies including, most recently, study 0-1353, "An Evaluation of HOV Lanes in Texas," and study 7-1994, "Implementation and Evaluation of Concurrent Flow HOV Lanes in Texas"(1, 2). The studies addressed an evaluation of HOV lanes in Houston and Dallas using trend line data to allow changes over time to be detected and a comparison of control freeways without HOV facilities to help isolate the HOV lane impacts. The results from these studies as well as previous studies (study 2-10-74-205 from 1974 through 1983, study 2-10-84-339 from 1984 through 1988, and study 2-10-89/3-1146 from 1989 through 1993) have been instrumental in bringing about the implementation of HOV lanes in both Houston and Dallas. The studies did not, however, address any potential safety issues with concurrent flow HOV facilities.

An evaluation of the impact on the corridor as a result of implementation of an HOV lane requires a substantial amount of data collection. Morning and evening peak period data is currently being collected on the HOV lanes in the Dallas District on a monthly basis as part of a DART project. The monthly data collected, however, consists of travel times and person volumes on the HOV lanes and travel times on the adjacent freeway general-purpose lanes. A more thorough evaluation is necessary to determine corridor impacts. The experience in Houston is that substantial changes in the corridor occur during the first two to four years of HOV lane operation (3). It is therefore essential that the corridors with new HOV lanes in Dallas initially be monitored more often to detect corridor changes. This study, specific to the Dallas area, allowed for data to be collected four times per year in the Dallas District corridors with HOV lanes. The data was collected in the three corridors with HOV lanes in Dallas as well as a fourth corridor without an HOV lane which is used as a control corridor to help isolate HOV lane impacts. The data collected in addition to the DART project consists of person volumes on the freeway general-purpose lanes and person volumes and travel times on the control corridor.

Many of the original objectives of the previous research projects have been accomplished including the development of a comprehensive document for planning, designing, and operating park-and-ride lots and a manual for planning, designing, and operating HOV facilities (4, 5). The latter manual, however, is specific to transitways which are defined as exclusive, physically separated, access controlled HOV priority treatment facilities. Many aspects of other types of HOV projects, such as concurrent flow lanes, remain less understood. The two interim concurrent flow HOV facilities in the Dallas District are the first concurrent flow lanes implemented in Texas and they are essentially demonstrations of the buffer-separated HOV lane concept in Texas.

The American Association of State Highway and Transportation Officials (AASHTO) has developed a guide for the design of HOV facilities (6). While the document provides guidance for the planning and design of HOV lanes, it is cautioned that experience is not extensive enough to firmly establish standards for HOV facilities that are incorporated into existing highway rights-of-way where width and lateral clearances are limited. In addition, many of the issues discussed in the AASHTO guide are given only general consideration.

An extensive summary of the experience of HOV lanes across the nation has been prepared by Parsons-Brinkerhoff, Inc. (7). The summary reinforces the fact that a wide variety of HOV lane types and designs have been implemented. It does not, however, evaluate the effectiveness of various types or designs. Additionally, the key to success is a thorough knowledge of the problems in a corridor and the ability to weave compromises into the design to mitigate the problems.

SAFETY STUDIES

Buffer-Separated HOV Lanes

The information regarding the safety of concurrent flow HOV projects has been inconclusive. Some studies have concluded that concurrent flow lanes are as safe as other types of projects, while other studies have indicated a safety concern with concurrent flow HOV projects.

The largest safety concern with concurrent flow HOV lanes is the potential speed differential between the HOV lane and the general-purpose lanes. Research suggests that safety concerns may result when the speed differential is greater than 25 mph. This finding is consistent with the AASHTO report, "A Policy on Geometric Design of Highways and Streets," which suggests that the greater a vehicle deviates from this average speed on a highway, the greater its chances of becoming involved in an accident (8).

A study was conducted comparing the frequency and characteristics (manner of collision, severity of collision, etc.) of accidents before and after an HOV lane was added to Riverside Freeway State Route 91 (SR 91) in the Los Angeles area. The HOV lane was created by taking the inside shoulder. The cross section consists of a 2 ft inside shoulder, 11 ft HOV lane, and a 2 ft buffer, and access/egress is limited to two locations identified by broken double yellow lines and signs. The study concluded that the HOV project did not have an adverse affect on the safety of the corridor, and the changes in accident characteristics are attributed to the change in location and timing of traffic congestion (9).

A study conducted by the California Polytechnic State University reported the effect that HOV lanes have on the safety of selected California freeways. The results of the study suggest that the accident patterns are based on differences in traffic flow and congestion rather than geometric and operational characteristics of the HOV facilities (10). The accident "hot spots" during the peak periods on freeways with and without HOV lanes are a result of localized congestion (10).

The attitudes of California drivers towards HOV lanes were obtained through a focus group study. Southern California drivers perceive the OR 55 and SR 91 concurrent flow HOV lanes to be "scary" and "dangerous" due to the high-speed differential, close proximity of the median barrier, and weaving vehicles (11). The OR 55 HOV lane is 11 ft wide with a 2 ft inside shoulder and a 1 ft painted buffer stripe, and the SR 91 HOV is 11ft wide with a 2 ft inside shoulder and a 2 ft painted buffer (two yellow lines linked by ladder block stripes). Northern California drivers did not have similar concerns with the concurrent flow lanes (Marin 101 and Santa Clara 101). The Marin 101 HOV lane is 12 ft wide with a 2 ft to 5 ft inside shoulder and a painted stripe buffer, while the Santa Clara 101 HOV lane is 12 ft wide with a 10 ft inside shoulder and a painted stripe buffer.

In conclusion, the previous studies on the safety of concurrent flow HOV lanes are inconclusive. There have been several highly successful concurrent flow HOV lane projects and several that have not been as successful. Due to the uniqueness of these facilities, caution should be used when designing these facilities, especially when design values are at or near the minimum recommended design values. Special care should be used when designing access and egress locations to minimize the potential for accidents. Typically, these locations have a higher frequency of accidents. The number of accidents that occur immediately after a facility is opened may be high because drivers are not familiar with the HOV operation and facility. It may take several weeks for the drivers to become familiar with the facility, especially if the design requires taking the inside shoulder. After the first several weeks, the number of accidents should stabilize as drivers become familiar with the HOV lane and its operation.

Barrier-Separated HOV Lanes

Barrier-separated facilities isolate the HOV traffic from the general-purpose lane traffic flow. Accidents in the general-purpose lanes can significantly disrupt HOV operation, and any impacts that the HOV operation may have on mixed-flow operation are isolated to a few select ingress/egress locations (7).

If the HOV traffic was not on a separate roadway (barrier-separated or elevated facility), an incident in the general-purpose lanes may have a significant impact on the HOV traffic, as motorists in the general-purpose lanes try to bypass the congestion by using the HOV lane or as motorists in the HOV lane slow down and "rubberneck" to observe the incident. Separate roadways also protect the HOV traffic and the general-purpose traffic from the considerable speed differential that may exist between the two traffic streams with concurrent flow HOV lanes (7).

There has been some concern that separate roadways limit the ability to handle incidents in either the HOV lane or mixed-flow facility, as there is less flexibility in traffic handling around an incident (7). While this is not one of the main purposes of an HOV lane, if there were continuous access between the two traffic flows, then traffic could be diverted to either facility during an incident.

VIOLATION STUDIES

Concurrent flow HOV lanes generally have a lower compliance rate than other types of HOV lanes regardless of the amount of enforcement (7). On California stripe-separated lanes, the violation rates vary considerably, from 5 percent to 10 percent on SR 91 to 15 percent to 20 percent on Santa Clara 101 (9). These facilities have the potential to become as congested as the mainlanes at a high violation rate. If these facilities become as congested, there is less incentive to form carpools or to continue to utilize an existing carpool.

Separated roadways generally have a low violation rate because the characteristics of these facilities deter potential violators. Due to the physical separation from the general-purpose lanes with controlled access points, violators who are spotted in the HOV lane can not enter the general-purpose lanes. For example, the violation rate for California separated HOV facilities is the lowest on any California mainlane HOV lane, with both the El Monte busway and I-15 violation rate below 5 percent (9).

III. DATA COLLECTION METHODOLOGY

In order for the HOV lanes to be evaluated and monitored, it is necessary to collect a substantial amount of operational data on the HOV lanes and the adjacent freeway general-purpose lanes. This section describes the type of data that has been collected to evaluate the effectiveness of the Dallas area HOV lanes.

Most of the HOV facilities in Houston have been operating for several years, resulting in "mature" facilities with little change from year to year, therefore these facilities are only monitored on a semi-annual basis. In Houston, experience has indicated that there is a significant amount of change in the corridor during the first two to four years that an HOV lane is operational (3). After this time period, a facility is considered "mature." It is, therefore, essential that the corridors in Dallas with new HOV lanes initially be monitored frequently to detect corridor changes.

FIELD DATA COLLECTION

Monthly and quarterly data collection is conducted to monitor the operational performance of the HOV lanes. The data is collected in the peak direction of the corridor. During the AM peak period, IH-30 and IH-35E North have approximately a 70 percent directional peak inbound (westbound and southbound, respectively). A reverse pattern occurs during the PM peak period. IH-635 in the vicinity of the HOV lane, however, has nearly an equal directional split during the AM and PM peak periods. Data is, therefore, collected in both the eastbound and westbound directions during both peak periods. This section will describe the monthly and quarterly field data collection effort.

Monthly Data Collection

Since the Dallas area HOV lanes are relatively new facilities, DART requested that they be monitored on a monthly basis. TTI is under contract with DART to collect AM peak period (6:00 AM to 9:00 AM) and PM peak period (4:00 PM to 7:00 PM) travel time runs and vehicle occupancy counts in the peak direction on the three HOV lanes in the Dallas area. The HOV lane vehicle occupancy counts are recorded by observers stationed on the side of the freeway, and the travel time runs are collected using the floating car method. Travel time runs are also conducted on the adjacent freeway mainlanes for each facility that has an HOV lane. By comparing the travel time runs on the HOV lane with the freeway general-purpose lanes, travel time savings (HOV lane benefits) can be calculated. The vehicle occupancy counts are used to monitor changes in HOV lane occupancy usage and violation rates. In addition, automatic counters are placed on the IH-35E North and IH-635 HOV lanes to obtain daily volume of traffic on the HOV lanes. (Daily counts are not needed on the IH-30 HOV lane because the HOV lane is only operational during the peak period.) The number of vehicles parked in the park-and-ride lots located near the HOV lanes is also monitored on a monthly basis.

Quarterly Data Collection

In addition to the monthly data collection, AM and PM peak period vehicle occupancy counts are collected quarterly on the general-purpose lanes of the three freeways that have HOV lanes. These occupancy counts are used to monitor corridor-wide impacts of HOV lanes during the peak period.

Corridor changes can be evaluated by comparing the data collected each quarter or month; however, without a "control" corridor, corridor changes can be either attributed to the presence of the HOV lane or to changes in freeway traffic characteristics occurring more generally in the Dallas area. Therefore, operational data is collected on a quarterly basis on IH-35E South (South R.L. Thornton Freeway), the "control" section without an HOV lane. Each quarter, travel time runs and vehicle occupancy counts are collected on the control section and compared to the facilities with HOV lanes.

ACCIDENT DATA

Annual accident data is available from the Texas Department of Public Safety (DPS) through the Texas Accident Data Files. The accident data can typically be used to calculate accident rates before and after the HOV lanes were operational. In addition, the accident data can be plotted by location (milepoint) to determine the areas where a significant number of accidents are occurring. If there is a significant difference in the pattern of accidents before and after the HOV lane opened, these differences may be attributed to the HOV lane. The geometric and operational characteristics of the HOV lane may provide insight into the high accident location(s). However, there is currently a several month delay in the coding of the data into the Accident Data Files. A little more than a year of after-data was available for the two concurrent flow HOV lanes. Conclusions could not be drawn due to the limited available data and, therefore, has not been summarized as part of this study. A follow-up study (7-4961) will include an analysis of accident data and add more definition to any potential safety issue.

IV. OPERATIONAL PERFORMANCE OF DALLAS AREA HOV LANES

This section describes the operational performance of each HOV lane and is divided into the following sections: vehicle and person volumes and vehicle occupancy, speeds and travel times, transit operation impacts, cost effectiveness, enforcement and violations, safety, air quality, and public acceptance. Many of the comparisons consist of "before" HOV lane data with "after" HOV lane data. The before-data consists of an average of four to six quarterly data collection periods prior to the construction of the HOV lanes in each corridor as discussed in the "Data Collection Methodology" section of this report. The after-data is an average of data collected since the HOV lanes became operational.

VEHICLE AND PERSON VOLUMES AND OCCUPANCY

One of the primary objectives of HOV lanes is to increase person-throughput. This is accomplished when individuals form carpools or vanpools or ride transit buses. With more occupants in fewer vehicles, the vehicle occupancy increases, enabling more people to use the facility. This section describes the trends in vehicle and person volumes and occupancy on the HOV lanes and control section (IH-35E South) since the HOV lanes have opened.

Vehicle Volumes

One of the objectives of HOV lanes is to increase *person*-throughput rather than *vehicle*-throughput in the corridor. It is, therefore, not very useful to analyze the number of vehicles using a facility. It is, however, important to investigate the number of multi-occupant vehicles utilizing a facility. An increase in the number of multi-occupant vehicles on a facility indicates an increase in the person-throughput of a facility. The number of two-or-more person (2+) carpools on each of the facilities, before and after the HOV lane opened, is shown in Figure 5. After each HOV lane was opened, there was a significant increase in the number of 2+ carpools on each of the facilities. As shown in Figure 6, the percent increase in carpools ranged from 79 percent on eastbound IH-635 to 296 percent increase on IH-35E North. An analysis of the carpool volumes indicates that the implementation of HOV lanes has resulted in a substantial increase in the number of carpools in each corridor.

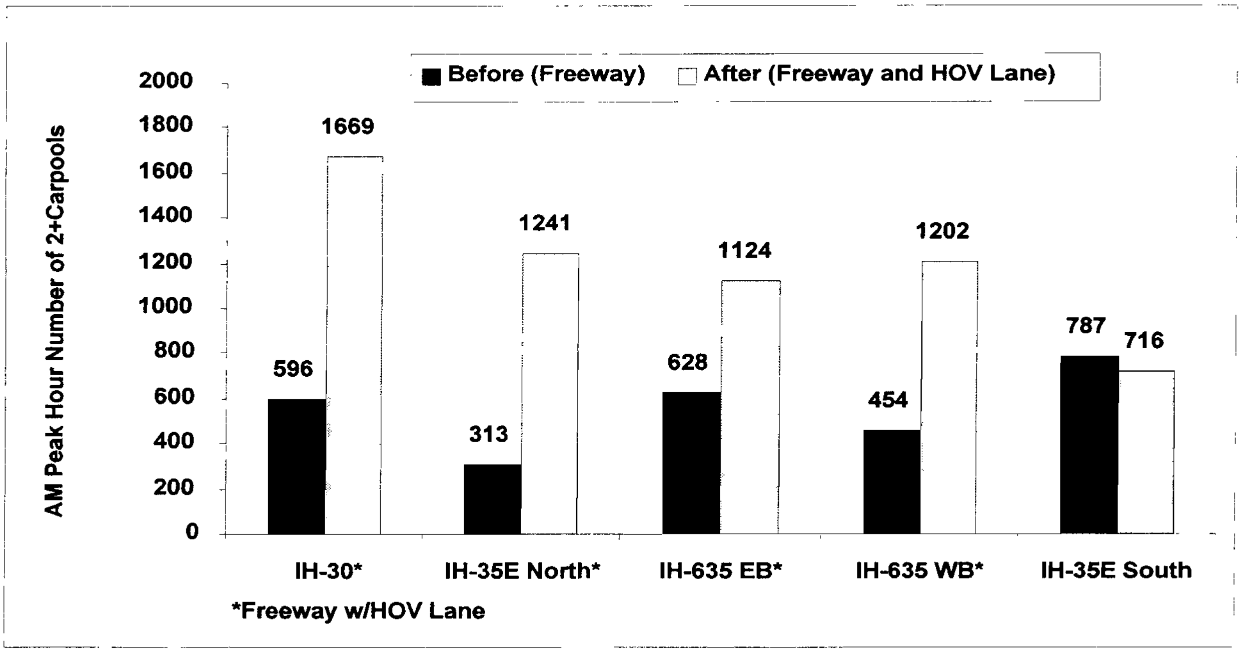


Figure 5. Change in AM Peak Hour Number of Carpools.

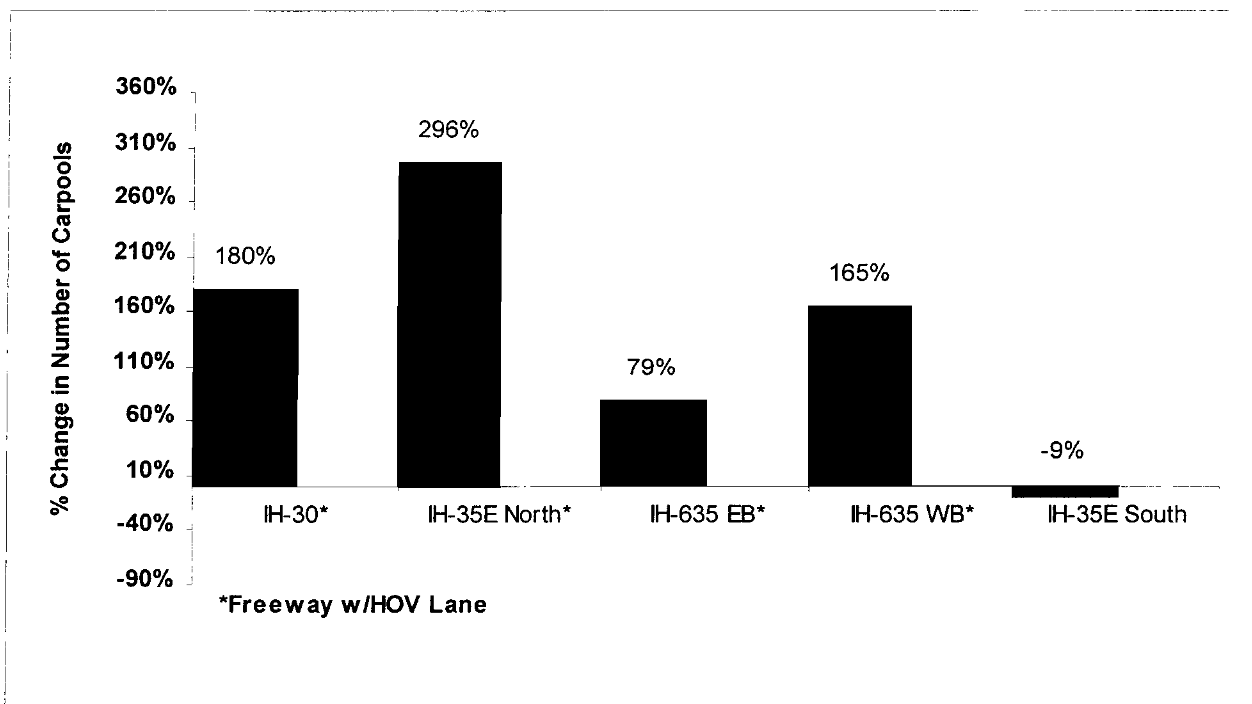


Figure 6. Percent Change in AM Peak Hour Number of Carpools.

Person Volumes

As previously mentioned, HOV lanes should increase person-throughput. Figure 7 shows the AM peak hour before and after person volumes in the peak direction for the freeway and HOV lane combined. An increase in the total person volume has been observed in each corridor since the opening of HOV lanes while a decrease in person movement has been observed in the control corridor.

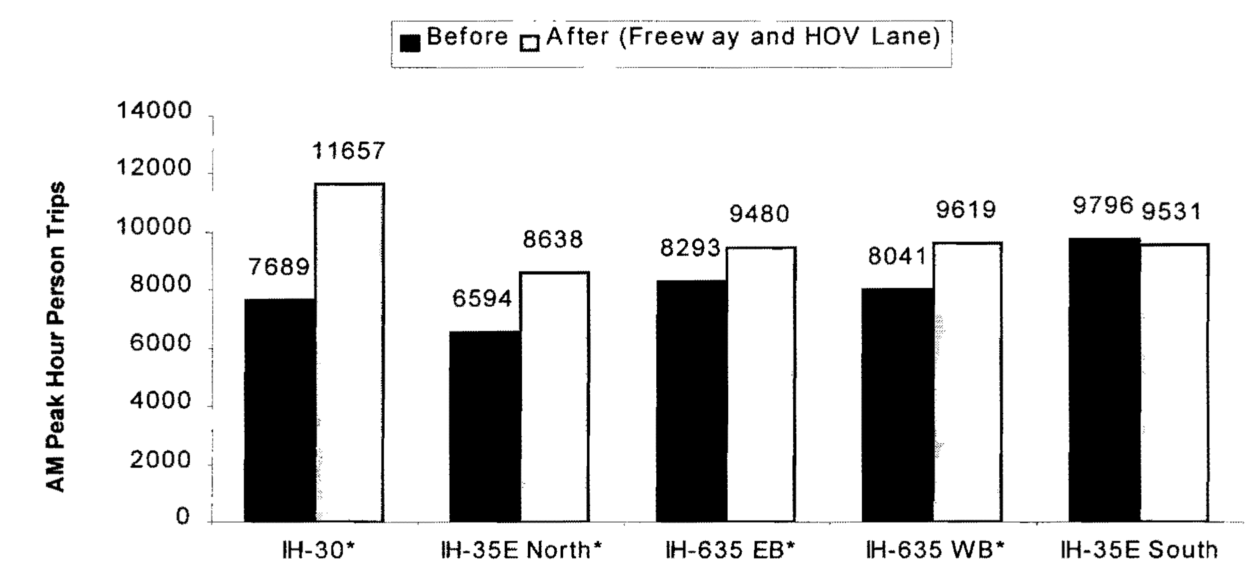


Figure 7. Change in AM Peak Hour Person Trips.

One guideline for HOV lanes is that an HOV lane should carry at least as many people as the average of the adjacent freeway mainlanes. Although there likely will be fewer vehicles in the HOV lane than in a general-purpose lane, the *number of people* in an HOV lane should be greater than the average number of people per mainlane. The peak hour person volume per lane for each of the HOV lanes and adjacent general-purpose lanes is shown in Figure 8. The IH-30 HOV lane carries more than twice the number of persons as an adjacent freeway lane during the peak hour, while the number of people in the IH-35E North is similar to an adjacent freeway lane, and the IH-635 eastbound and westbound HOV lanes are greater than an adjacent freeway lane. It is important to note that there are approximately 50 DART buses that utilize the I-30 HOV lane during the peak

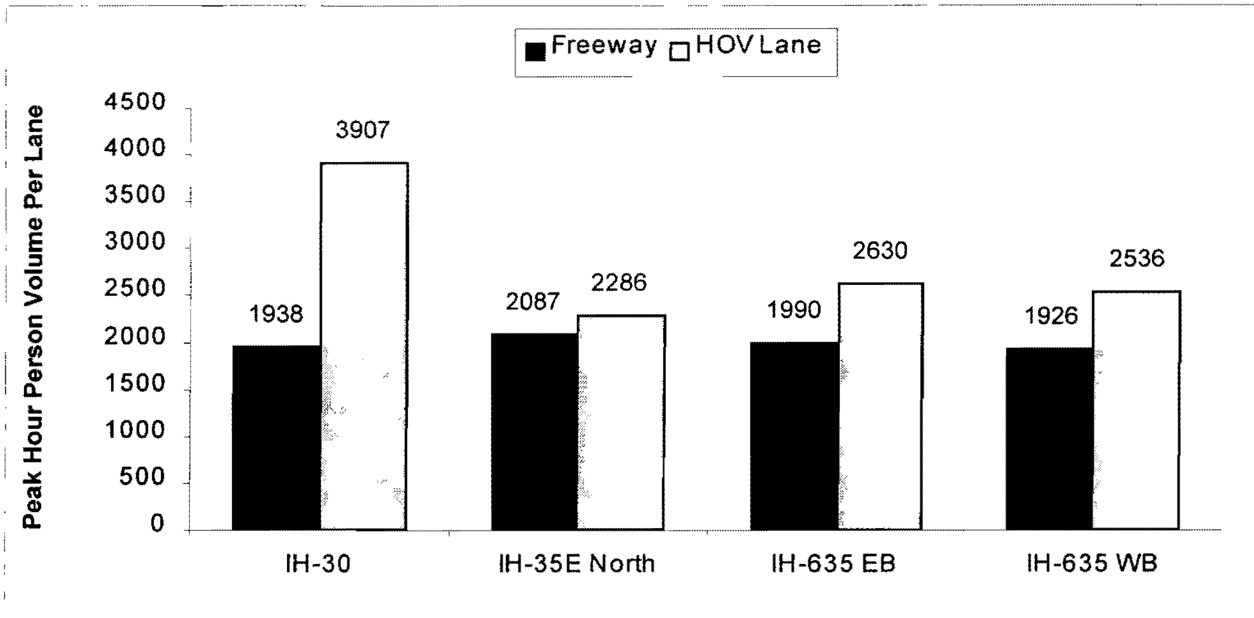


Figure 8. Peak Hour Person Volume per Lane.

hour, while only 10 buses utilize the IH-35E HOV lane. There are currently no fixed DART bus routes on the IH-635 HOV lanes. The presence of transit routes significantly increases the person carrying capability of a facility.

Occupancy

The average peak hour automobile and vehicle occupancy for the freeways with an HOV lane and IH-35E South, the control corridor, are shown in Figures 9 and 10, respectively. Due to the presence of several bus routes on IH-30, both the average vehicle occupancy and the average automobile occupancy were evaluated so that an unbiased comparison could be made between the occupancy rates in each corridor. The four facilities with an HOV lane show a similar increase in the average automobile occupancy rate after the HOV lane was implemented, while the vehicle occupancy varies amongst the corridors due to the number of transit buses during the peak hour.

Change in automobile occupancy is one method to determine if motorists are forming carpools to utilize the benefits of an HOV lane. The percent change in average automobile occupancy after an HOV lane was opened on IH-30, IH-35E North, and IH-635 is shown in Figure 11.

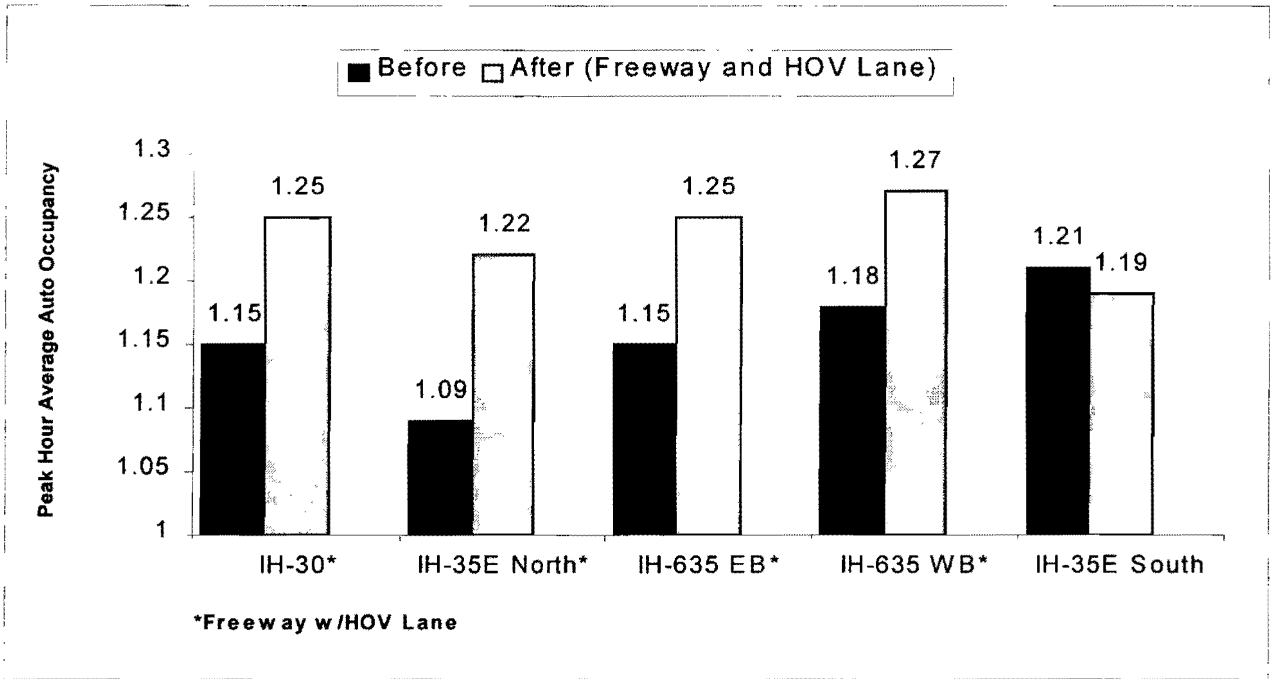


Figure 9. Change in Average Automobile Occupancy.

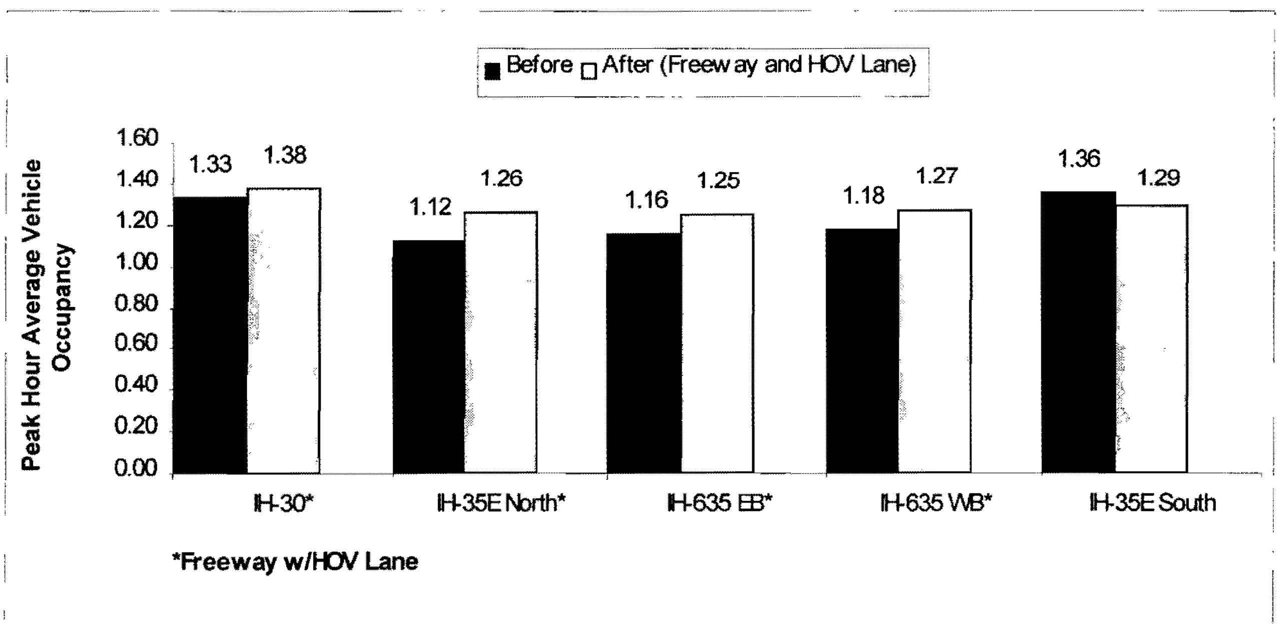


Figure 10. Change in Average Vehicle Occupancy.

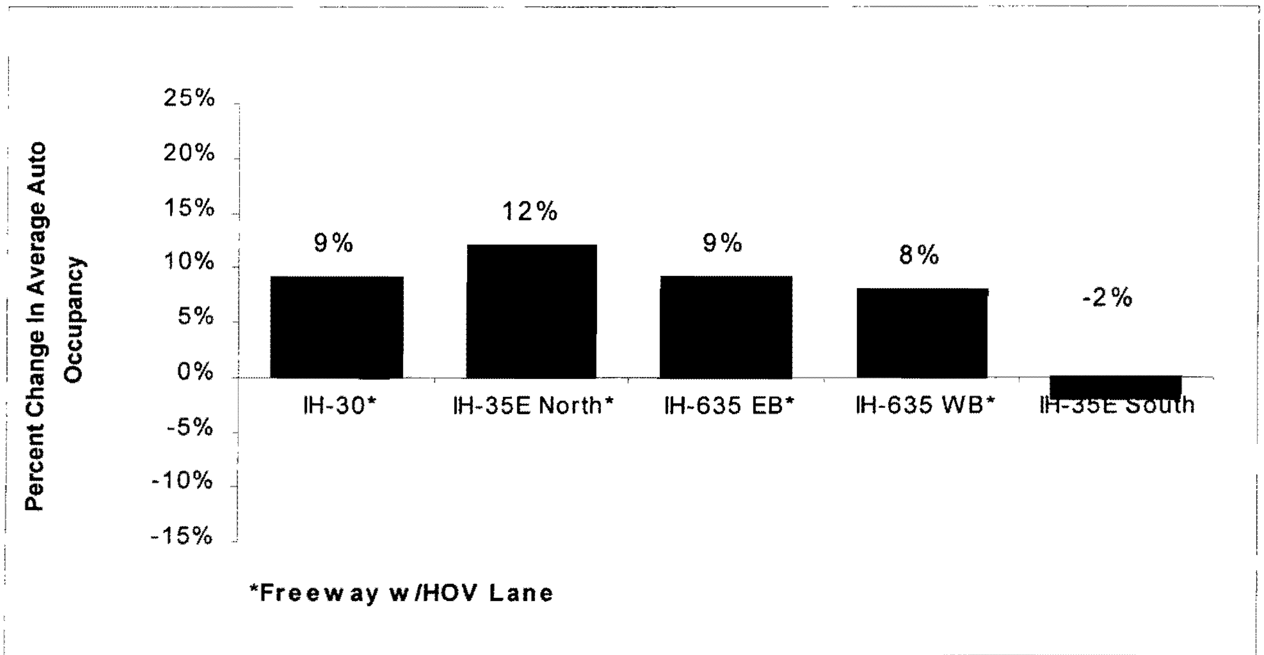


Figure 11. Percent Change in Average Automobile Occupancy.

All four freeways with an HOV lane have an 8 percent to 12 percent increase in the average automobile occupancy, while the average automobile occupancy on IH-35E South (without an HOV lane) has decreased by 2 percent. The increase in average automobile occupancy indicates that motorists are carpooling to gain the benefits of traveling in an HOV lane.

The operational data for the IH-30, IH-35E North, and IH-635 freeways indicate an increase in the person trips and automobile and vehicle occupancy on each facility after an HOV lane opened. In comparison, the control freeway, IH-35E South, did not have a similar increase in person trips and automobile occupancy.

SPEEDS AND TRAVEL TIMES

Operating speeds and travel time savings are two factors that are important to motorists who utilize the HOV lane. HOV lane users expect to travel faster than vehicles in the adjacent general-purpose lanes, thus saving commuting time. The speed and travel time characteristics of the Dallas area facilities with HOV lanes are summarized in this section.

Speeds

A guideline for HOV lanes is that the lane should not negatively impact the mainlanes. If implementing an HOV lane causes travel speeds on the adjacent mainlanes to decrease, the efficiency of the roadway system would be diminished, and there will be public opposition to the project. The peak hour travel speeds on the HOV lanes and adjacent mainlanes are shown in Figure 12. There was an increase in mainlane speeds after the HOV lane opened on IH-30. Opening an HOV lane on IH-35E North and IH-635 eastbound and westbound appears to have essentially no impact (positive or negative) on the mainlane operating speeds. In addition, on each of the facilities, the HOV lane speeds were significantly higher than the speeds on the adjacent general-purpose lanes.

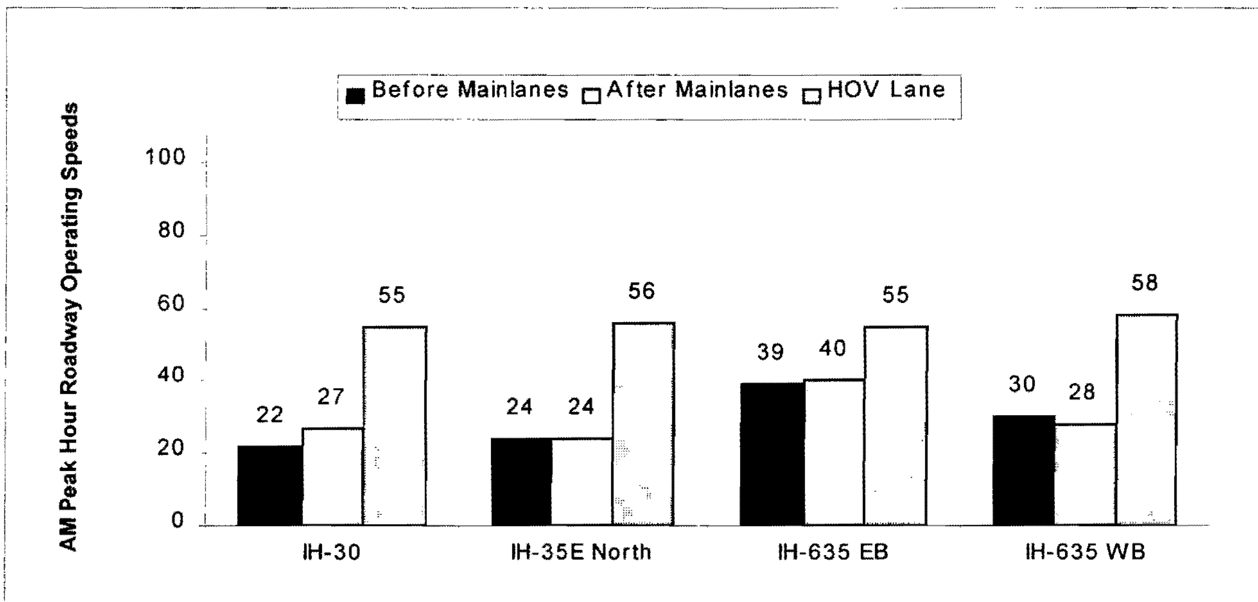


Figure 12. Change in Roadway Operating Speeds.

Travel Times

Travel time savings are directly related to operating speed. It has been found that to encourage the formation of carpools or to increase bus utilization, a minimum of five minutes of total travel time savings over the general-purpose lanes is required. Travel time savings are easiest benefits for passengers to measure directly; therefore, it is imperative that the HOV lane provide users travel time savings over the general-purpose lanes. The peak hour travel time savings on incident-free days for each of the HOV lanes are shown in Figure 13. This travel time savings actually underestimates the *average* weekday travel time savings due to incidents on the freeway mainlanes. An incident on the freeway mainlanes would likely increase the travel time on the mainlanes; however, it may or may not have an impact on the HOV lane travel times depending on the type of incident. In general, the HOV lanes save motorists more than five minutes over the general-purpose lanes on incident-free days.

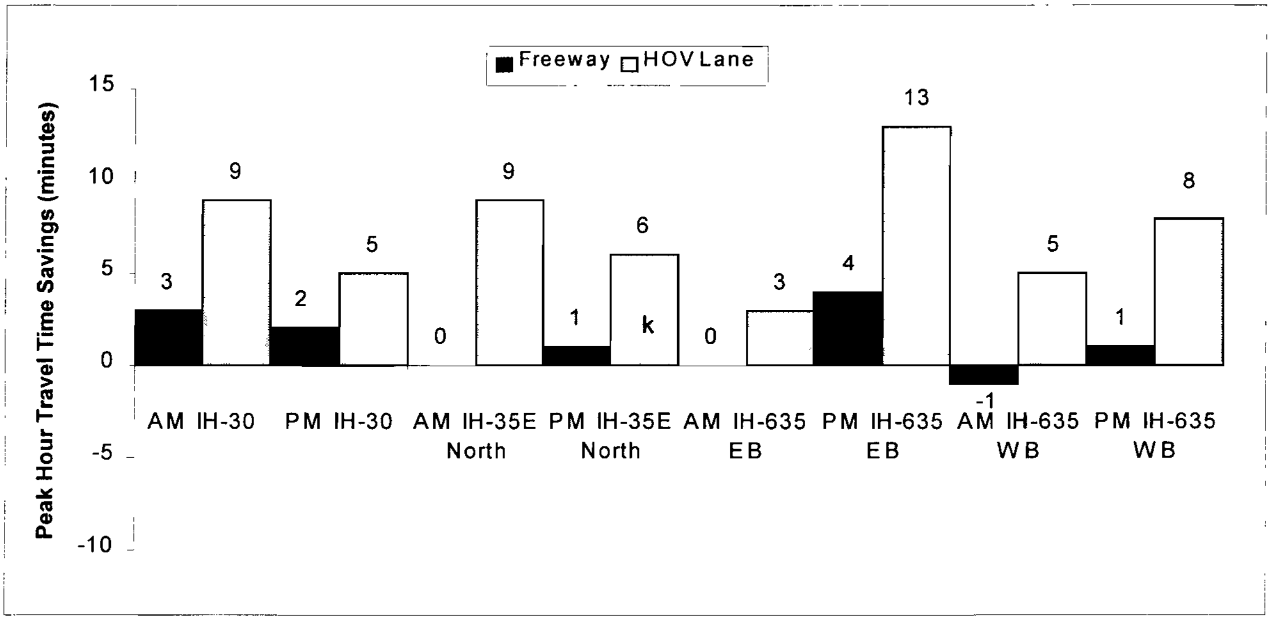


Figure 13. Peak Hour Travel Time Savings After HOV Lane Opening.

Perceived travel time savings may be of greater importance than actual travel time savings. A survey of IH-30 motorists in 1995 determined that the transit users perceived travel time savings as 13 minutes during the AM peak and 12 minutes in the PM peak (12). Similarly, the IH-30 carpoolers perceived they saved 16 minutes during the AM peak and 13 minutes in the PM peak over the general-purpose lanes. At this time, there has not been a motorist survey conducted on either the IH-35E North corridor or the IH-635 corridor.

TRANSIT OPERATION IMPACTS

Potential HOV lane impacts on transit operations may affect transit route and transit ridership, which are discussed in the next section. DART has modified several bus routes to allow them to utilize the HOV lanes and take advantage of the travel time savings provided. The IH-635 corridor, however, does not currently have any fixed transit bus routes using the HOV lanes on a regular basis.

Transit Routes

Bus operating speeds have more than doubled since the opening of the HOV lanes on IH-30 and IH-35E North during the AM and PM peak hour, as shown in the "Speeds and Travel Times" section of this report. In the IH-30 corridor, which has approximately 50 DART buses using the HOV lane during the peak hour, the result is that the operating cost of DART buses using the lane has been reduced by approximately $402,000 per year because fewer buses are required to run the "before" HOV lane routes due to the travel time savings and trip time reliability. Additionally, the bus schedule times have been reduced by six minutes on IH-30 during the AM and PM peak hours as a result of the travel time savings previously discussed. The cost of operating DART buses on IH-35E North has also been reduced by approximately $185,000 per year as a result of implementation of the HOV lane.

Transit Ridership

The AM and PM peak hour bus ridership is shown in Figure 14. An increase in the bus ridership has not been observed since the opening of HOV lanes on IH-30 and IH-35E North and, in fact, a decrease has been observed on IH-30. The reason for this may be, in part, related to the increase in the number of carpools using the HOV lane. A review of the ridership on the HOV lane during the past several data collection periods appears to indicate a correlation between bus and carpool ridership. While the total persons using the HOV lane has increased, the bus and carpool person volumes fluctuate inversely to each other (i.e., the carpool ridership is high while the bus ridership is low during some data collection periods and vice versa during others). This appears to indicate that some commuters utilize whichever mode, bus or carpool, is more convenient on any given day.

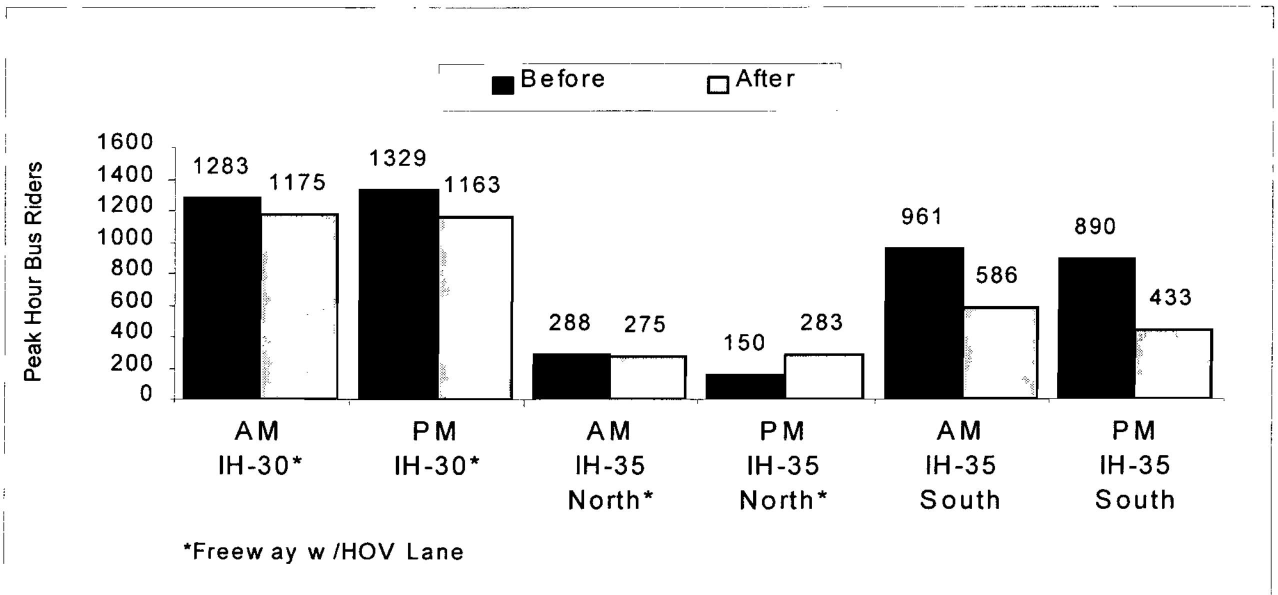


Figure 14. Change in Transit Bus Riders.

COST EFFECTIVENESS

The cost effectiveness of each of the three HOV lanes projected out to 10 years is shown in Tables 2, 3, and 4. The tables show the benefit/cost ratio at the end of each fiscal year (September through August) with the exception of the IH-635 HOV lane. The HOV lane on IH-635 opened half-way into fiscal year 1997, so the benefits are for six months in 1997 and for six months in the final year (2007) for a total of 10 years. The benefits are based on the travel time savings afforded to users of the HOV and, in the case of the IH-30 HOV lane, include benefits to persons on the adjacent freeway general-purpose lanes as they realized a travel time savings with the implementation of the lane. The benefits are based on measured travel time savings through fiscal year 1997. Benefits in future years are assumed to be the same as fiscal year 1997 benefits. The value of time used is $11.47 per person. All three HOV lane projects are cost effective and have attained, or are projected to attain, a benefit cost ratio greater than 1.0 within the first five years of operation.

Table 2. IH-30 East R.L. Thornton HOV Lane Benefit/Cost Analysis.[1]

Benefits and Costs (Million Dollars)[4]						
Comment	Fiscal Year	Capital Cost	Operation/ Enforcement	HOV Lane Benefits	Mainlane Benefits	B/C Ratio
Initial construction	1992	12.2	0.60	2.85	2.64	0.43
	1993	-	0.60	2.89	3.68	0.88
	1994[2]	-	0.60	2.66	2.45	1.19
AM auxiliary lane	1995	0.2	0.60	3.28	3.92	1.57
PM extension	1996[3]	5.0	0.60	2.99	3.31	1.46
	1997	-	0.60	3.47	2.88	1.68
	1998	-	0.60	4.00	3.00	1.92
	1999	-	0.60	4.12	3.12	2.14
	2000	-	0.60	4.12	3.12	2.34
	2001	-	0.60	4.12	3.12	2.53

Notes: [1]HOV lane opened in September 1991.
[2]AM auxiliary lane opened in July 1994.
[3]PM extension opened in February 1996.
[4]Benefits include $402,000 DART bus operating cost savings per year.

Table 3. IH-35E Stemmons HOV Lane Benefit/Cost Analysis.[1]

Benefits and Costs (Million Dollars)[2]						
Comment	Fiscal Year	Capital Cost	Operation/ Enforcement	HOV Lane Benefits	Mainlane Benefits	B/C Ratio
HOV lane	1997	7.0				
S-Ramp		2.9	0.20	2.59	0.00	0.26
	1998	-	0.20	2.67	0.00	0.50
	1999	-	0.20	2.42	0.00	0.71
	2000	-	0.20	2.42	0.00	0.90
	2001	-	0.20	2.42	0.00	1.07
	2002	-	0.20	2.42	0.00	1.24
	2003	-	0.20	2.42	0.00	1.39
	2004	-	0.20	2.42	0.00	1.54
	2005	-	0.20	2.42	0.00	1.67
	2006	-	0.20	2.42	0.00	1.80

Note: [1]HOV lane opened in September 1996.
[2]Benefits include $185,000 DART bus operating cost savings per year.

Table 4. IH-635 LBJ HOV Lane Benefit/Cost Analysis.[1]

Benefits and Costs (Million Dollars)						
Comment	**Fiscal Year**	**Capital Cost**	**Operation/ Enforcement**	**HOV Lane Benefits**	**Mainlane Benefits**	**B/C Ratio**
Initial construction	1997[2]	16.3	0.10	4.84	0.00	0.30
	1998	-	0.20	9.23	0.00	0.83
	1999	-	0.20	9.60	0.00	1.35
	2000	-	0.20	9.60	0.00	1.84
	2001	-	0.20	9.60	0.00	2.30
	2002	-	0.20	9.60	0.00	2.73
	2003	-	0.20	9.60	0.00	3.14
	2004	-	0.20	9.60	0.00	3.53
	2005	-	0.20	9.60	0.00	3.89
	2006	-	0.20	9.60	0.00	4.24
	2007[3]	-	0.10	4.80	0.00	4.41

Notes: [1]HOV lane opened in March 1997.
[2]Includes 3rd and 4th quarters of FY 1997 only (6 months).
[3] Includes 1st and 2nd quarters of FY 2007 only (6 months).

ENFORCEMENT AND VIOLATIONS

The HOV lanes are enforced by DART Transit Police. Although the number of enforcement officers monitoring the lanes varies, the IH-35E North and IH-635 HOV lanes are routinely enforced by a combination of roving and stationary enforcement in squad cars and motorcycles during the peak periods and sporadically during the off-peak periods.

More officers, however, are required to enforce the concurrent flow lanes than the barrier-separated contraflow lane on IH-30. The IH-30 HOV lane is effectively enforced by two transit police officers while the concurrent flow lanes require three to four officers each during the peak periods.

The peak hour violation rate for each of the HOV facilities is shown in Figure 15. Due to the presence of DART Transit Police officers on the facility, the violation rates on the HOV lanes have been relatively low. The violation rates on the concurrent flow lanes are at the lower end of typical nationally reported concurrent flow HOV lane violation rates, ranging between 5 percent and 40 percent.

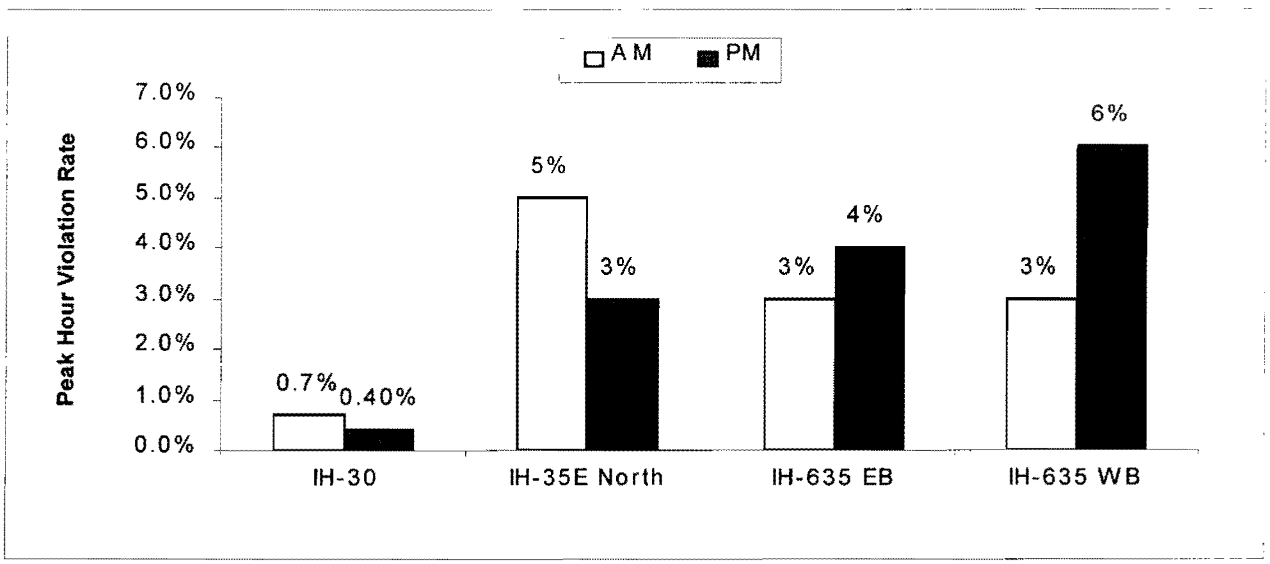


Figure 15. Observed Occupancy Violation Rates.

In addition to traditional HOV lane enforcement methods, a public telephone hotline (HERO) for reporting HOV lane violators, similar to the program in the Seattle area, is currently being studied by DART for implementation. The HERO program consists of a dedicated phone number for motorists to report HOV lane violators and identifies specific individuals who need additional information about the benefits of HOV lanes.

AIR QUALITY

As previously mentioned, one of the benefits of HOV lanes is a reduction in fuel consumption and vehicle emissions as vehicle speeds increase from stop-and-go congested conditions. A study conducted by NCTCOG estimated the reduction in vehicle emissions from the implementation of each of the HOV lanes in the Dallas area (13). This reduction is based on changes in travel patterns for three groups of commuters: new carpools formed from single-occupant vehicles to use the HOV lane, existing carpools in the mainlanes utilizing the HOV lane, and drivers on the parallel arterials switching to use the mainlanes. It is estimated that the volatile organic compound (VOC) emissions are reduced by 51.4 lbs/day on I-30, 109.9 lbs/day on IH-35E North, and 236.7 lbs/day on I-635 due to the HOV lane(s) on each of these facilities. No attempt has been made to refine or verify the estimates since NCTCOG staff used operational data supplied by TTI to estimate the emissions.

PUBLIC ACCEPTANCE

In 1995, a survey of IH-30 carpoolers and bus riders using the HOV lane and motorists in the general-purpose lanes was conducted to determine motorists' attitudes regarding commuter travel behavior (12). The primary reasons cited for using transit service were that it is cheaper and more convenient than driving, while the primary reasons for carpooling were that it is cheaper than driving alone and saves time.

DART and TxDOT have been very receptive to the public comments about the HOV lanes, and they have been continually improving operations. After the IH-30 HOV lane was opened, a bus route was switched from an arterial to the freeway HOV lane to gain the travel time savings. In July 1994, to improve AM operations, an auxiliary lane was added at the terminus of the westbound HOV lane. In addition, in February 1996, the eastbound HOV lane for PM operations was extended from Dolphin Road to Jim Miller Road to mitigate recurrent congestion at Dolphin Road.

When the IH-635 HOV lane was opened, motorists from the Dallas North Tollway could not access the westbound IH-635 HOV lane. Due to public response, another access location was added to provide access from the Tollway to the westbound HOV lane.

It is anticipated that a survey of HOV lane users and nonusers will be conducted on IH-35E North and IH-635 to assess the public opinion of concurrent flow lanes.

V. OTHER BARRIER- VERSUS BUFFER-SEPARATED HOV LANE ISSUES

In addition to the quantitative issues associated with barrier-separated and buffer-separated HOV lanes (Section IV), there are also several qualitative issues that must be considered. These qualitative issues include design requirements, implementation time, capacity, access/egress, and flexibility, which are discussed in this section.

DESIGN REQUIREMENTS

Barrier-separated HOV lanes or separated roadways are generally implemented in corridors with a high HOV demand. The benefits of an HOV project must outweigh the cost of building a separated roadway for HOVs. In addition, separated roadways usually require more right-of-way than other types of HOV facilities because of acceleration and deceleration lanes at access/egress areas and wider areas to allow for direct connect ramps. This, many times, makes it difficult to retrofit these types of facilities into existing cross sections.

Buffer-separated or concurrent flow HOV lanes generally require less right-of-way (ROW) than separated roadways. These facilities are typically located on the inside lane of the freeway; however, they can be the outside lane of the freeway, although non-HOV traffic would need to access the HOV lane to enter and exit the freeway, which is undesirable.

IMPLEMENTATION TIME

Separated roadways generally take the longest time to implement. The additional time is required for designing permanent structures, obtaining needed ROW, and obtaining funding for the project, similar to any long-term construction project. The implementation time for concurrent flow HOV lanes is relatively short, particularly when an inside freeway shoulder already exists. Many concurrent flow HOV projects can be accommodated in the existing ROW by converting the inside shoulder to an HOV lane. In addition, reducing the general-purpose lane widths or shifting the lanes may be required to provide a buffer or enforcement area along the facility.

CAPACITY

The capacity of any facility is dependent on many factors, including design speed, lane width, and the presence of vehicles other than passenger cars in the traffic stream. Differences in capacity specific to the generic comparison of barrier- versus buffer-separated can be attributed to the number of and the design of access/egress areas and the offset to either a barrier or general-purpose lane traffic. The capacity of an HOV facility is in the 1500 vph to 1700 vph range to ensure free-flow operations before considering the buffer- and barrier-separated issues that impact capacity.

Concurrent flow lanes with continuous access and egress will have continuous merging of high- and low-speed traffic, which will reduce the capacity of the facility. Limited access via a painted buffer will focus this merging activity to specific areas and should improve operations. However, without acceleration and deceleration lanes, which typically are provided at barrier-separated access/egress areas, operations and capacity will be negatively impacted.

The reduction in capacity due to an offset of less than 6 ft to a fixed barrier can be quantified using procedures in the Highway Capacity Manual (14). The capacity reduction for a buffer-separated lane with an offset of less than 6 ft to a congested general-purpose freeway lane, however, is not known and is beyond the scope of this research to determine.

ACCESS/EGRESS

Access to separated roadways is controlled and more limited than on concurrent flow facilities, which provide safe and efficient operations. Access can be provided with direct connector ramps to/from transit centers, park-and-ride lots, and frontage roads or by slip ramps to/from the freeway mainlanes or frontage road. In addition, the barriers provide effective delineation of entrance and exit points (7).

On separate facilities, carpools must travel the entire distance on the HOV lane; however, on concurrent flow facilities, carpools can travel the entire HOV facility or just a portion of the facility, as dictated by their origin and destination. The access to concurrent flow facilities is much less restrictive than separate roadways facilities. On concurrent flow facilities, access may be provided continuously along the facility or restricted to certain locations, as delineated by pavement markings. The amount of access along the facility should be a decision based on safety and traffic operations concerns. Frequent access increases the potential number of carpoolers but also decreases operational effectiveness.

Concurrent flow HOV lanes are typically the inside lane on the freeway. Therefore, vehicles entering the freeway (generally a right-hand entrance ramp) must weave across several congested freeway lanes to access a median HOV lane, and then weave across several congested freeway lanes to exit the freeway (generally a right-hand exit ramp). The weaving to/from the freeway ramps and HOV lane limit the distance that carpools can travel in the HOV lane; therefore, concurrent flow HOV lanes are typically longer distance projects. This weaving maneuver has the potential to negatively affect the mainlane traffic operations. Additionally, if there are left-side entrance or exit ramps, provisions must be made to allow general traffic to use the HOV lane in the proximity of the ramp which, from a traffic operations standpoint, is not a desirable design.

INCIDENT MANAGEMENT

Incident management is an issue that must be addressed in all freeway corridors. Incident management in corridors with concurrent flow HOV lanes is especially critical. HOV lane users who do not regularly gain a travel time savings and trip time reliability may not continue to use the HOV lane. Incidents that occur on the freeway general-purpose lanes can, and have, blocked the concurrent flow HOV lane because of the lack of a physical barrier separating the HOV lane and adjacent general-purpose lanes. DART has personnel that patrol the HOV lanes and respond to all incidents that occur on the facilities. A project is currently being conducted in the IH-635 corridor to improve incident management response times on the general-purpose lanes. It involves staging a tow truck within the corridor to expedite response times to crashes and mechanical breakdowns.

FLEXIBILITY

A separate roadway facility allows for flexibility in the criteria for eligible users because of the limited access. On the other hand, concurrent flow HOV lanes have flexibility in design – these projects can be interim projects that are retrofitted in the existing cross section, or they can be designed as long-term permanent facilities.

Hours of Operation (24-Hour versus Peak Period Operation)

Typically, barrier-separated HOV lanes are reversible, so they can serve the peak direction commuting traffic; therefore, they usually can not operate 24 hours a day. Buffer-separated HOV lanes can either operate 24 hours a day or peak periods only and be used as general-purpose lanes or shoulders during certain hours (non-peak) of the day. In some corridors across the country, concurrent flow HOV lanes are used as general-purpose lanes or shoulders during off-peak periods. Examples of this occur in Miami, Orlando, Minneapolis, Nashville, Phoenix, and San Francisco. Drawbacks of this type of operation, however, may include confusion on the part of commuters, more difficult enforcement and increased signing needs.

The two concurrent flow HOV lanes in the Dallas area currently operate 24 hours a day. The typical vehicle and person volumes for each hour of the day are shown in Figures 16 through 19. The traffic patterns on IH-35E North are such that approximately 70 percent of the total corridor traffic is traveling southbound (inbound) during the morning peak period and the opposite occurs during the evening peak period in the northbound (outbound) direction. There is no recurrent congestion in the off peak direction or outside of the peak periods on the freeway general-purpose lanes. This pattern is reflected in the HOV lane usage shown in Figures 16 and 17. IH-635, however, has a nearly equal amount of corridor traffic traveling in each direction during the morning and evening peak periods. There is also some recurrent congestion in the general-purpose lanes outside of the peak periods. As shown in Figures 18 and 19, the HOV lanes on IH-635 are being utilized during the off-peak periods but no benefits have been quantified to account for this.

Toll Applications

Congestion pricing can be more easily implemented on barrier-separated HOV lanes, due to their limited access, to allow single-occupant vehicles and/or trucks to pay a toll to use the facility during certain time periods. However, congestion pricing can not be easily implemented on buffer-separated (concurrent flow) HOV lanes due to the lack of physical separation. If there was no physical separation between the HOV lane and the general-purpose lanes, drivers may weave between the HOV lane and the general-purpose lane to avoid toll booths or toll tag readers. Because of this it is not recommended that any type of congestion pricing be implemented on the concurrent

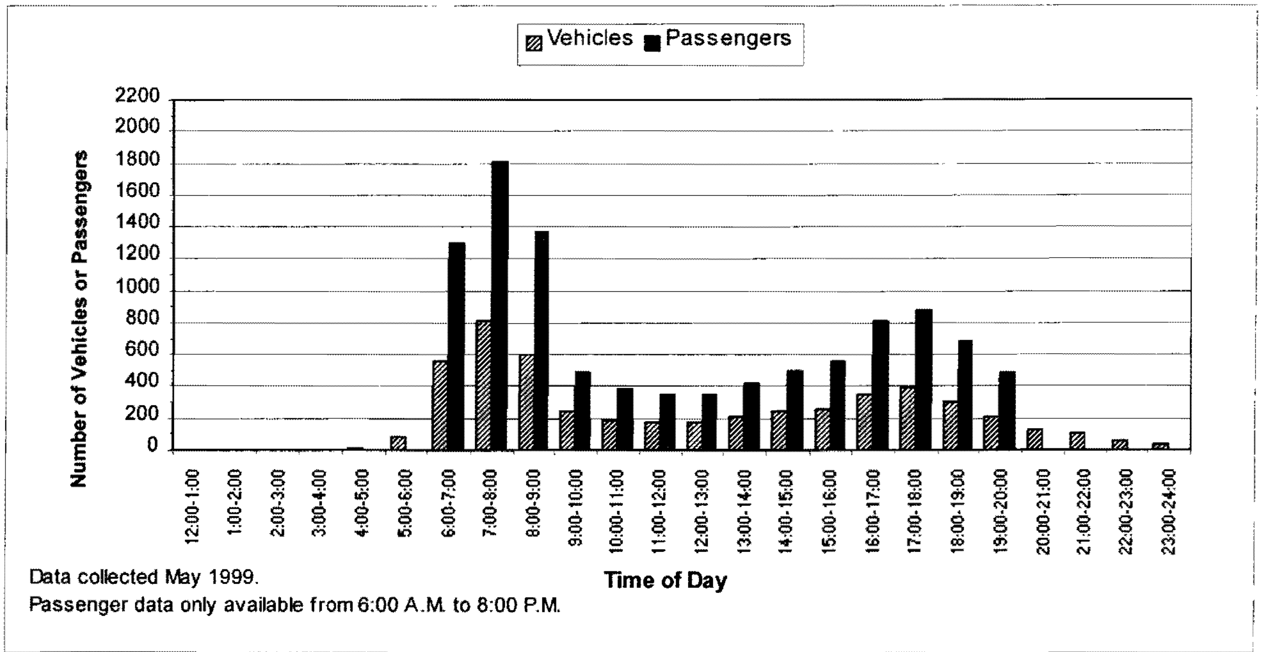


Figure 16. IH-35E North (Stemmons Freeway) Southbound HOV Lane Hourly Volumes.

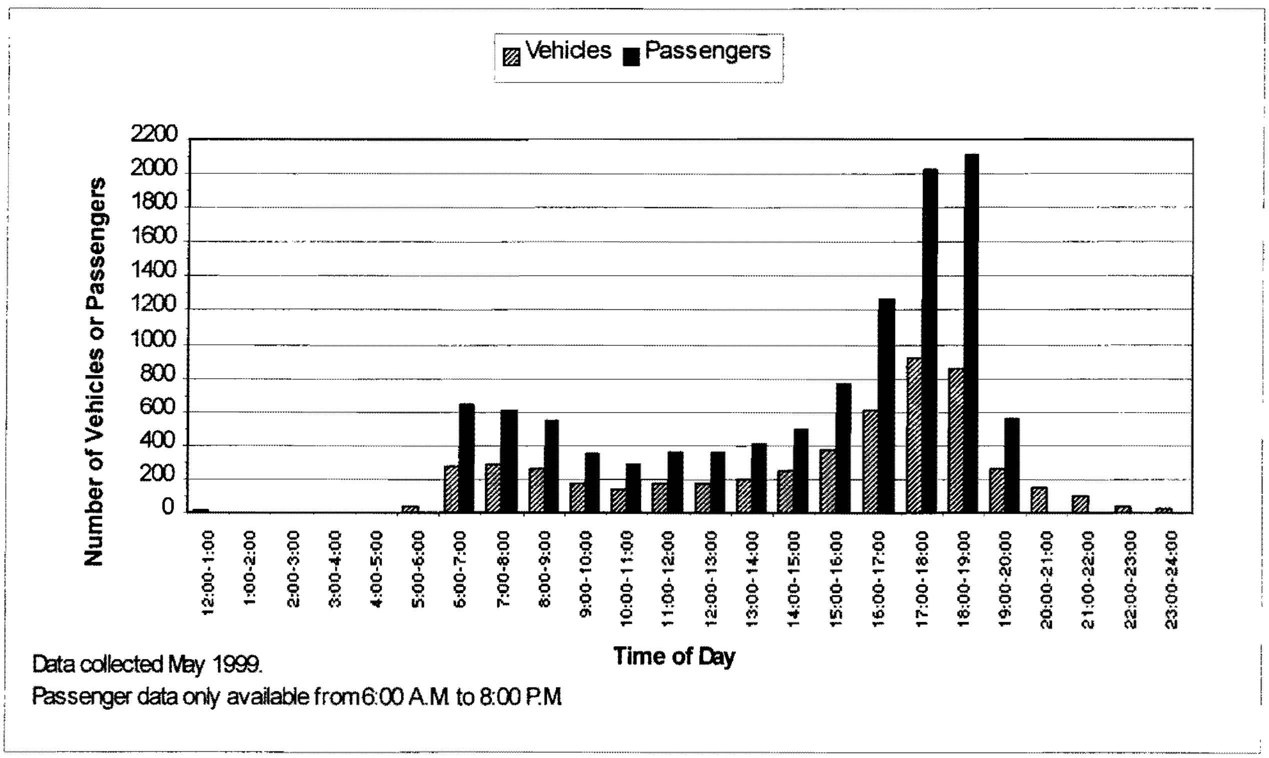


Figure 17. IH-35E North (Stemmons Freeway) Northbound HOV Lane Hourly Volumes.

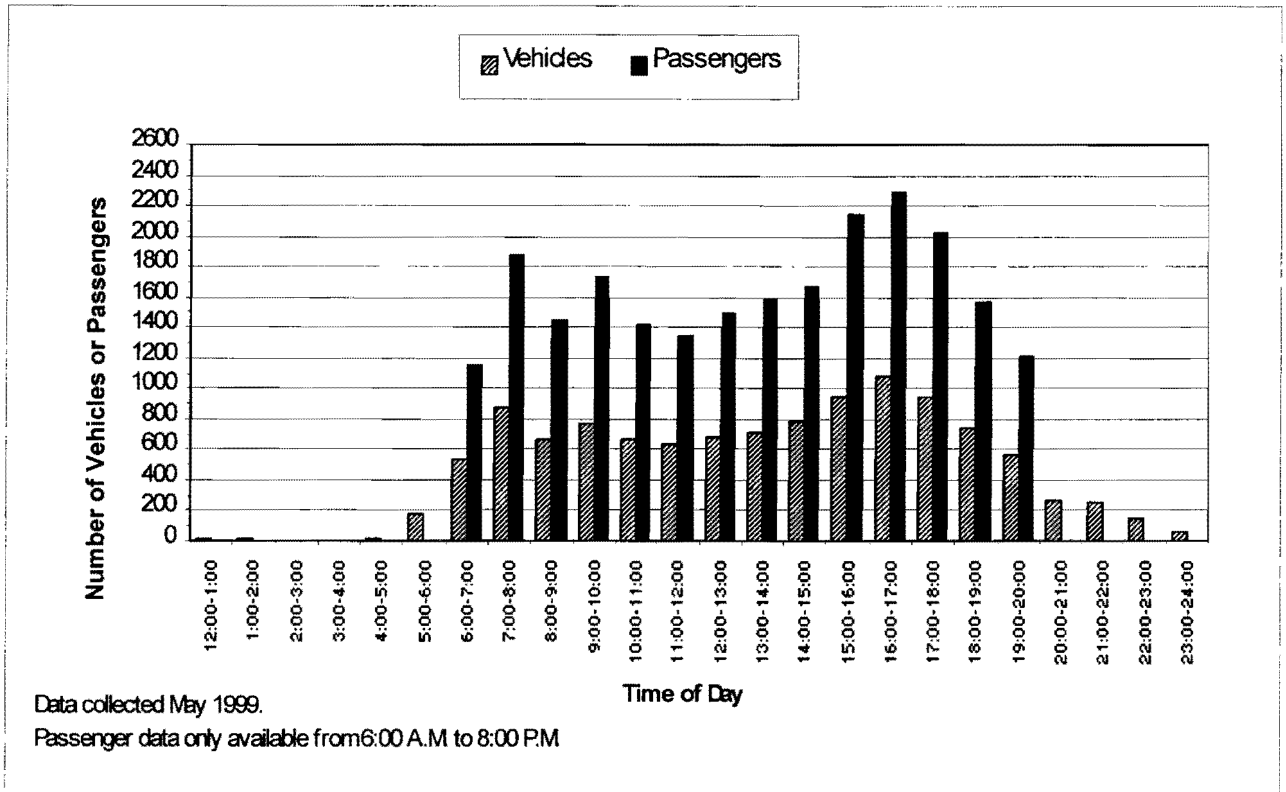


Figure 18. IH-635 (LBJ Freeway) Westbound HOV Lane Hourly Volumes.

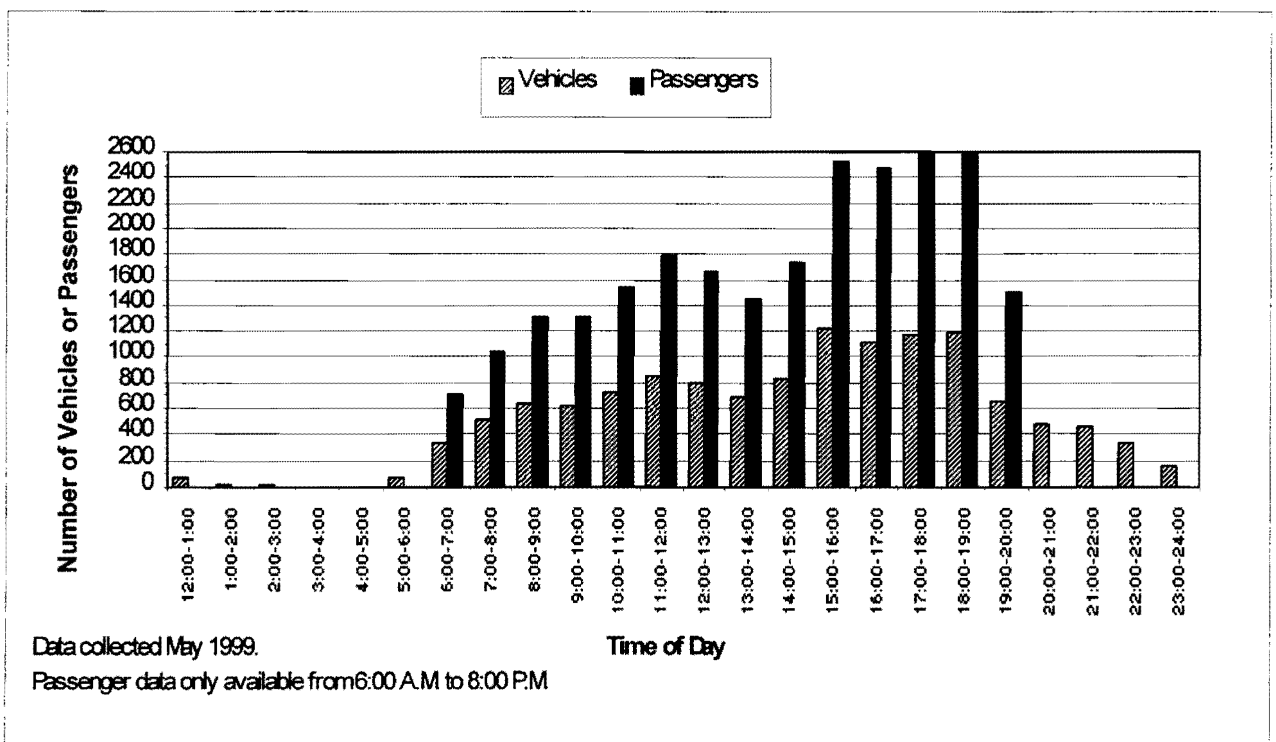


Figure 19. IH-635 (LBJ Freeway) Eastbound HOV Lane Hourly Volumes.

flow HOV lanes in the Dallas area. Additionally, as discussed in the previous section, a need does not currently exist for congestion pricing based on the HOV lane volumes and congestion patterns in the two corridors.

SUMMARY OF QUALITATIVE ISSUES

Table 5 shows a summary of the qualitative issues previously discussed.

Table 5. Qualitative HOV Lane Issues.

Characteristic	Barrier-Separated	Buffer-Separated
Design Requirements	High HOV demand Wide cross section needed	Require less right-of-way
Implementation Time	Longest time to implement	Relatively short
Capacity	1,500 vph to 1,700 vph	Potentially less than barrier-separated
Access	Limited	May be unlimited
Flexibility	Flexibility in eligible users May include congestion pricing	Convert to general-purpose lanes Many different trips served

VI. CONCLUSIONS

The goal of this research was to investigate the operational effectiveness of the new concurrent flow HOV lanes in the Dallas area as well as to assess the effectiveness of concurrent flow (buffer-separated) versus contraflow (barrier-separated) HOV lanes in the Dallas area. As shown in Table 6 and the data summary in Tables 7 through 11, the concurrent flow lanes have generated a substantial number of carpools, have increased the person movement in the corridor, have increased the occupancy rate in the corridor, and have not negatively impacted the operation of the adjacent freeway general-purpose lanes. The person movement increase, however, to date only, marginally justifies the HOV lanes as they are moving only slightly more persons than a single adjacent general-purpose lane during the peak hour. Experience from Houston, however, indicates that two to four years of operation of a facility is required before a complete and thorough assessment can be made.

Table 6. Summary of HOV Lane Measures of Effectiveness.

Measure	IH-30	IH-35E N	IH-635 EB	IH-635 WB
Has there been an increase in the number of carpools in the corridor?	Yes	Yes	Yes	Yes
Does the HOV lane carry as many people as an adjacent general-purpose lane?	Yes	Yes	Yes	Yes
Has the person volume increased at least as much as the percent increase in number of lanes?	Yes	No	No	No
Has the occupancy rate in the corridor increased?	Yes	Yes	Yes	Yes
In terms of speed, has the HOV lane not negatively impacted the general-purpose lanes?	Yes	Yes	Yes	Yes
Are the HOV lanes saving HOV lane vehicles at least 5 minutes of travel time?	Yes	Yes	No	Yes
Are the HOV lanes providing motorists at least a minute per mile travel time savings?	Yes	Yes	No	No

Note: Answers provided are for the AM peak hour.

All three HOV lane projects are cost effective and have attained, or are projected to attain, a benefit cost ratio greater than 1.0 within the first five years of operation. While this appears to indicate that either type of HOV lane is acceptable, other issues must be considered such as the safety of a non-barrier-separated lane. Limited crash data was available when this report was prepared to assess the impact on crash rates as a result of implementing the concurrent flow lanes. It is therefore recommended that the lanes continue to be monitored and a reassessment of their effectiveness be conducted when additional data is available.

Table 7. IH-35E North (Stemmons) Directional Corridor Operational Data.

Operational Data	"Before" [1] (Mainlanes)	"After" [2] (Mainlanes & HOV)	Percent Change
Vehicle Volumes			
Total			
AM Peak Hour-Southbound	5,965	6,862	+15 %
PM Peak Hour-Northbound	5,902	6,678	+13 %
2+ Occupant Automobiles			
AM Peak Hour-Southbound	313	1,241	+296 %
PM Peak Hour-Northbound	465	1,204	+159 %
DART Bus			
AM Peak Hour-Southbound	8	9	--
PM Peak Hour-Northbound	5	9	--
Person Volumes			
Total			
AM Peak Hour-Southbound	6,594	8,638	+31 %
PM Peak Hour-Northbound	6,607	8,366	+27 %
2+ Occupant Automobiles			
AM Peak Hour-Southbound	651	2,630	+304 %
PM Peak Hour-Northbound	992	2,566	+159 %
DART Bus			
AM Peak Hour-Southbound	261	267	-2 %
PM Peak Hour-Northbound	137	244	+78 %
Occupancy Rate			
Automobile			
AM Peak Hour-Southbound	1.06	1.21	+14 %
PM Peak Hour-Northbound	1.09	1.22	+12 %
Vehicle			
AM Peak Hour-Southbound	1.11	1.24	+12 %
PM Peak Hour-Northbound	1.12	1.26	+10 %
Operational Data	**"Before" (Mainlanes)**	**"After" (Mainlanes)**	**Percent Change**
Travel Time (minutes)			
AM Peak Hour-Southbound	16.6	16.9	+2 %
PM Peak Hour-Northbound	12.1	11.6	-4 %
Speeds (miles per hour)			
AM Peak Hour-Southbound	24	24	0 %
PM Peak Hour-Northbound	28	29	+4 %
Operational Data	**"Before" (Mainlanes)**	**"After" (HOV Lane)**	**Percent Change**
Travel Time (minutes)			
AM Peak Hour-Southbound	16.6	7.3	-56 %
PM Peak Hour-Northbound	12.1	6.5	-46 %
Speed (miles per hour)			
AM Peak Hour-Southbound	24	56	+133 %
PM Peak Hour-Northbound	28	52	+86 %
Park-and-Ride Lot Usage [3]	526	652	+11 %

Notes: [1] "Before" data is an average of quarterly data collected from September 1993-March 1995.
[2] "After" data is an average of December 1996-March 1999 quarterly data.
[3] Before is quarterly data from March 1992-June 1996, while after is quarterly data from September 1996-March 1999.

Table 8. IH-30 (East R.L. Thornton Freeway) Directional Corridor Operational Data.

Operational Data	"Before"[1] (Mainlanes)	"After"[2] (Mainlanes & HOV)	Percent Change
Vehicle Volumes			
Total			
AM Peak Hour-Westbound	5,692	8,659	+52 %
PM Peak Hour-Eastbound	7,104	8,859	+25 %
2+ Occupant Automobiles			
AM Peak Hour-Westbound	596	1,669	+180 %
PM Peak Hour-Eastbound	954	1,877	+97 %
DART Bus			
AM Peak Hour-Westbound	40	42	+5 %
PM Peak Hour-Eastbound	40	45	+13 %
Person Volumes			
Total			
AM Peak Hour-Westbound	7,689	11,657	+52 %
PM Peak Hour-Eastbound	9,549	12,177	+28 %
2+ Occupant Automobiles			
AM Peak Hour-Westbound	1,290	3,820	+196 %
PM Peak Hour-Eastbound	2,059	4,010	+95 %
DART Bus			
AM Peak Hour-Westbound	1,262	1,092	-13 %
PM Peak Hour-Eastbound	1,314	1,096	-17 %
Occupancy Rate			
Automobile			
AM Peak Hour-Westbound	1.13	1.22	+8 %
PM Peak Hour-Eastbound	1.15	1.25	+9 %
Vehicle			
AM Peak Hour-Westbound	1.33	1.35	+1 %
PM Peak Hour-Eastbound	1.33	1.38	+3 %

Operational Data	"Before" (Mainlanes)	"After" (Mainlanes)	Percent Change
Travel Time (minutes)			
AM Peak Hour-Westbound	14.7	12.1	-18 %
PM Peak Hour-Eastbound	11.2[3]	9.6	-14 %
Speeds (miles per hour)			
AM Peak Hour-Westbound	22	27	+23 %
PM Peak Hour-Eastbound	29[3]	34	+17 %

Operational Data	"Before" (Mainlanes)	"After" (HOV Lane)	Percent Change
Travel Time (minutes)			
AM Peak Hour-Westbound	14.7	6.0	-59 %
PM Peak Hour-Eastbound	11.2[3]	6.2	-45 %
Speed (miles per hour)			
AM Peak Hour-Westbound	22	55	+150 %
PM Peak Hour-Eastbound	29[3]	53	+83 %
Park-and-Ride Lot Usage	859	866	+1 %

Notes: [1] "Before" data is an average of quarterly data collected from October 1989 - June 1991.
[2] "After" data is an average of June 1996 - March 1999 quarterly data.
[3] "Before" data is an average of December 1991 - December 1992 quarterly data to account for the extension of the PM HOV lane limits.

Table 9. IH-635 (Lyndon B. Johnson Freeway) Eastbound Corridor Operational Data.

Operational Data	"Before" [1] (Mainlanes)	"After" [2] (Mainlanes & HOV)	Percent Change
Vehicle Volumes			
Total			
AM Peak Hour	7,486	8,124	+9 %
PM Peak Hour	7,175	8,104	+13 %
2+ Occupant Automobiles			
AM Peak Hour	628	1,124	+79 %
PM Peak Hour	868	1,573	+81 %
DART Bus			
AM Peak Hour	1	1	--
PM Peak Hour	2	2	--
Person Volumes			
Total			
AM Peak Hour	8,293	9,480	+14 %
PM Peak Hour	8,311	10,135	+22 %
2+ Occupant Automobiles			
AM Peak Hour	1,368	2,390	+75 %
PM Peak Hour	1,887	3,465	+84 %
DART Bus			
AM Peak Hour	0	16	--
PM Peak Hour	8	16	--
Occupancy Rate			
Automobile			
AM Peak Hour	1.11	1.17	+5 %
PM Peak Hour	1.15	1.25	+9 %
Vehicle			
AM Peak Hour	1.11	1.17	+5 %
PM Peak Hour	1.16	1.25	+8 %

Operational Data	"Before"[1] (Mainlanes)	"After"[2] (Mainlanes)	Percent Change
Travel Time (minutes)			
AM Peak Hour	9.7	9.6	-1 %
PM Peak Hour	21.2	17.5	-17 %
Speeds (miles per hour)			
AM Peak Hour	39	40	+3 %
PM Peak Hour	18	22	+22 %

Operational Data	"Before"[1] (Mainlanes)	"After"[2] (HOV Lane)	Percent Change
Travel Time (minutes)			
AM Peak Hour	9.7	7.0	-28 %
PM Peak Hour	21.2	8.0	-62 %
Speed (miles per hour)			
AM Peak Hour	39	55	+41 %
PM Peak Hour	18	48	+167 %
Park-and-Ride Lot Usage	1,112	1,287	+3 %

Notes: [1] "Before" data is an average of quarterly data collected from June 1994-June 1995.
[2] "After" data is an average of quarterly data collected from June 1997 - March 1999.

Table 10. IH-635 (Lyndon B. Johnson Freeway) Westbound Corridor Operational Data.

Operational Data	"Before" [1] (Mainlanes)	"After" [2] (Mainlanes & HOV)	Percent Change
Vehicle Volumes			
Total			
AM Peak Hour	7,428	8,161	+10 %
PM Peak Hour	7,902	8,178	-4 %
2+ Occupant Automobiles			
AM Peak Hour	454	1,202	+165 %
PM Peak Hour	1,166	1,771	+51 %
DART Bus			
AM Peak Hour	2	2	--
PM Peak Hour	1	0	--
Person Volumes			
Total			
AM Peak Hour	8,041	9,619	+20 %
PM Peak Hour	9,312	10,417	+12 %
2+ Occupant Automobiles			
AM Peak Hour	982	2,587	+163 %
PM Peak Hour	2,503	3,899	+56 %
DART Bus			
AM Peak Hour	8	11	--
PM Peak Hour	0	13	--
Occupancy Rate			
Automobile			
AM Peak Hour	1.07	1.18	+10 %
PM Peak Hour	1.18	1.27	+8 %
Vehicle			
AM Peak Hour	1.08	1.18	+9 %
PM Peak Hour	1.18	1.27	+8 %

Operational Data	"Before" [1] (Mainlanes)	"After" [2] (Mainlanes)	Percent Change
Travel Time (minutes)			
AM Peak Hour	11.2	11.9	+6 %
PM Peak Hour	13.6	12.8	-6 %
Speeds (miles per hour)			
AM Peak Hour	30	28	-7 %
PM Peak Hour	25	26	+4 %

Operational Data	"Before" [1] (Mainlanes)	"After" [2] (HOV Lane)	Percent Change
Travel Time (minutes)			
AM Peak Hour	11.2	5.8	-48 %
PM Peak Hour	13.6	6.1	-55 %
Speed (miles per hour)			
AM Peak Hour	30	58	+93 %
PM Peak Hour	25	55	+120 %
Park-and-Ride Lot Usage	1,112	1,287	+3 %

Notes: [1] "Before" data is an average of quarterly data collected from June 1994-June 1995.
[2] "After" data is June 1997 - March 1999 quarterly data.

Table 11. HOV Lane Operational Data.

Characteristic	Contraflow	Concurrent Flow		
	IH-30	IH-35E North	IH-635 EB	IH-635 WB
General				
Opening Date	September 1991	September 1996	March 1997	March 1997
Operating Hours	WB:6-9AM EB:4-7PM	24 hours/day	24 hours/day	24 hours/day
Length (miles)	EB:5.2, WB:5.2	NB:5.5, SB:6.8	6.5	6.2
Vehicle Volume				
Total				
AM Peak Hour	1,372	986	718	891
AM Peak Period	2,788	2,032	1,803	2,189
PM Peak Hour	1,201	883	1,186	1,170
PM Peak Period	2,527	2,017	3,238	3,083
24 hour	4,994	9,247 [1]	11,109 [1]	10,712 [1]
Carpool				
AM Peak Hour	1,298	917	689	842
AM Peak Period	2,618	1,873	1,721	2,092
PM Peak Hour	1,132	830	1,119	1,094
PM Peak Period	2,382	1,888	3,054	2,846
DART Bus				
AM Peak Hour	42	8	1	2
AM Peak Period	97	21	3	4
PM Peak Hour	43	9	1	1
PM Peak Period	90	19	2	6
Vanpools, MC, and Other Buses				
AM Peak Hour	18	13	11	17
AM Peak Period	39	34	28	35
PM Peak Hour	18	15	24	16
PM Peak Period	36	45	65	41
Person Volumes				
Total				
AM Peak Hour	3,907	2,286	1,519	1,948
AM Peak Period	8,021	4,753	3,795	4,663
PM Peak Hour	3,561	2,098	2,630	2,536
PM Peak Period	7,192	4,767	7,158	6,580
24 hour	14,438	21,163 [1]	23,797 [1]	24,149 [1]
Carpool				
AM Peak Hour	2,722	2,027	1,449	1,822
AM Peak Period	5,483	4,165	3,620	4,467
PM Peak Hour	2,397	1,828	2,482	2,405
PM Peak Period	5,047	4,182	6,761	6,245
DART Bus				
AM Peak Hour	1,088	258	16	10
AM Peak Period	2,318	571	31	23
PM Peak Hour	1,069	243	3	6
PM Peak Period	1,969	520	16	13
Vanpools, MC, and Other Buses				
AM Peak Hour	82	37	38	85
AM Peak Period	187	93	91	115
PM Peak Hour	86	56	103	66

Table 11. HOV Lane Operational Data (Continued).

Characteristic	Contraflow	Concurrent Flow		
	IH-30	IH-35E North	IH-635 EB	IH-635 WB
Occupancy Rate				
Automobile				
AM Peak Hour	2.09	2.08	2.09	2.14
AM Peak Period	2.09	2.07	2.08	2.12
PM Peak Hour	2.14	2.09	2.20	2.14
PM Peak Period	2.13	2.10	2.20	2.14
Vehicle				
AM Peak Hour	2.85	2.32	2.12	2.19
AM Peak Period	2.88	2.34	2.10	2.13
PM Peak Hour	2.96	2.37	2.22	2.17
PM Peak Period	2.85	2.36	2.21	2.16
Enforcement				
AM Peak Hour Violation Rate	< 1 %	5 %	3 %	3 %
AM Peak Period Violation Rate	1 %	5 %	3 %	3 %
PM Peak Hour Violation Rate	< 1 %	3 %	4 %	6 %
PM Peak Period Violation Rate	< 1 %	4 %	4 %	5 %
Citations Per Day	6	8	13	13
Other				
Construction Cost	$17.4 M	$9.9 M	$16.3 M	
Construction Cost per Mile	$1.67 M	$0.80 M	$1.28 M	
Operation & Enforcement	$0.6 M	$0.2 M	$0.2 M	
Cost/Year	$6.4 M [2]	$2.4 M	$9.68 M	
FY 1999 Annual HOV Benefits	2.4 yrs	4.8 yrs	1.8 yrs	
Operating years to be Cost Effective				

[1]Daily total (24 hour) counts are collected with automatic vehicle counters on the HOV lane with an applied observed occupancy rate to estimate the number of passengers.
[2] Includes mainlane and HOV lane benefits.

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APPENDIX A

IH-30 (East R.L. Thornton) Contraflow HOV Lane

Table A-1. East R.L. Thornton Freeway (IH-30) Contraflow HOV Lane Operation: Opening Dates and Vehicle Eligibility.

Operation	Limits	Length (miles)	Time	Date	Eligible Vehicles					
					Buses	Vanpools	Carpool Occupancy			MC
							4+	3+	2+	
HOV Lane Opens for Evening Operation Only	AM: None PM: Central Expressway to Dolphin Road	--- 3.3	6:00-9:00 AM 4:00-7:00 PM	9/23/91	X	X				
HOV Lane Opens for Morning Operation	AM: Dolphin Road to Central Expressway PM: Central Expressway to Dolphin Road	3.3 3.3	6:00-9:00 AM 4:00-7:00 PM	9/30/91	X	X				
Carpool Operation (3+)	AM: Dolphin Road to Central Expressway PM: Central Expressway to Dolphin Road	3.3 3.3	6:00-9:00 AM 4:00-7:00 PM	10/07/91	X	X		X		
Carpool Operation (2+)	AM: Dolphin Road to Central Expressway PM: Central Expressway to Dolphin Road	3.3 3.3	6:00-9:00 AM 4:00-7:00 PM	10/21/91	X	X			X	
AM Operation Extended	AM: Jim Miller to Central Expressway PM: Central Expressway to Dolphin Road	5.2 3.3	6:00-9:00 AM 4:00-7:00 PM	11/04/91	X	X			X	
DART Buses Added to Existing Routes	AM: Jim Miller to Central Expressway PM: Central Expressway to Dolphin Road	5.2 3.3	6:00-9:00 AM 4:00-7:00 PM	11/25/91	X	X			X	
AM Operating Hours Shortened Reconstruction of Fair Park Bridge Began	AM: Jim Miller to Central Expressway AM: Dolphin to Central Expressway PM: Central Expressway to Dolphin Road	5.2 3.3 3.3	6:00-8:00 AM 6:00-8:30 AM 4:00-7:00 PM	5/93	X	X			X	
AM Operating Hours Lengthened	AM: Jim Miller to Central Expressway PM: Central Expressway to Dolphin Road	5.2 3.3	6:00-9:00 AM 4:00-7:00 PM	7/93	X	X			X	
Motorcycles Allowed	AM: Jim Miller to Central Expressway PM: Central Expressway to Dolphin Road	5.2 3.3	6:00-9:00 AM 4:00-7:00 PM	9/01/93	X	X			X	X
East Garland Park-and-Ride Lot Closed. South Garland Park-and-Ride Lot moved from IH-635 @ Shilo to Saturn @ Northwest Hwy.	NA	NA	NA	12/93	NA	NA	NA	NA	NA	NA
Audubon Park-and-Ride Lot Closed. Lake Ray Hubbard Park-and-Ride Lot Opened.	NA	NA	NA	3/94	NA	NA	NA	NA	NA	NA
Westbound Auxiliary Lane added @ Contraflow lane egress.	NA	NA	NA	7/94	X	X			X	X
Construction of PM Extension began	NA	NA	NA	4/95	X	X			X	X
AM Operating Limits Shortened due to Construction of PM Extension	AM: Dolphin Road to Central Expressway PM: Central Expressway to Dolphin Road	3.3 3.3	6:00-9:00 AM 4:00-7:00 PM	10/95	X	X			X	X
Construction of PM Extension ended. Reconstruction of Fair Park Bridge ended	AM: Jim Miller to Central Expressway PM: Central Expressway to Jim Miller	5.2 5.2	6:00-9:00 AM 4:00-7:00 PM	2/96	X	X			X	X

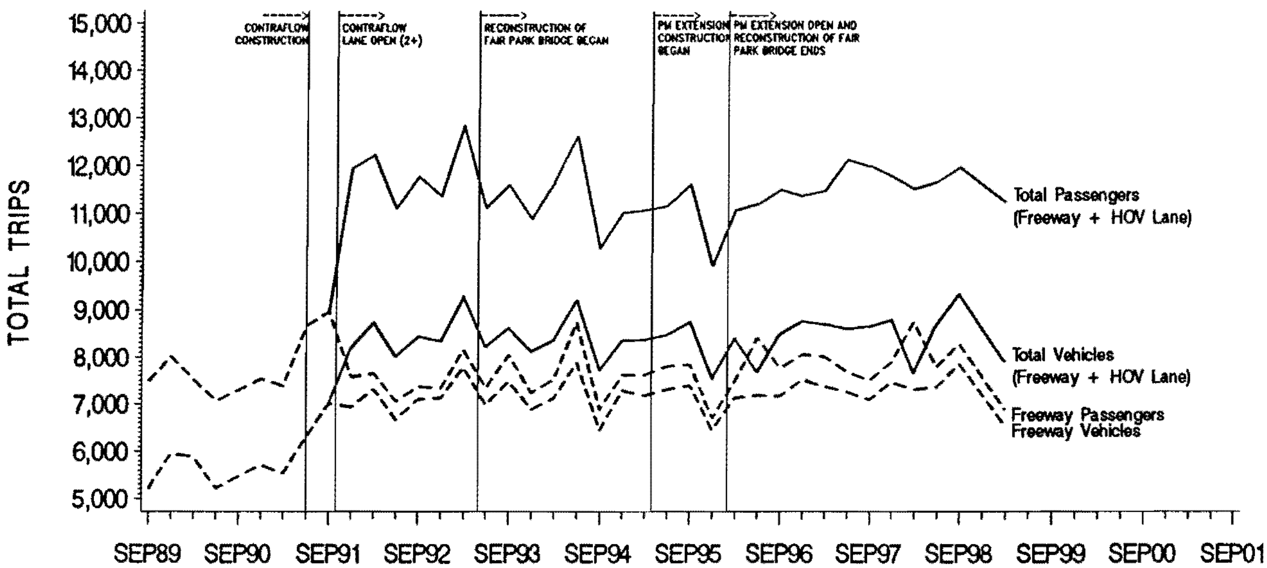
Notes: (1) MC denotes motorcycles.

Table A-2. East R.L. Thornton Freeway (IH-30) Operational Summary (1) - MARCH 1999.

Vehicle Type	Peak Direction Mixed-Flow Lanes						Contraflow Lane						Total Peak Direction Lanes					
	AM Westbound			PM Eastbound			AM Westbound			PM Eastbound			AM Westbound			PM Eastbound		
	Vehicles	Persons	Average Occpancy	Vehicles	Persons	Average Occupancy	Vehicles	Persons	Average Occupancy	Vehicles	Persons	Average Occupancy	Vehicles	Persons	Average Occupancy	Vehicles	Persons	Average Occupancy
D A R T B U S E S																		
Peak Hour	0	0	0.00	1	30	30.00	45	1,635	36.33	37	920	24.86	45	1,635	36.33	38	950	25.00
Peak Period	3	10	3.33	7	90	12.86	108	3,400	31.48	69	1,530	22.17	111	3,410	30.72	76	1,620	21.32
O T H E R B U S E S																		
Peak Hour	10	0	0.00	17	90	5.29	1	40	40.00	3	30	10.00	11	40	3.64	20	120	6.00
Peak Period	19	20	1.05	29	180	6.21	4	40	10.00	3	30	10.00	23	60	2.61	32	210	6.56
V A N P O O L S																		
Peak Hour	0	0	0.00	13	71	5.46	3	12	4.00	1	2	2.00	3	12	4.00	14	73	5.21
Peak Period	3	20	6.67	21	117	5.57	10	47	4.70	3	6	2.00	13	67	5.15	24	123	5.13
2 + C A R P O O L S																		
Peak Hour	306	652	2.13	562	1,195	2.13	1,281	2,648	2.07	1,109	2,270	2.05	1,587	3,300	2.08	1,671	3,465	2.07
Peak Period	790	1,659	2.10	1,677	3,651	2.18	2,689	5,608	2.09	2,520	5,183	2.06	3,479	7,267	2.09	4,197	8,834	2.10
M O T O R C Y C L E S																		
Peak Hour	5	5	1.00	3	3	1.00	7	7	1.00	1	1	1.00	12	12	1.00	4	4	1.00
Peak Period	6	6	1.00	9	9	1.00	18	18	1.00	5	5	1.00	24	24	1.00	14	14	1.00
1 P E R S O N / V E H I C L E (2)																		
Peak Hour	6,076	6,076	1.00	6,623	6,623	1.00	37	37	1.00	0	0	0.00	6,113	6,113	1.00	6,623	6,623	1.00
Peak Period	16,542	16,542	1.00	18,906	18,906	1.00	58	58	1.00	0	0	0.00	16,600	16,600	1.00	18,906	18,906	1.00
H E A V Y V E H I C L E S (3)																		
Peak Hour	154	154	1.00	153	160	1.05	NA	NA	NA	NA	NA	NA	154	154	1.00	153	160	1.05
Peak Period	493	495	1.00	393	411	1.05	NA	NA	NA	NA	NA	NA	493	495	1.00	393	411	1.05
T O T A L																		
Peak Hour	6,551	6,887	1.05	7,372	8,172	1.11	1,374	4,379	3.19	1,151	3,223	2.80	7,925	11,266	1.42	8,523	11,395	1.34
Peak Period	17,856	18,752	1.05	21,042	23,364	1.11	2,887	9,171	3.18	2,600	6,754	2.60	20,743	27,923	1.35	23,642	30,118	1.27
Peak Hour Persons/Lane	1,722			2,043			4,379			3,223			2,253			2,279		

Notes
(1) Peak direction Mixed-flow data was collected westbound between Dolphin Entrance and Winslow Exit and eastbound between Winslow Entrance and Dolphin Exit
Contraflow Lane data was collected westbound and eastbound near western limits
(2) 1 Person/Vehicle on the Contraflow lane are counted by TTI field crew and are considered violators These single occupant vehicles are included in total vehicles on the HOV lane
(3) Heavy vehicles refers to trucks over two axles. These vehicles are not allowed on the Contraflow lane
(4) N/A=Not Applicable
(5) Source Texas Transportation Institute

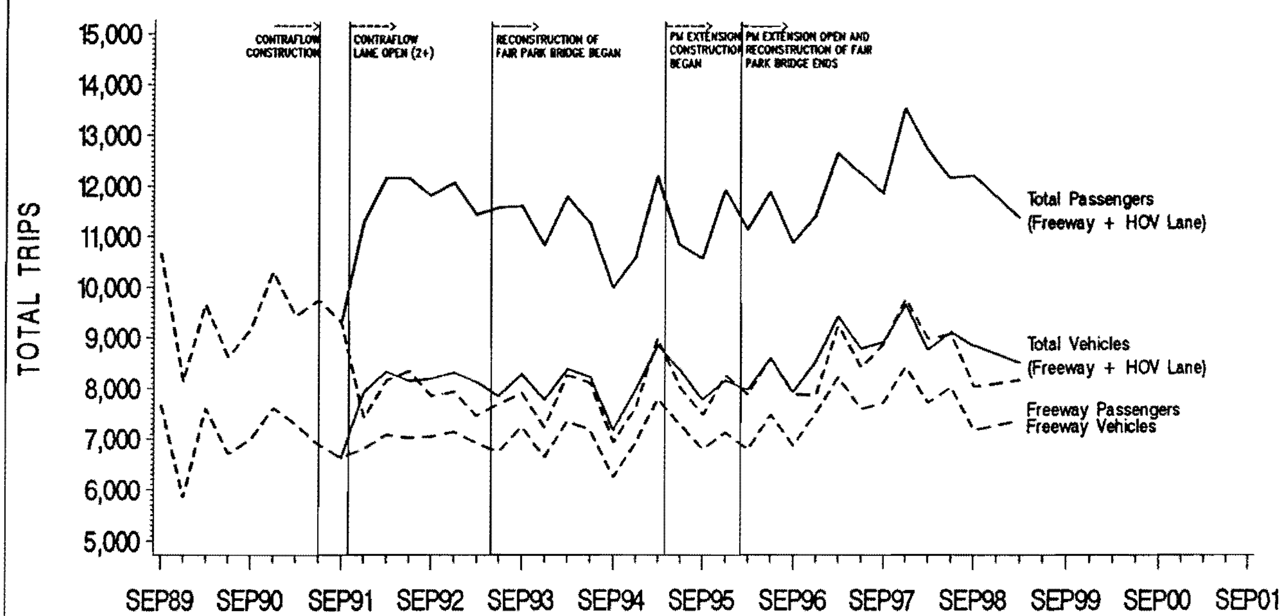
FIGURE A-1
EAST R.L. THORNTON (IH-30) FREEWAY
A.M. PEAK HOUR WESTBOUND VEHICLE/PASSENGER UTILIZATION



NOTE: COUNT LOCATION IS WEST OF DOLPHIN ROAD ENTRANCE.

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE A-2
EAST R.L. THORNTON (IH-30) FREEWAY
P.M. PEAK HOUR EASTBOUND VEHICLE/PASSENGER UTILIZATION



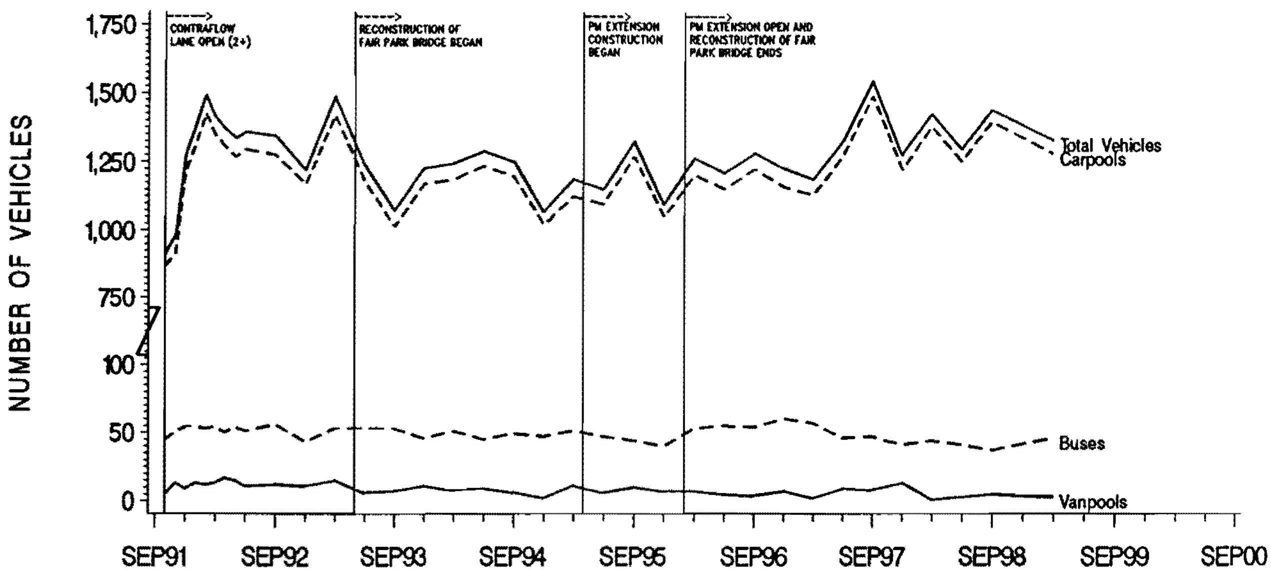
NOTE: COUNT LOCATION IS WEST OF DOLPHIN ROAD EXIT

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE A-3

EAST R.L. THORNTON (IH-30) CONTRAFLOW HOV LANE

A.M. PEAK HOUR VEHICLE UTILIZATION



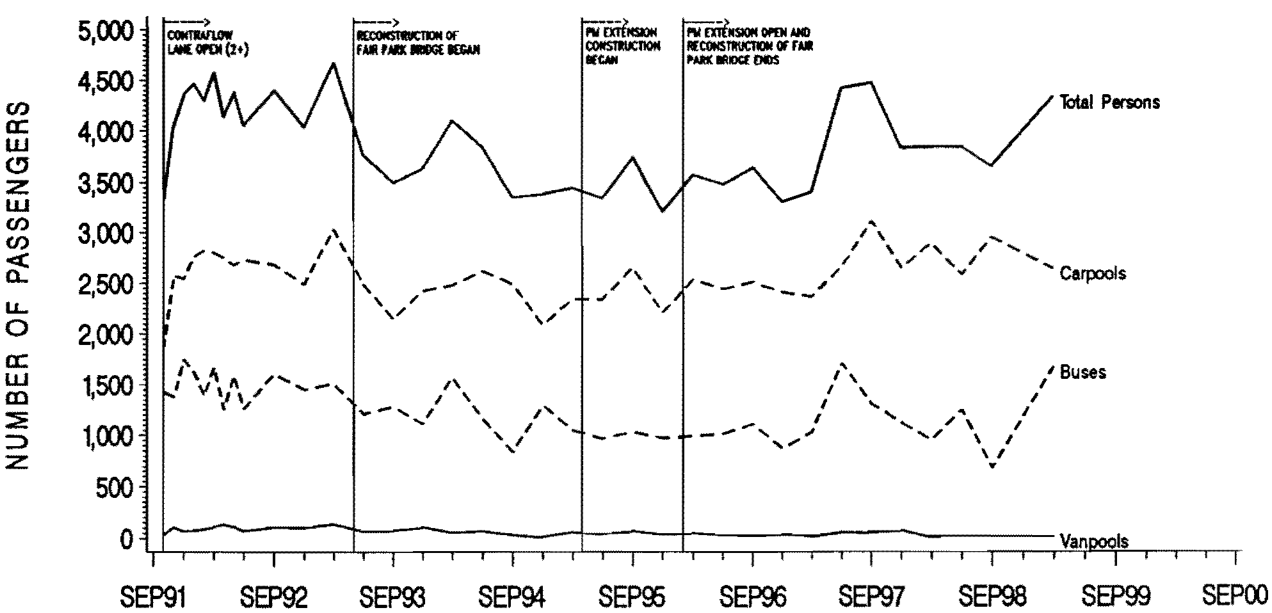
NOTE: COUNT LOCATION IS EAST OF CBD CROSSOVER

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE A-4

EAST R.L. THORNTON (IH-30) CONTRAFLOW HOV LANE

A.M. PEAK HOUR PERSON MOVEMENT

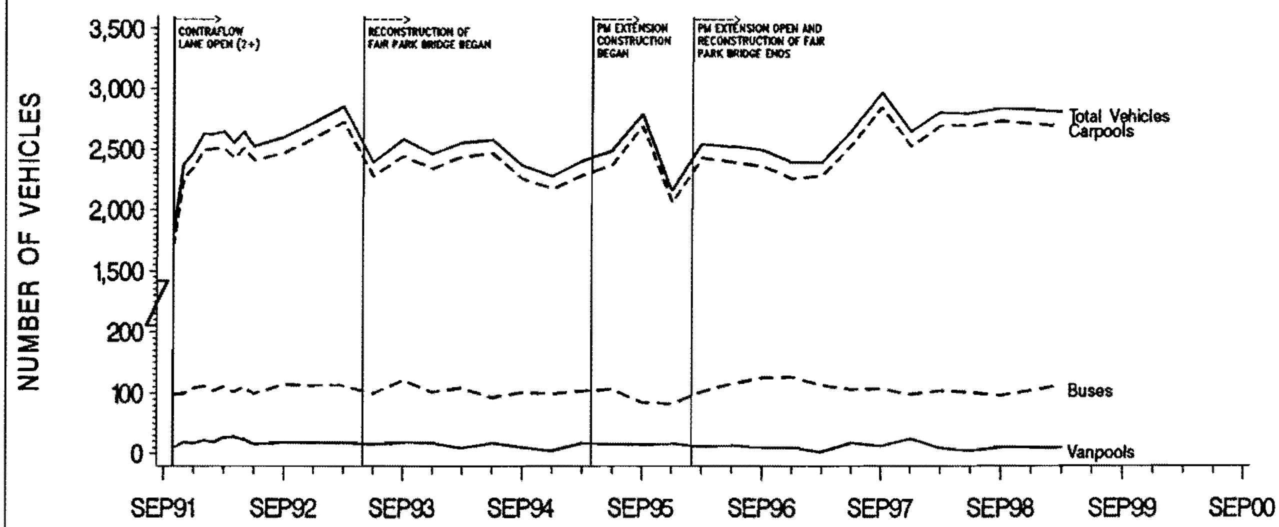


NOTE: COUNT LOCATION IS EAST OF CBD CROSSOVER

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE A–5

EAST R.L. THORNTON (IH–30) CONTRAFLOW HOV LANE
A.M. PEAK PERIOD VEHICLE UTILIZATION

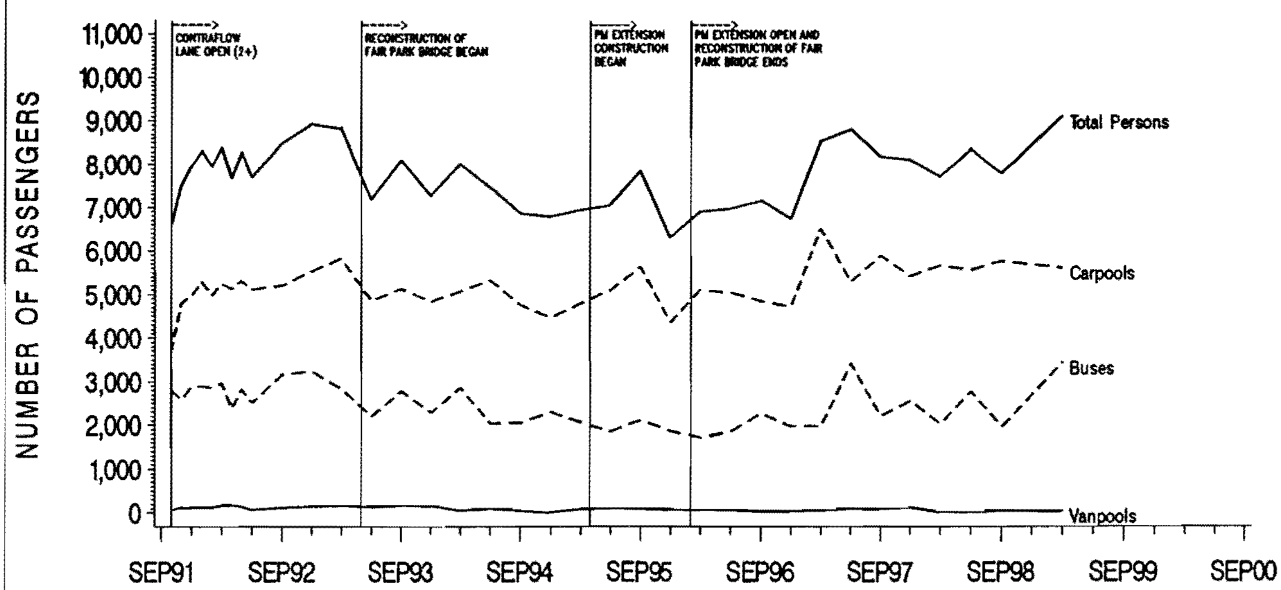


PEAK PERIOD IS FROM 6:00 A.M. TO 9:00 A.M.
NOTE: COUNT LOCATION IS EAST OF CBD CROSSOVER

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE A–6

EAST R.L. THORNTON (IH–30) CONTRAFLOW HOV LANE
A.M. PEAK PERIOD PERSON MOVEMENT



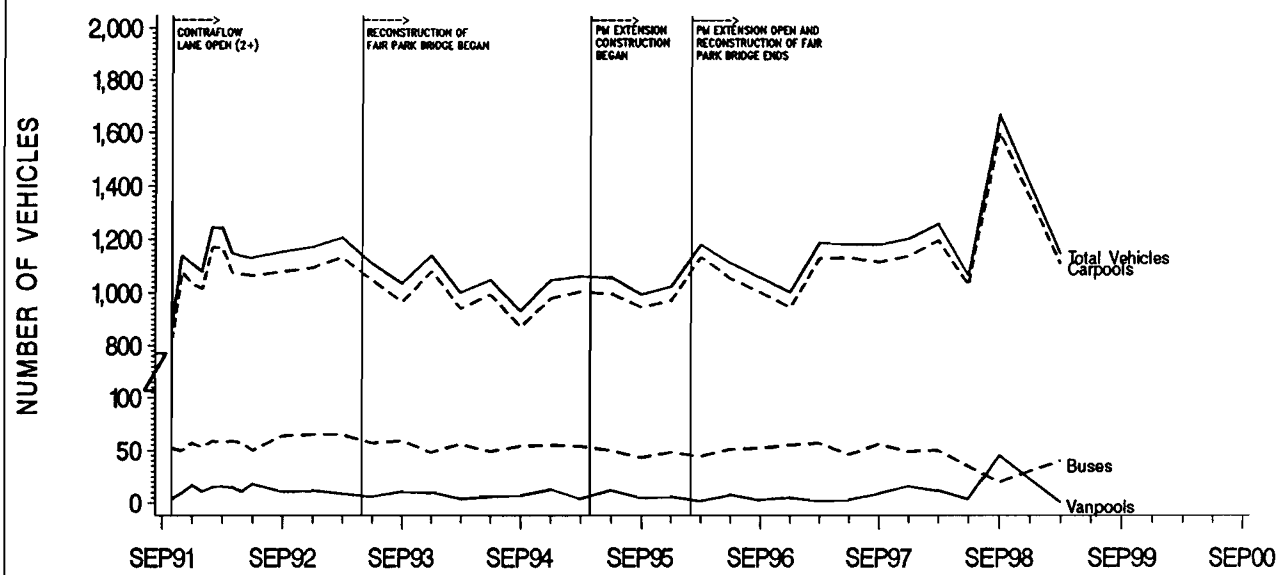
PEAK PERIOD IS FROM 6:00 A.M. TO 9:00 A.M.
NOTE: COUNT LOCATION IS EAST OF CBD CROSSOVER

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE A-7

EAST R.L. THORNTON (IH-30) CONTRAFLOW HOV LANE

P.M. PEAK HOUR VEHICLE UTILIZATION



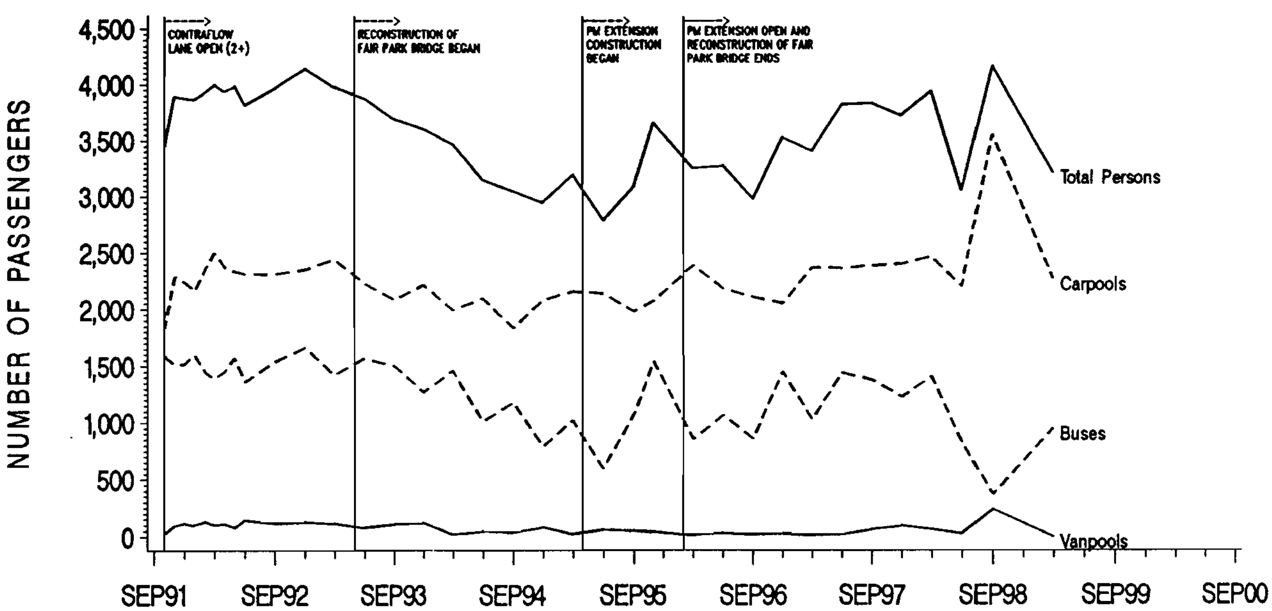
NOTE: COUNT LOCATION IS EAST OF CBD CROSSOVER

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE A-8

EAST R.L. THORNTON (IH-30) CONTRAFLOW HOV LANE

P.M. PEAK HOUR PERSON MOVEMENT



NOTE: COUNT LOCATION IS EAST OF CBD CROSSOVER

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE A-9

EAST R.L. THORNTON (IH-30) CONTRAFLOW HOV LANE

P.M. PEAK PERIOD VEHICLE UTILIZATION

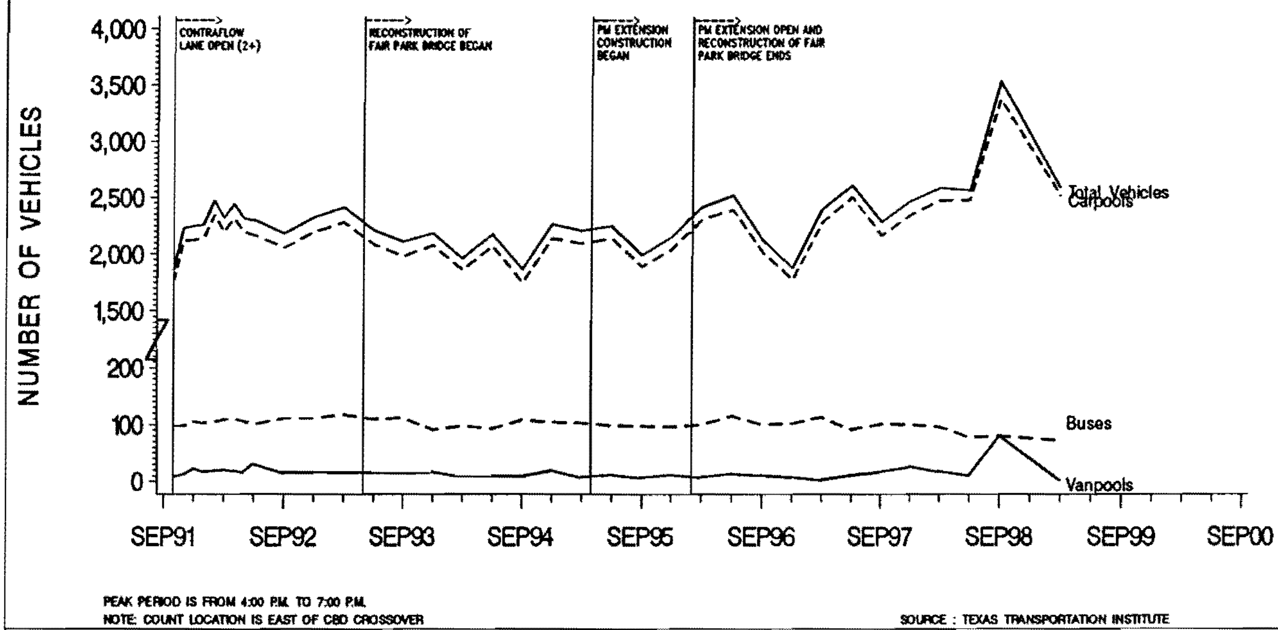


FIGURE A-10

EAST R.L. THORNTON (IH-30) CONTRAFLOW HOV LANE

P.M. PEAK PERIOD PERSON MOVEMENT

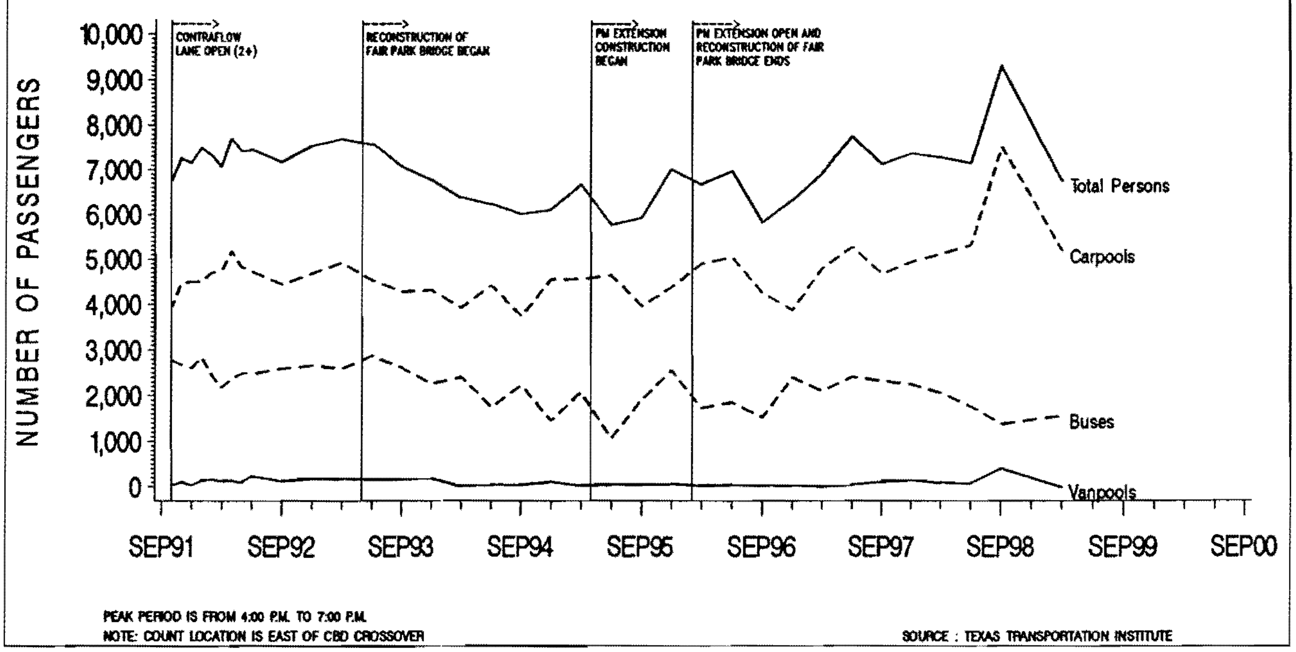
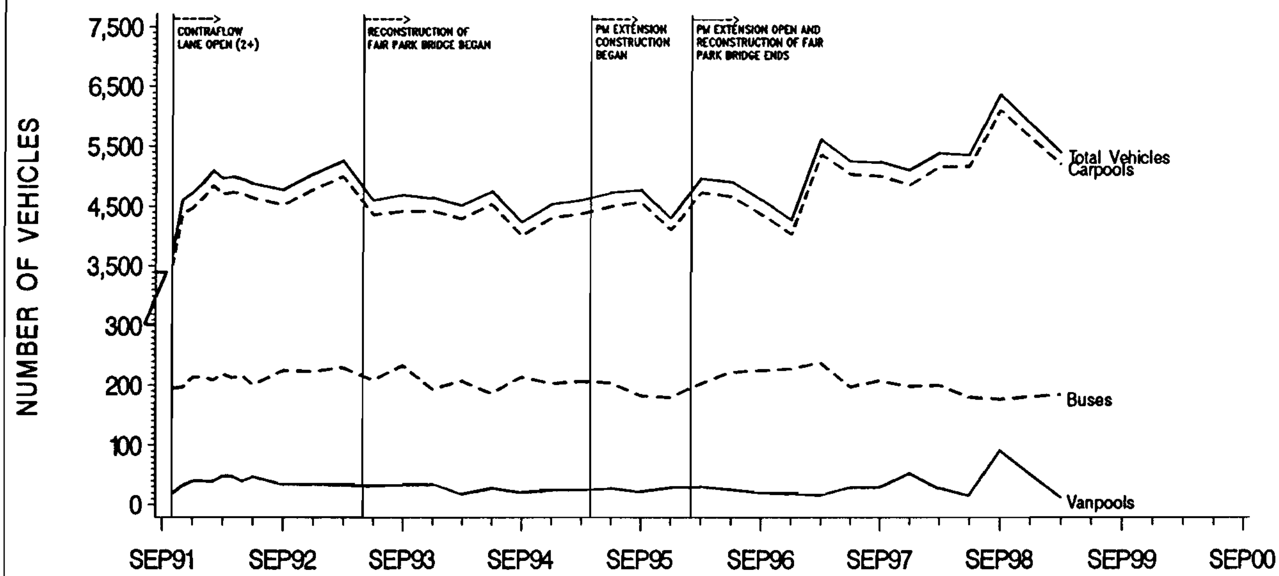


FIGURE A-11

EAST R.L. THORNTON (IH-30) CONTRAFLOW HOV LANE
TOTAL PEAK PERIOD VEHICLE UTILIZATION

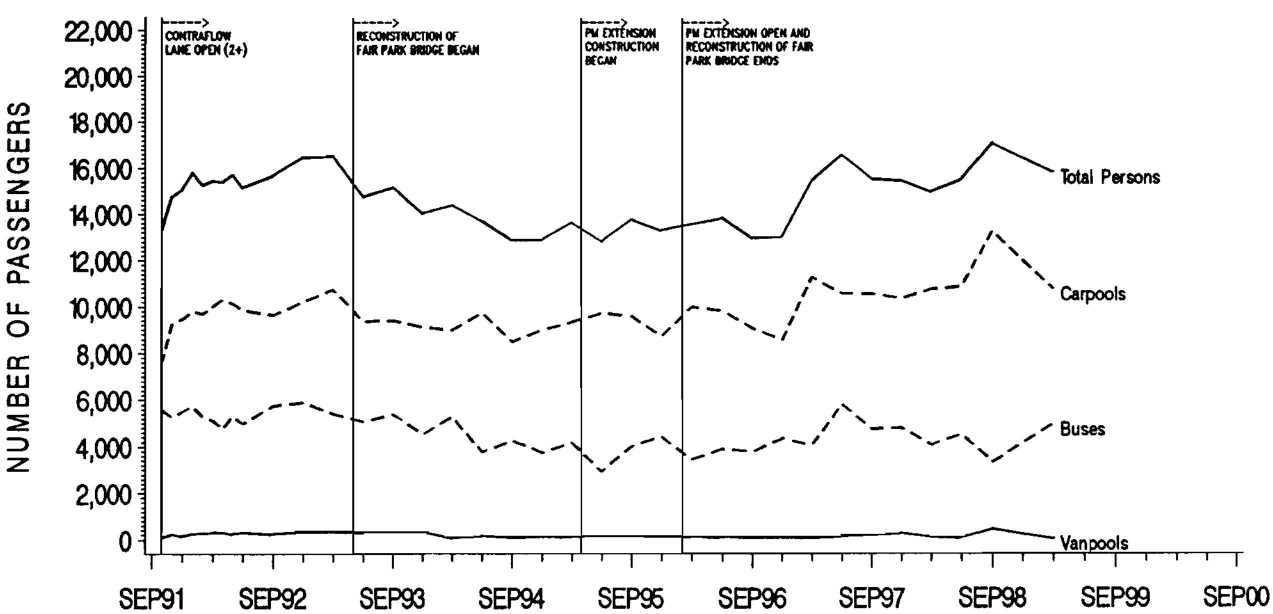


NOTE: COUNT LOCATION IS EAST OF CBD CROSSOVER

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE A-12

EAST R.L. THORNTON (IH-30) CONTRAFLOW HOV LANE
TOTAL PEAK PERIOD PERSON MOVEMENT

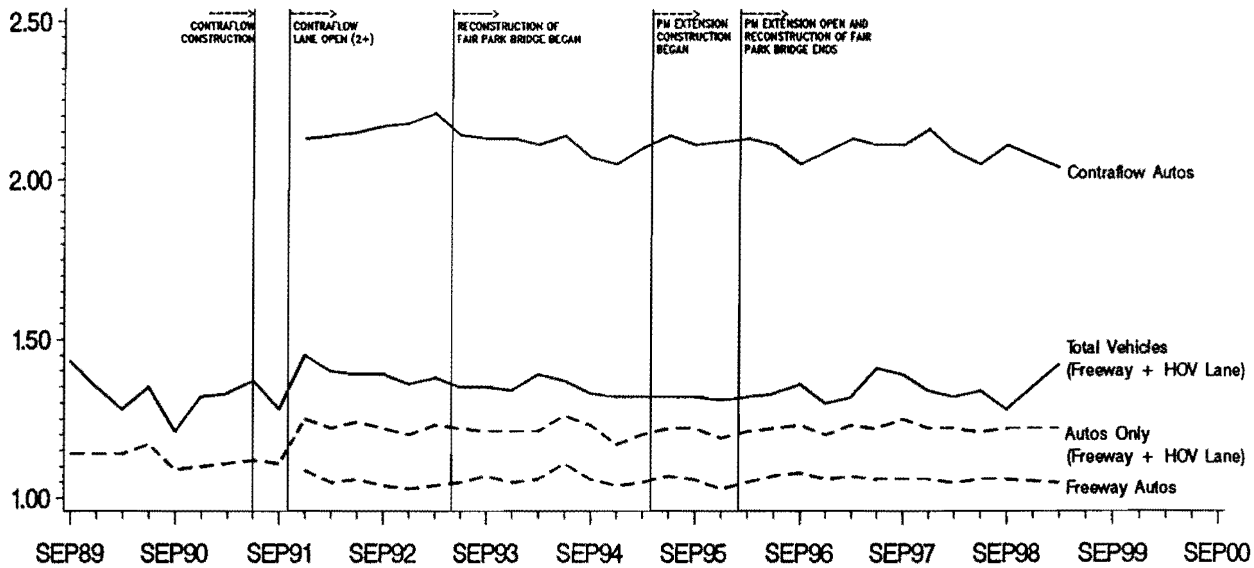


NOTE: COUNT LOCATION IS EAST OF CBD CROSSOVER

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE A-13

EAST R.L. THORNTON (IH-30) FREEWAY
A.M. PEAK HOUR WESTBOUND OCCUPANCY RATES

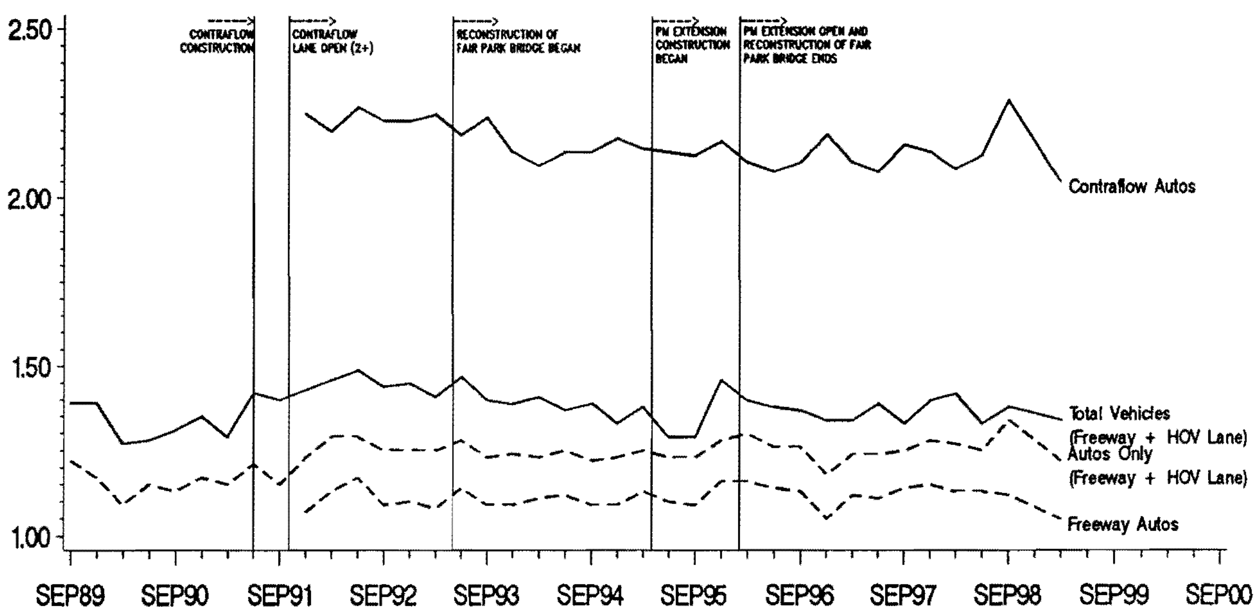


NOTE: COUNT LOCATION IS WEST OF DOLPHIN ROAD ENTRANCE

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE A-14

EAST R.L. THORNTON (IH-30) FREEWAY
P.M. PEAK HOUR EASTBOUND OCCUPANCY RATES

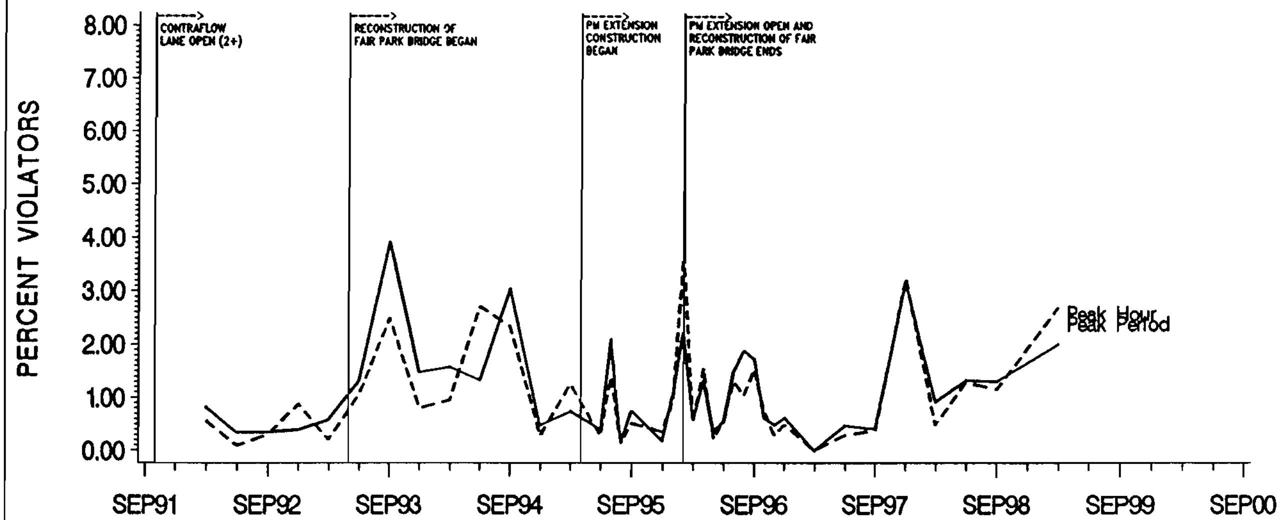


NOTE: COUNT LOCATION IS WEST OF DOLPHIN ROAD ENTRANCE

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE A-15

EAST R.L. THORNTON (IH-30) CONTRAFLOW HOV LANE
A.M. PEAK WESTBOUND VIOLATOR RATES

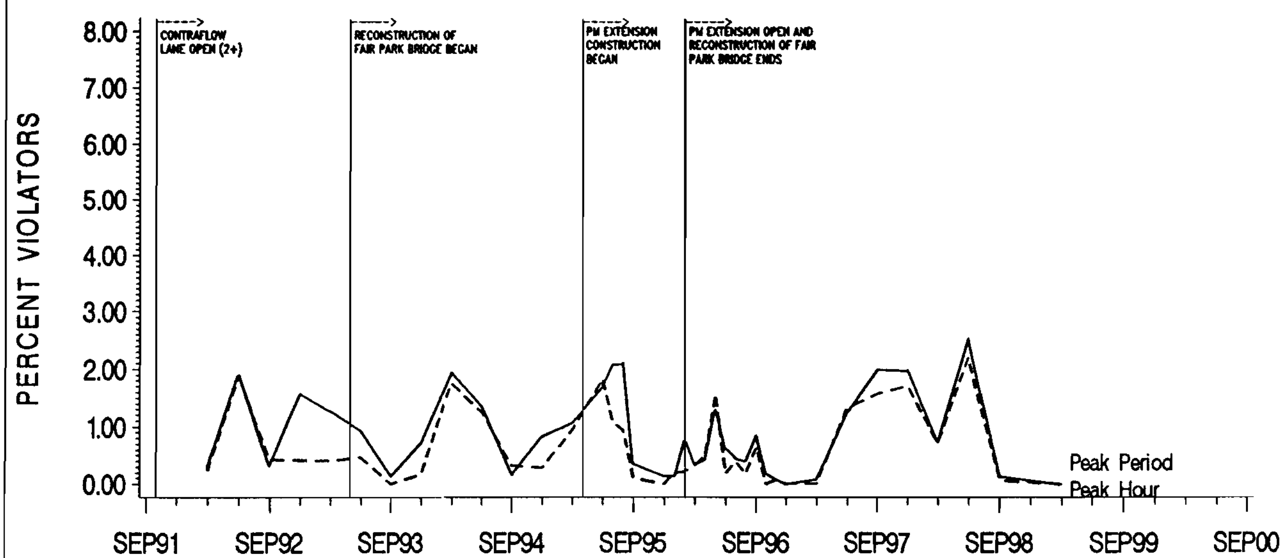


NOTE: (1) COUNT LOCATION IS EAST OF CBD CROSSOVER
(2) DATA NOT AVAILABLE PRIOR TO MARCH 1992
(3) PERCENT VIOLATORS – (SINGLE PASSENGER VEHICLES/ TOTAL VEHICLES)

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE A-16

EAST R.L. THORNTON (IH-30) CONTRAFLOW HOV LANE
P.M. PEAK EASTBOUND VIOLATOR RATES



NOTE: (1) COUNT LOCATION IS EAST OF CBD CROSSOVER
(2) DATA NOT AVAILABLE PRIOR TO MARCH 1992
(3) PERCENT VIOLATORS – (SINGLE PASSENGER VEHICLES/ TOTAL VEHICLES)

SOURCE : TEXAS TRANSPORTATION INSTITUTE

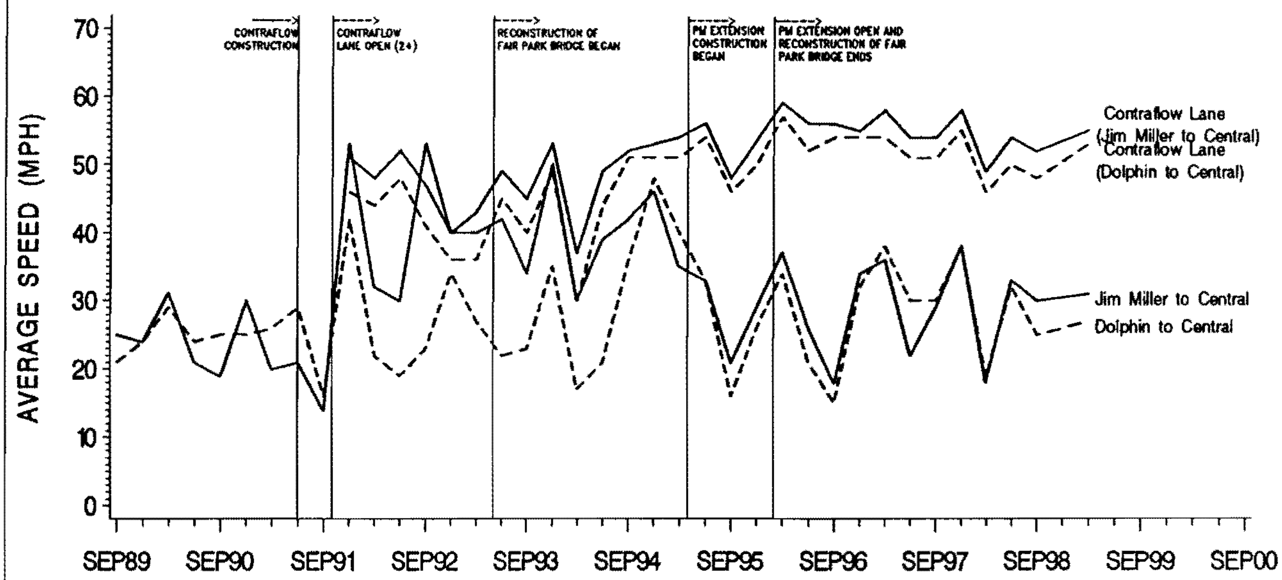
Table A-3. East R.L. Thornton Freeway (IH-30)Average Speeds (MPH)
Big Town to Central Expressway - MARCH 1999.

Time Period	Big Town to / from Jim Miller (2.0 miles)		Jim Miller to / from Ferguson (1.4 miles)		Ferguson to / from Winslow (1.4 miles)		Winslow to / from Central (2.7 miles)		**HOV Limits** Jim Miller to / from Central (5.5 miles)	
	Speed (mph)	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)
PEAK DIRECTION MIXED-FLOW LANES										
AM Peak Hour, WB	67	1.79	39	2.05	35	2.42	26	6.26	**30**	**11.17**
AM Peak Period, WB	64	1.86	49	1.65	45	1.89	40	4.07	**38**	**8.71**
PM Peak Hour, EB	58	2.02	54	1.47	47	1.83	24	6.75	**32**	**10.13**
PM Peak Period, EB	62	1.92	58	1.39	53	1.60	31	5.24	**38**	**8.75**
CONTRAFLOW LANE										
AM Peak Hour, WB	--	--	60	1.35	57	1.49	52	3.14	**52**	**6.31**
AM Peak Period, WB	--	--	64	1.26	60	1.43	56	2.92	**56**	**5.94**
PM Peak Hour, EB	--	--	59	1.34	60	1.45	55	2.97	**54**	**6.11**
PM Peak Period, EB	--	--	60	1.31	60	1.43	57	2.90	**57**	**5.78**
TRAVEL TIME SAVINGS										
AM Peak Hour, WB	--	--	--	0.70	--	0.93	--	3.12	--	**4.86**
AM Peak Period, WB	--	--	--	0.39	--	0.46	--	1.15	--	**2.77**
PM Peak Hour, EB	--	--	--	0.13	--	0.38	--	3.78	--	**4.02**
PM Peak Period, EB	--	--	--	0.08	--	0.17	--	2.34	--	**2.97**

Notes (1) Peak Direction Mixed Flow AM Peak Hour=6:00-7:00 AM; PM Peak Hour=5:00-6:00 PM.
Contraflow Lane AM Peak Hour=7:15-8:15 AM; PM Peak Hour =5:00-6:00 PM.
Peak Period=6:00-9:00 AM and 4:00-7:00 PM for both types.
(2) Source: Texas Transportation Institute

FIGURE A-17

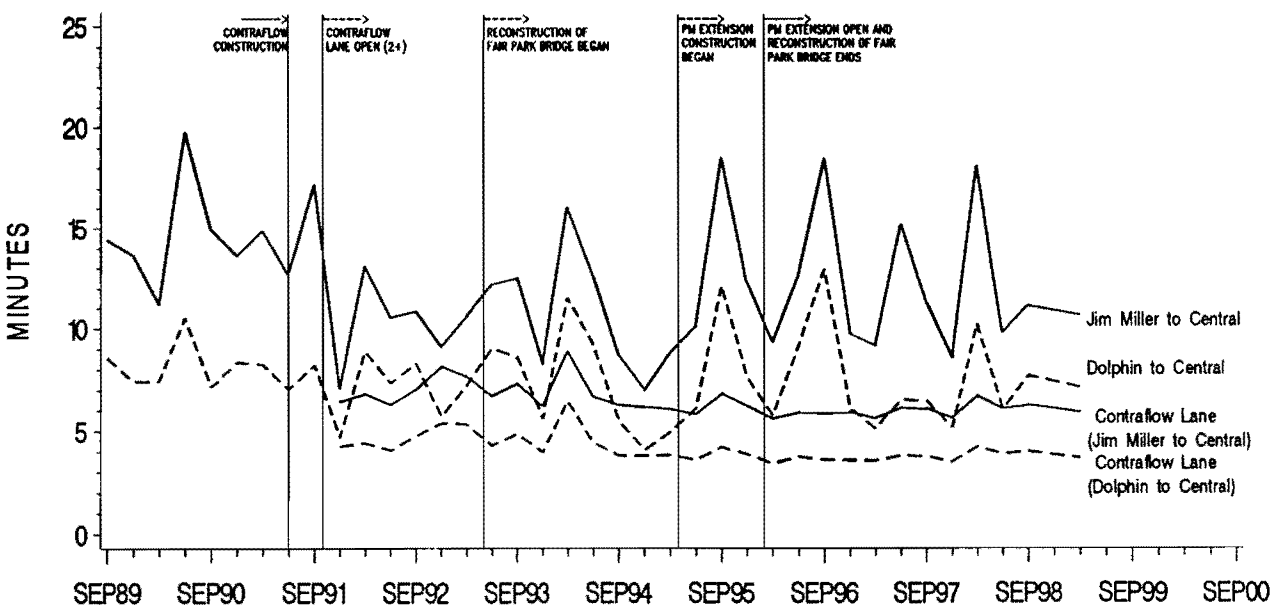
EAST R.L. THORNTON (IH-30) FREEWAY
A.M. PEAK HOUR WESTBOUND AVERAGE SPEEDS



SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE A-18

EAST R.L. THORNTON (IH-30) FREEWAY
A.M. PEAK HOUR WESTBOUND TRAVEL TIMES



SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE A-19

EAST R.L. THORNTON (IH-30) FREEWAY

P.M. PEAK HOUR EASTBOUND AVERAGE SPEEDS

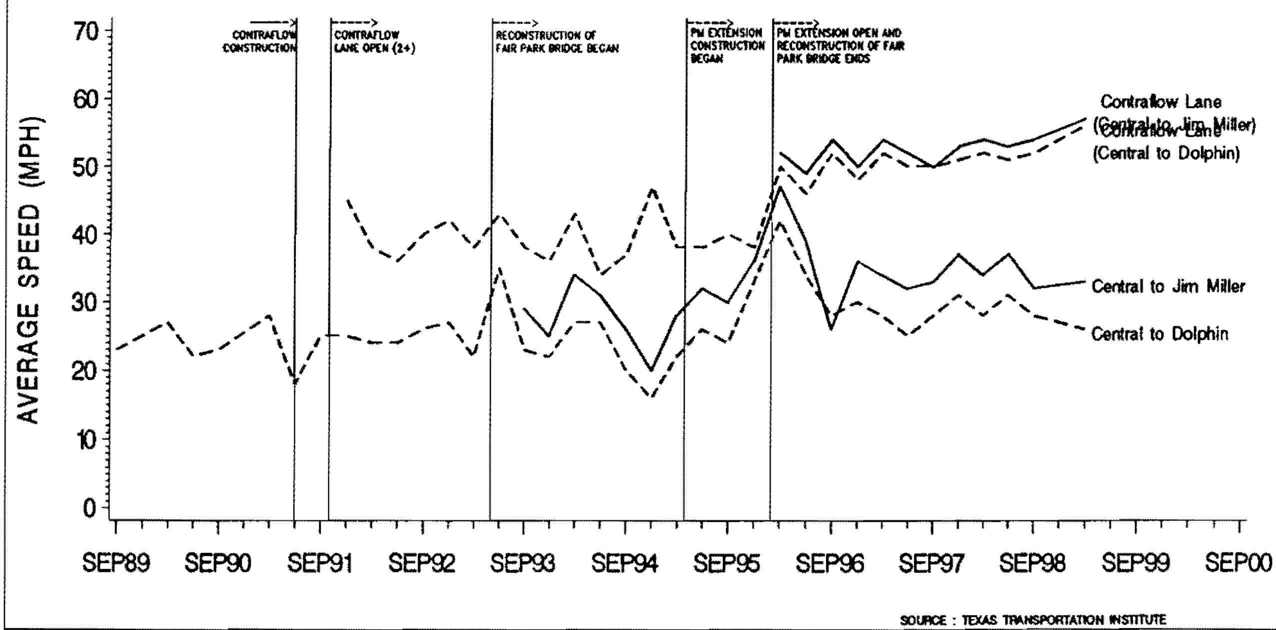


FIGURE A-20

EAST R.L. THORNTON (IH-30) FREEWAY

P.M. PEAK HOUR EASTBOUND TRAVEL TIMES

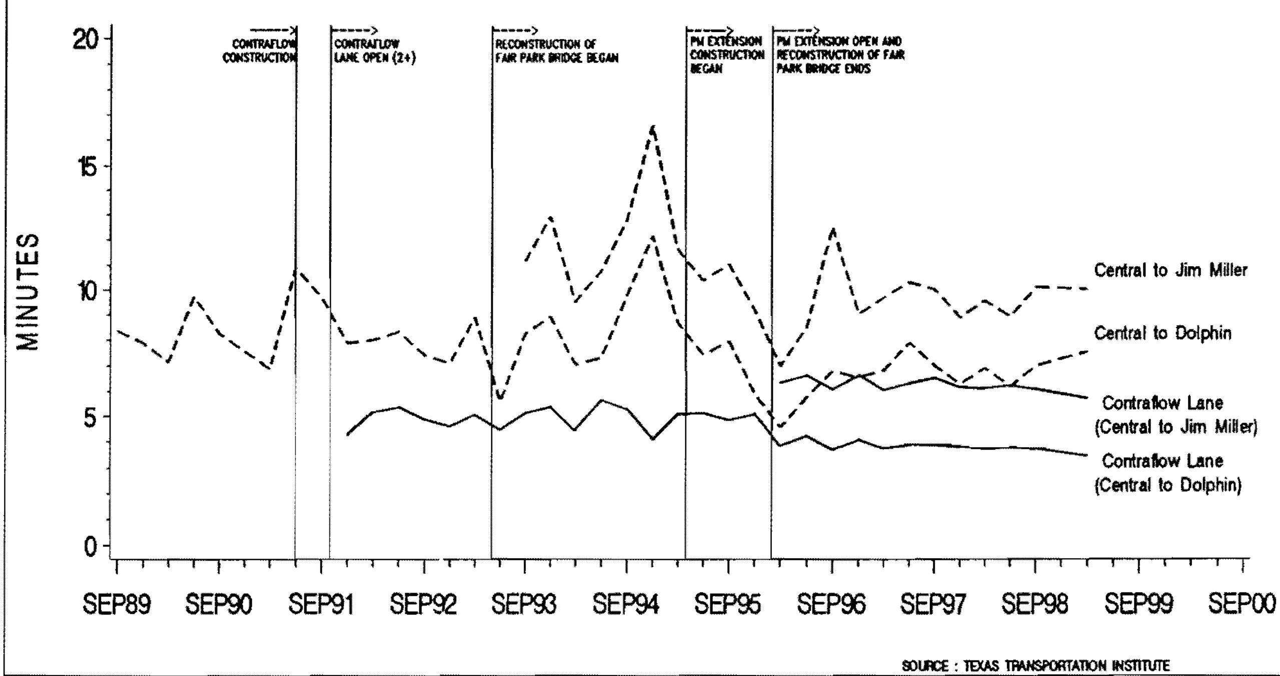
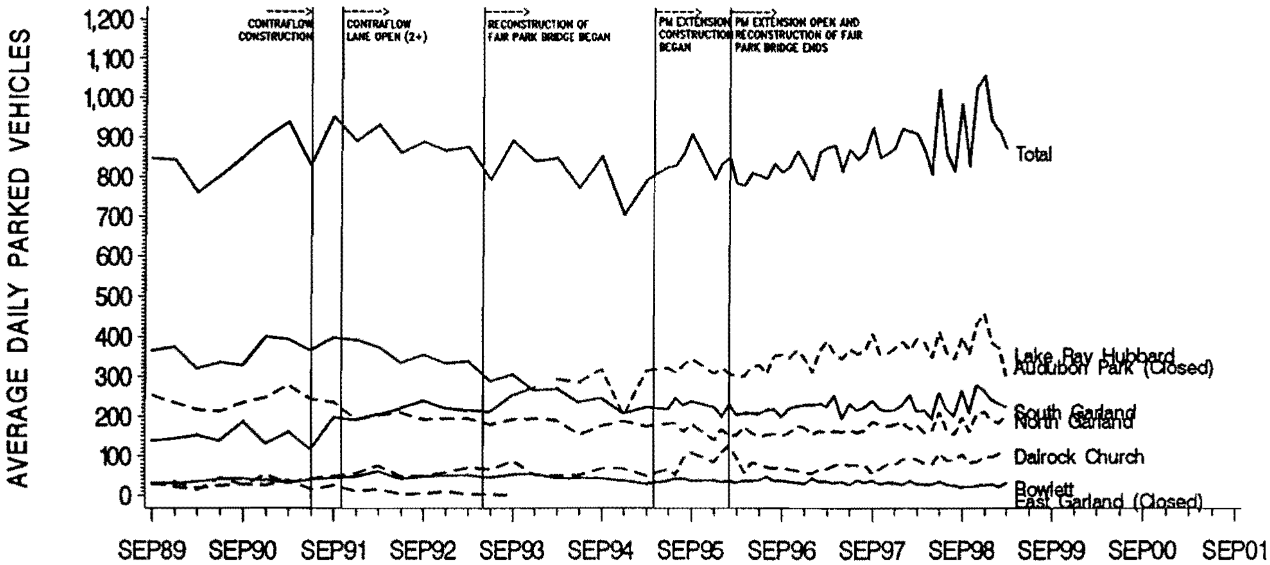


FIGURE A-21

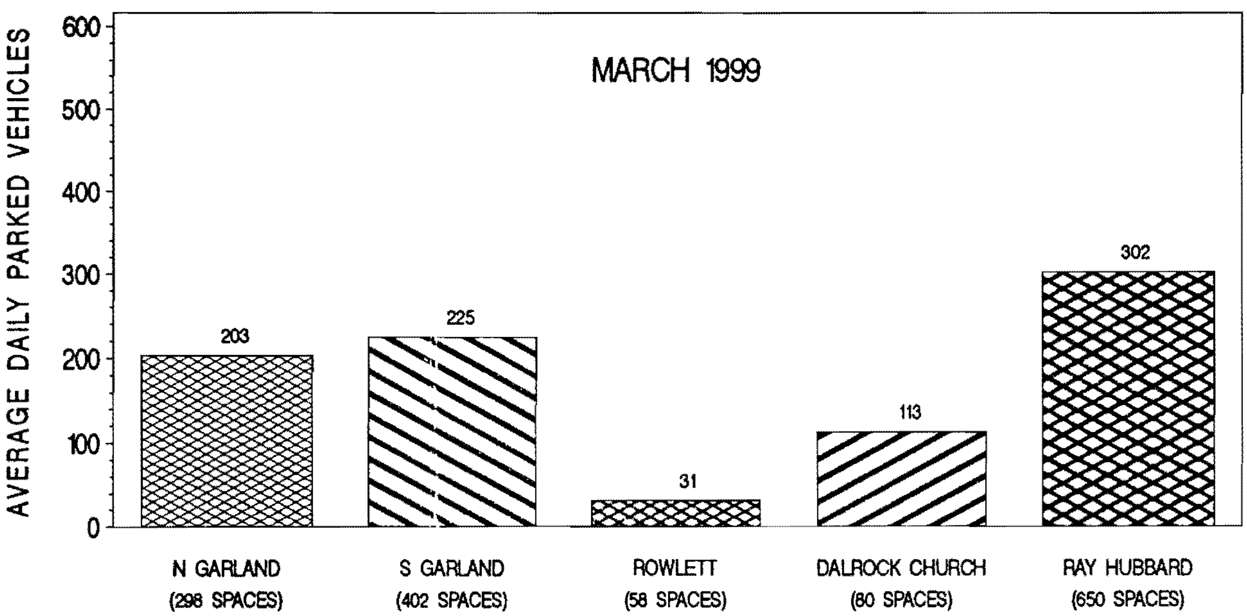
EAST R.L. THORNTON (IH-30) FREEWAY
PARK-AND-RIDE LOT UTILIZATION



SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE A-22

EAST R.L. THORNTON (IH-30) FREEWAY
CORRIDOR PARK-AND-RIDE LOT UTILIZATION



SOURCE: TEXAS TRANSPORTATION INSTITUTE

PARKING CAPACITY FOR CORRIDOR = 1488 SPACES

APPENDIX B

IH-35E (Stemmons) Concurrent Flow HOV Lane

Table B-1. Stemmons Freeway (IH-35E North) Concurrent Flow Lane Operation: Opening Dates and Vehicle Eligibility.

Operation	Limits	Length (miles)	Time	Date	Eligible Vehicles					
					Buses	Vanpools	Carpool Occupancy			MC
							4+	3+	2+	
HOV Lane Construction Began	AM: Frankford to IH-635 PM: IH 635 to Trinity Mills	7.3 5.6	NA NA	6/6/95	NA	NA	NA	NA	NA	NA
HOV Lane Opens for Operation	AM: Northern Limits of HOV Lane to S-Ramp PM: S-Ramp to Northern Limits of HOV Lane	7.3 5.6	24 hours	9/16/96	X	X			X	X

Notes (1) MC denotes motorcycles.

Table B-2. Stemmons Freeway (IH-35E North) Operational Summary [(1)] - MARCH 1999.

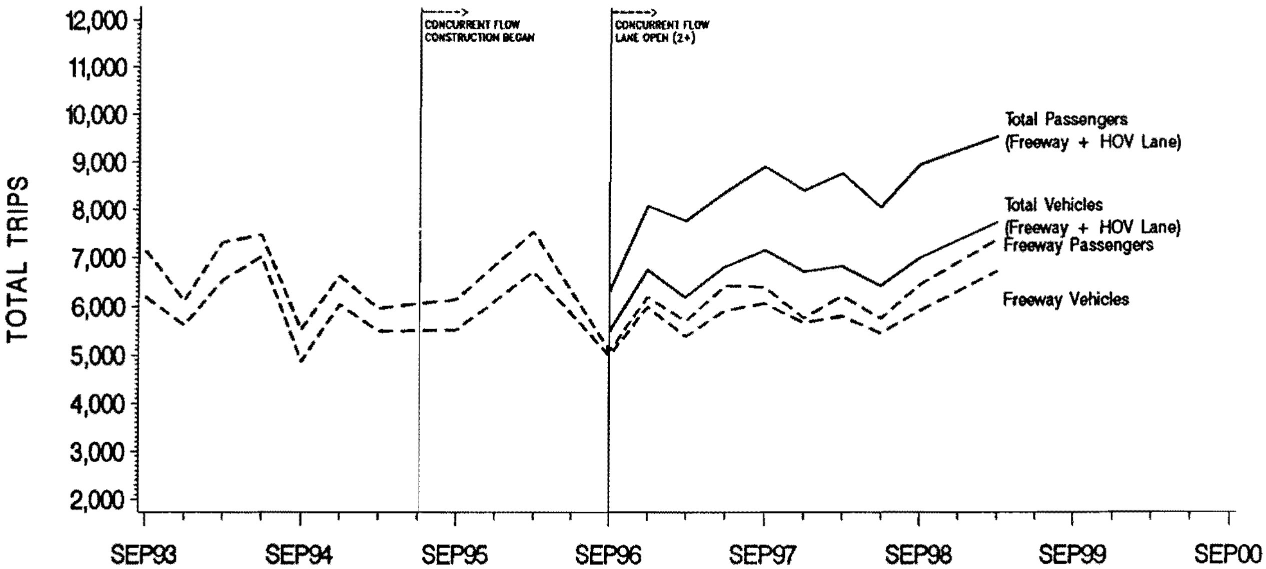
Vehicle Type	Peak Direction Mixed-Flow Lanes						Concurrent Flow Lane						Total Peak Direction Lanes					
	AM Southbound			PM Northbound			AM Southbound			PM Northbound			AM Southbound			PM Northbound		
	Vehicles	Persons	Average Occupancy	Vehicles	Persons	Average Occupancy	Vehicles	Persons	Average Occupancy	Vehicles	Persons	Average Occupancy	Vehicles	Persons	Average Occupancy	Vehicles	Persons	Average Occupancy
DART BUSES																		
Peak Hour	0	0	0.00	1	10	10.00	7	110	15.71	12	270	22.50	7	110	15.71	13	280	21.54
Peak Period	0	0	0.00	6	85	14.17	18	430	23.89	19	440	23.16	18	430	23.89	25	525	21.00
OTHER BUSES																		
Peak Hour	3	0	0.00	1	30	30.00	1	0	0.00	0	0	0.00	4	0	0.00	1	30	30.00
Peak Period	4	0	0.00	3	30	10.00	3	20	6.67	0	0	0.00	7	20	2.86	3	30	10.00
VANPOOLS																		
Peak Hour	3	15	5.00	22	116	5.27	7	41	5.86	13	71	5.46	10	56	5.60	35	187	5.34
Peak Period	5	25	5.00	44	241	5.48	18	105	5.83	32	172	5.38	23	130	5.65	76	413	5.43
2+ CARPOOLS																		
Peak Hour	600	1,237	2.06	375	771	2.06	879	1,895	2.16	869	1,827	2.10	1,479	3,132	2.12	1,244	2,598	2.09
Peak Period	1,517	3,177	2.09	887	1,807	2.04	1,920	4,116	2.14	2,119	4,422	2.09	3,437	7,293	2.12	3,006	6,229	2.07
MOTORCYCLES																		
Peak Hour	1	1	1.00	1	1	1.00	18	18	1.00	14	14	1.00	19	19	1.00	15	15	1.00
Peak Period	8	8	1.00	4	4	1.00	36	36	1.00	29	29	1.00	44	44	1.00	33	33	1.00
1 PERSON/VEHICLE[(2)]																		
Peak Hour	6,019	6,019	1.00	4,492	4,492	1.00	105	105	1.00	26	26	1.00	6,124	6,124	1.00	4,518	4,518	1.00
Peak Period	16,857	16,857	1.00	12,254	12,254	1.00	229	229	1.00	57	57	1.00	17,086	17,086	1.00	12,311	12,311	1.00
HEAVY VEHICLES[(3)]																		
Peak Hour	97	99	1.02	144	154	1.07	NA	NA	NA	NA	NA	NA	97	99	1.02	144	154	1.07
Peak Period	502	504	1.00	401	420	1.05	NA	NA	NA	NA	NA	NA	502	504	1.00	401	420	1.05
TOTAL																		
Peak Hour	6,723	7,371	1.10	5,036	5,574	1.11	1,017	2,169	2.13	934	2,208	2.36	7,740	9,540	1.23	5,970	7,782	1.30
Peak Period	18,893	20,571	1.09	13,599	14,841	1.09	2,224	4,936	2.22	2,256	5,120	2.27	21,117	25,507	1.21	15,855	19,961	1.26
Peak Hour Persons/Lane	2,457			1,858			2,169			2,208			2,385			1,946		

Notes (1) Peak direction Mixed-flow data was collected at Valwood, Concurrent Flow Lane data was collected at Sandy Lake
(2) 1 Person/Vehicle on the concurrent flow lane are counted by TTI field crew and are considered violators These single occupant vehicles are included in total vehicles on the HOV lane
(3) Heavy vehicles refers to trucks over two axles These vehicles are not allowed on the Concurrent Flow Lane
(4) N/A=Not Applicable
(5) Source Texas Transportation Institute

FIGURE B-1

STEMMONS (IH-35E NORTH) FREEWAY

A.M. PEAK HOUR SOUTHBOUND VEHICLE/PASSENGER UTILIZATION



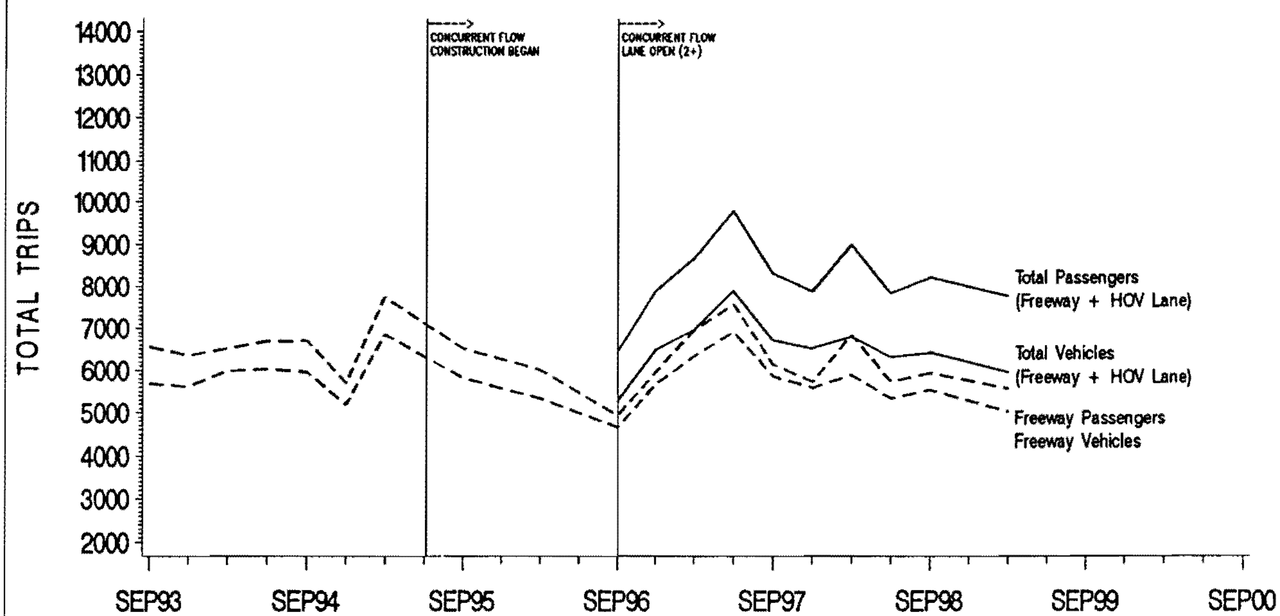
NOTE: COUNT LOCATION IS OVER VALWOOD

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE B-2

STEMMONS (IH-35E NORTH) FREEWAY

P.M. PEAK HOUR NORTHBOUND VEHICLE/PASSENGER UTILIZATION



NOTE: COUNT LOCATION OVER VALWOOD

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE B-3

STEMMONS (IH-35E NORTH) CONCURRENT FLOW HOV LANE
A.M. PEAK HOUR SOUTHBOUND VEHICLE UTILIZATION

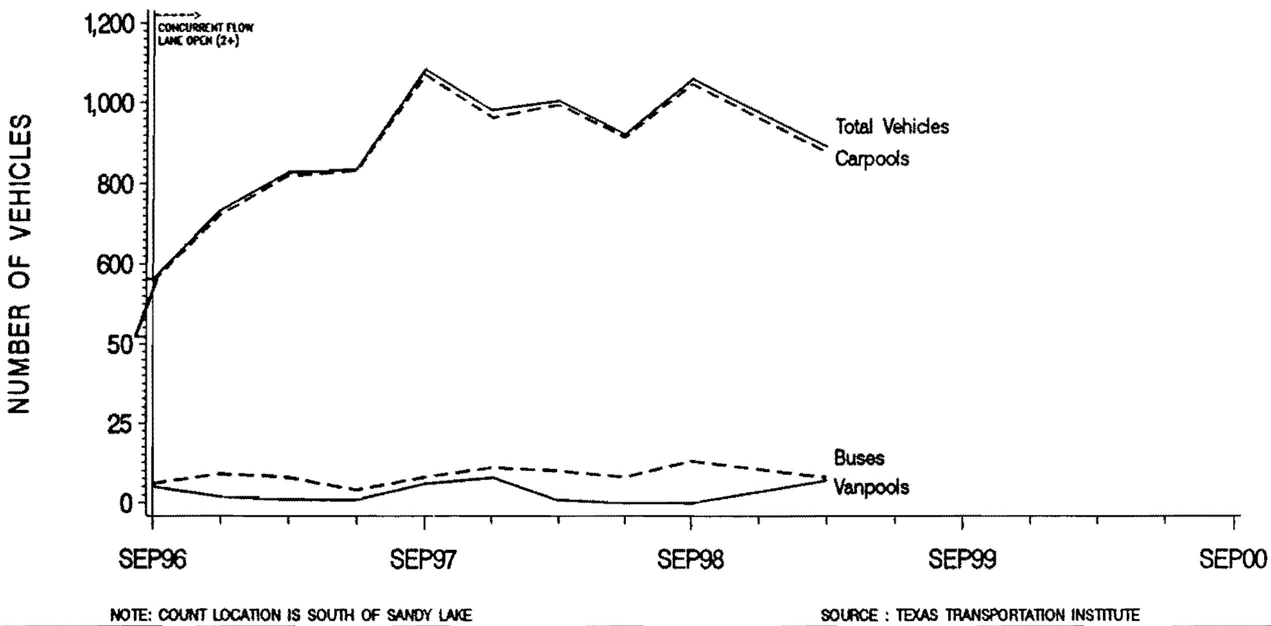


FIGURE B-4

STEMMONS (IH-35E NORTH) CONCURRENT FLOW HOV LANE
A.M. PEAK HOUR SOUTHBOUND PERSON MOVEMENT

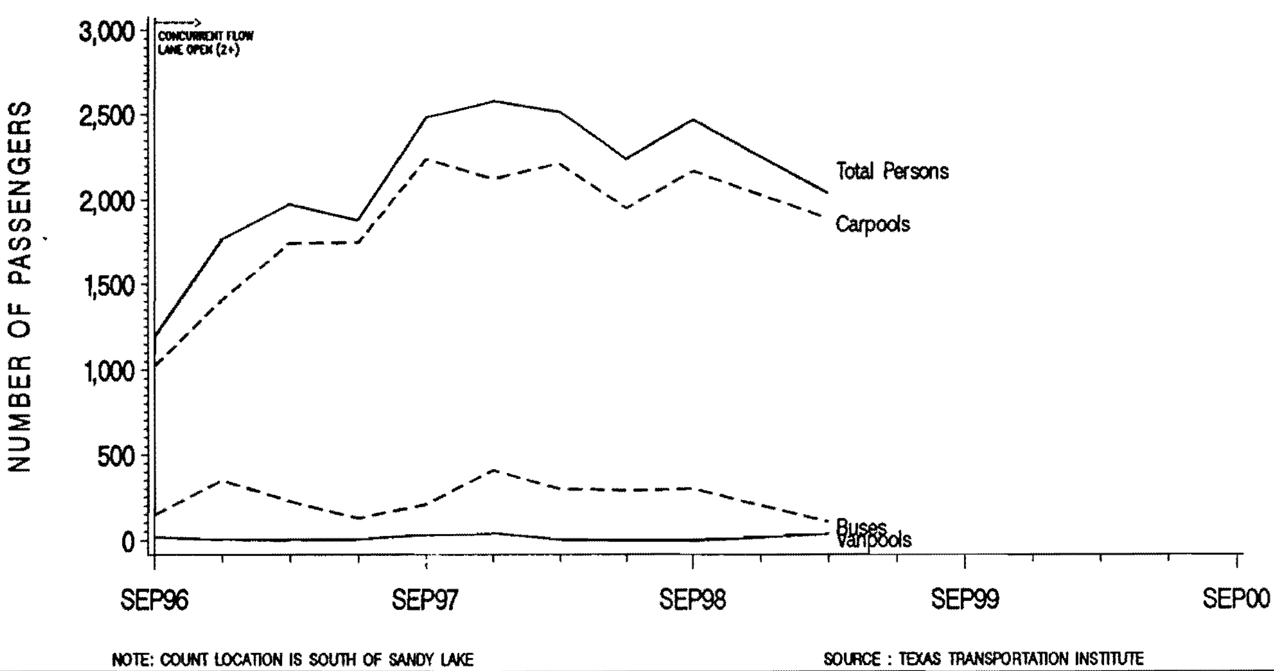
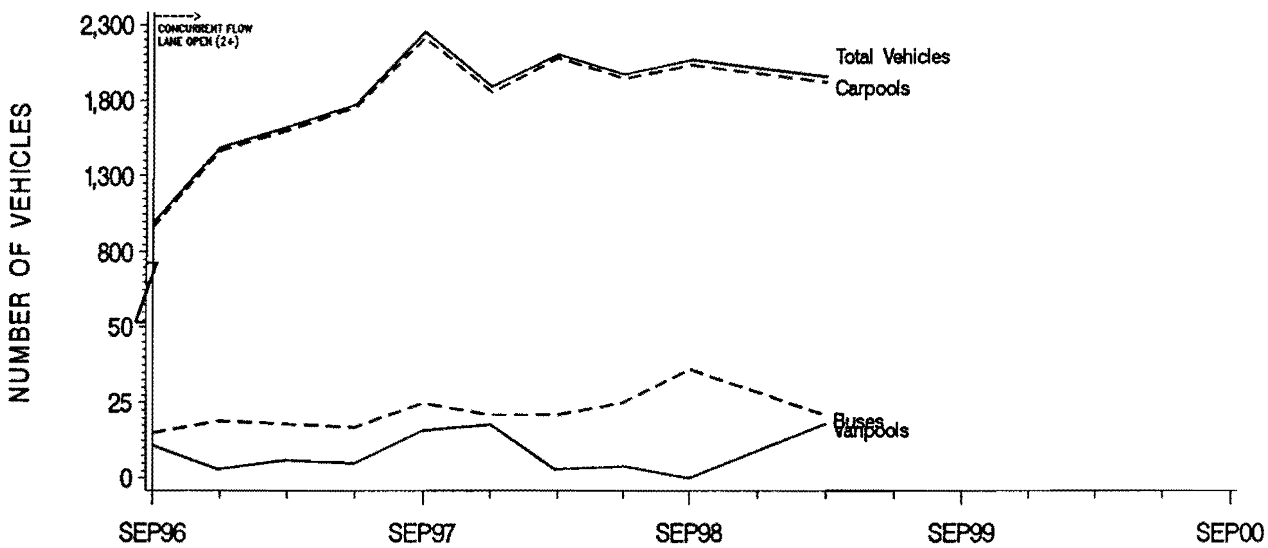


FIGURE B-5

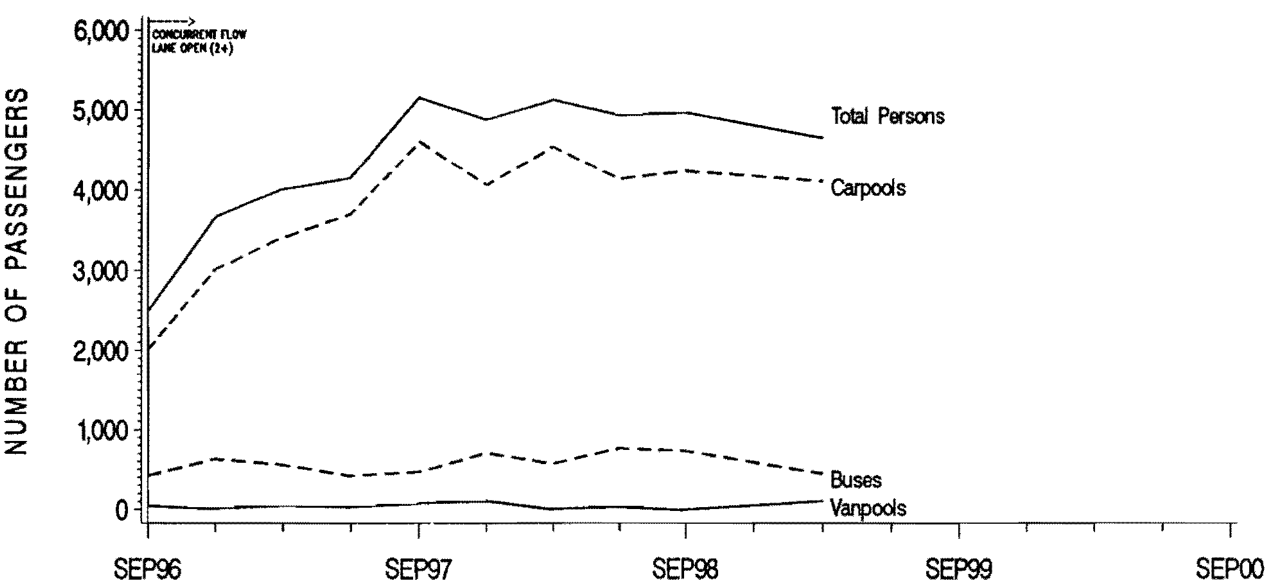
STEMMONS (IH-35E NORTH) CONCURRENT FLOW HOV LANE
A.M. PEAK PERIOD SOUTHBOUND VEHICLE UTILIZATION



PEAK PERIOD IS FROM 6:00 A.M. TO 9:00 A.M.
NOTE: COUNT LOCATION IS SOUTH OF SANDY LAKE
SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE B-6

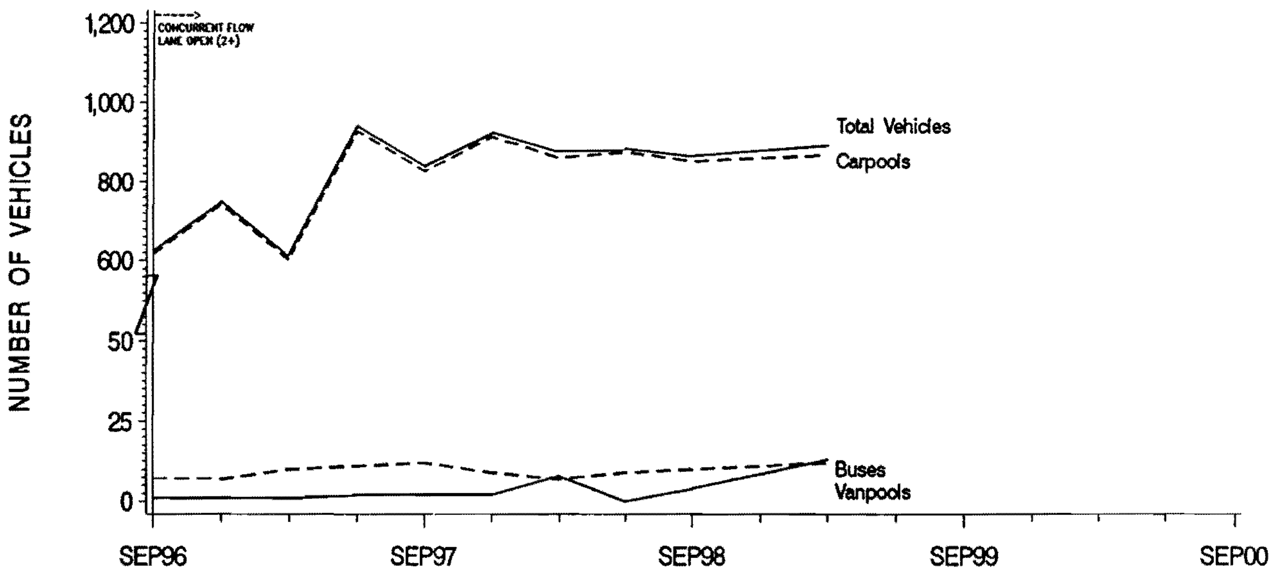
STEMMONS (IH-35E NORTH) CONCURRENT FLOW HOV LANE
A.M. PEAK PERIOD SOUTHBOUND PERSON MOVEMENT



PEAK PERIOD IS FROM 6:00 A.M. TO 9:00 A.M.
NOTE: COUNT LOCATION IS SOUTH OF SANDY LAKE
SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE B-7

STEMMONS (IH-35E NORTH) CONCURRENT FLOW HOV LANE
P.M. PEAK HOUR NORTHBOUND VEHICLE UTILIZATION

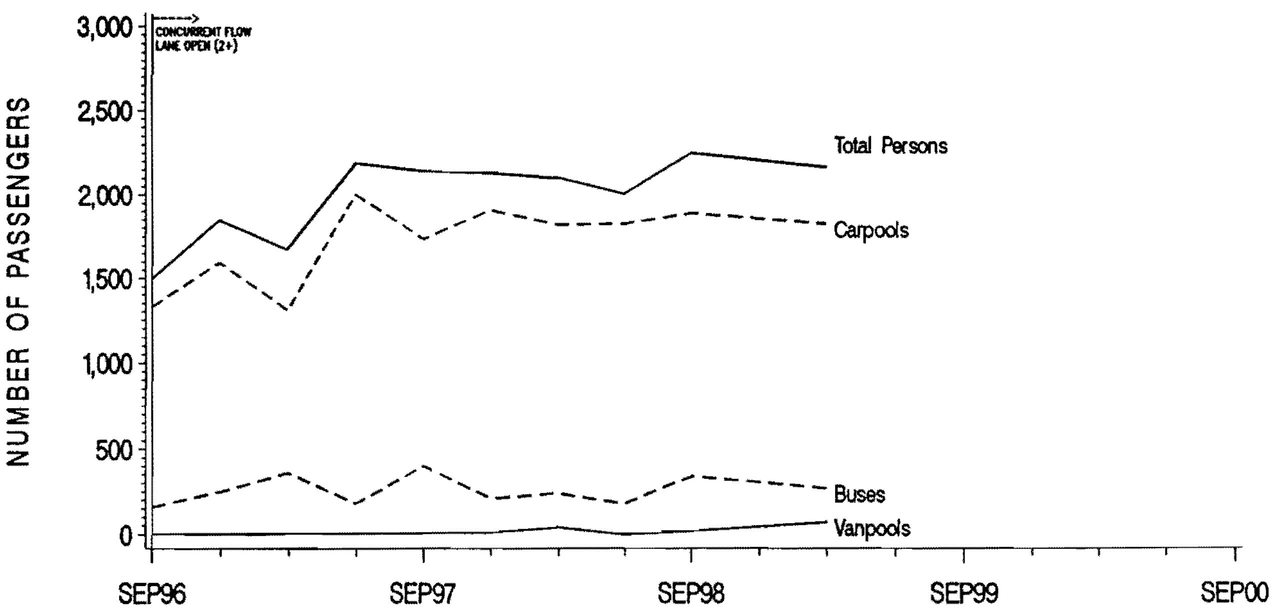


NOTE: COUNT LOCATION IS SOUTH OF SANDY LAKE

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE B-8

STEMMONS (IH-35E) CONCURRENT FLOW HOV LANE
P.M. PEAK HOUR NORTHBOUND PERSON MOVEMENT

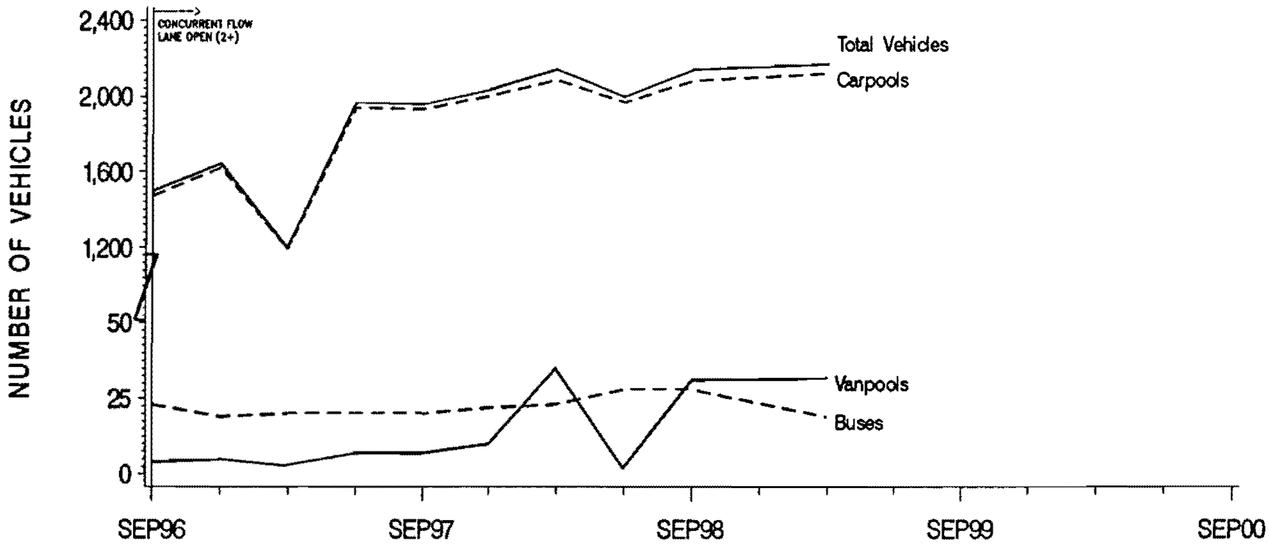


NOTE: COUNT LOCATION IS SOUTH OF SANDY LAKE

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE B-9

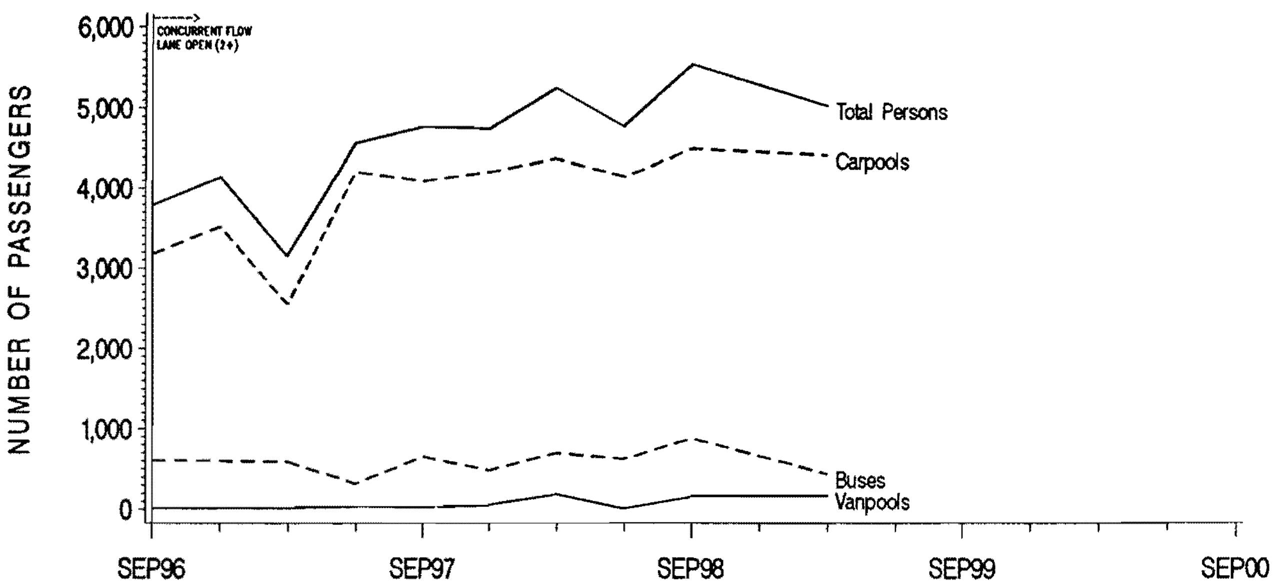
STEMMONS (IH-35E NORTH) CONCURRENT FLOW HOV LANE
P.M. PEAK PERIOD NORTHBOUND VEHICLE UTILIZATION



PEAK PERIOD IS FROM 4:00 P.M. TO 7:00 P.M.
NOTE: COUNT LOCATION IS SOUTH OF SANDY LAKE
SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE B-10

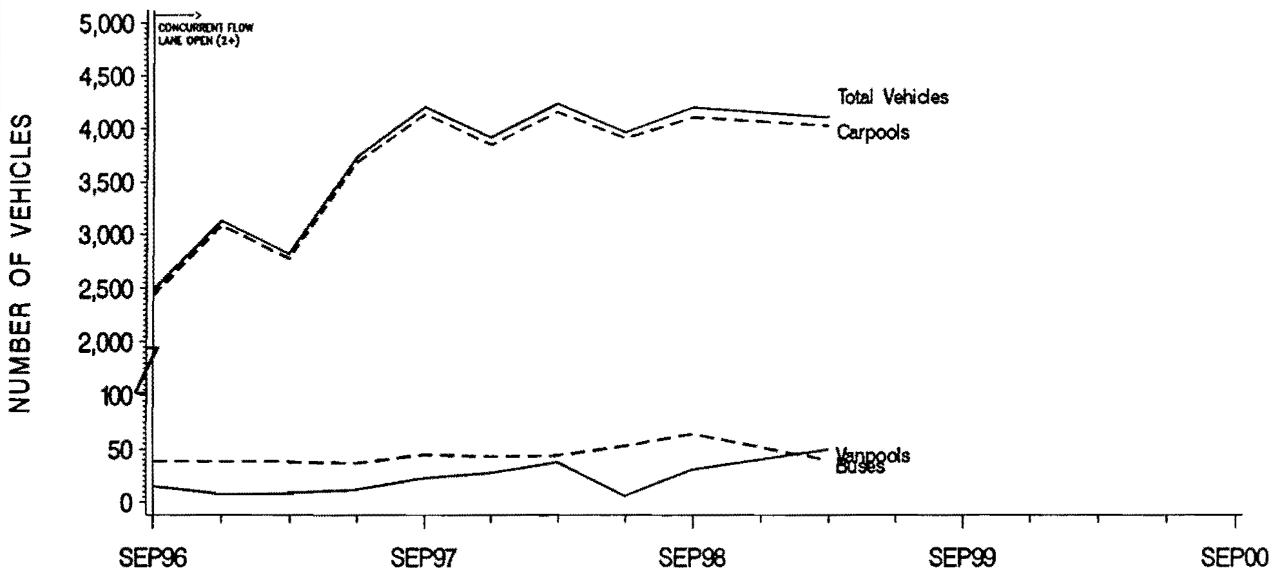
STEMMONS (IH-35E NORTH) CONCURRENT FLOW HOV LANE
P.M. PEAK PERIOD NORTHBOUND PERSON MOVEMENT



PEAK PERIOD IS FROM 4:00 P.M. TO 7:00 P.M.
NOTE: COUNT LOCATION IS SOUTH OF SANDY LAKE
SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE B-11

STEMMONS (IH-35E NORTH) CONCURRENT FLOW HOV LANE
TOTAL PEAK PERIOD VEHICLE UTILIZATION

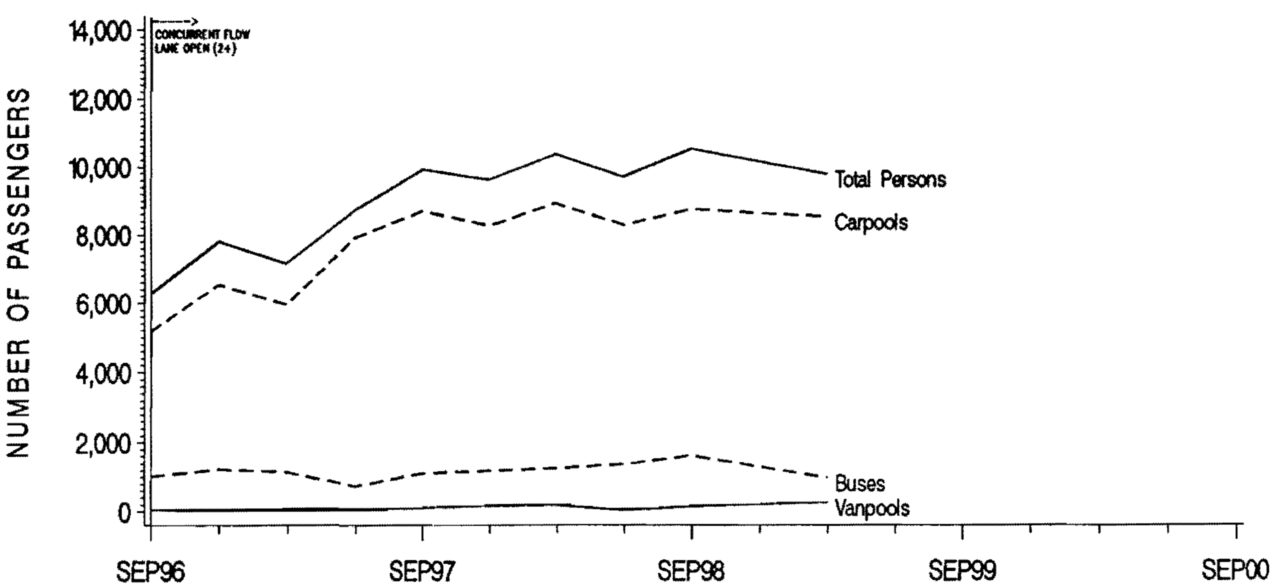


NOTE: COUNT LOCATION IS SOUTH OF SANDY LAKE

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE B-12

STEMMONS (IH-35E NORTH) CONCURRENT FLOW HOV LANE
TOTAL PEAK PERIOD PERSON MOVEMENT



NOTE: COUNT LOCATION IS SOUTH OF SANDY LAKE

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE B-13

STEMMONS (IH-35E NORTH) FREEWAY

A.M. PEAK HOUR SOUTHBOUND OCCUPANCY RATES

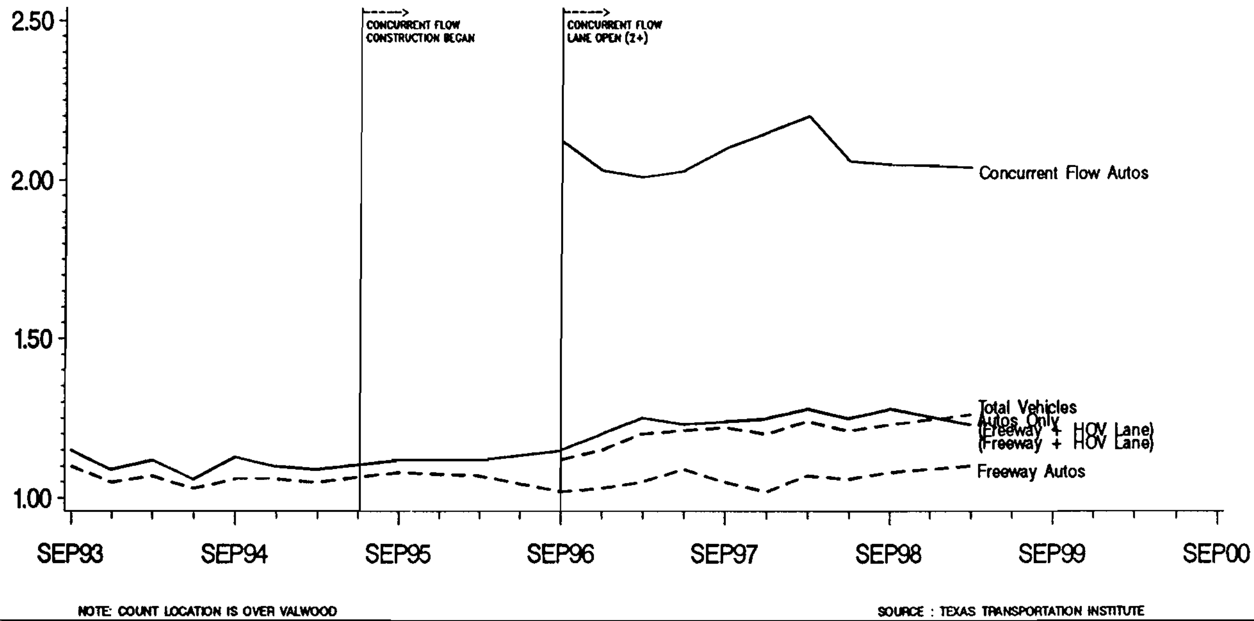


FIGURE B-14

STEMMONS (IH-35E NORTH) FREEWAY

P.M. PEAK HOUR NORTHBOUND OCCUPANCY RATES

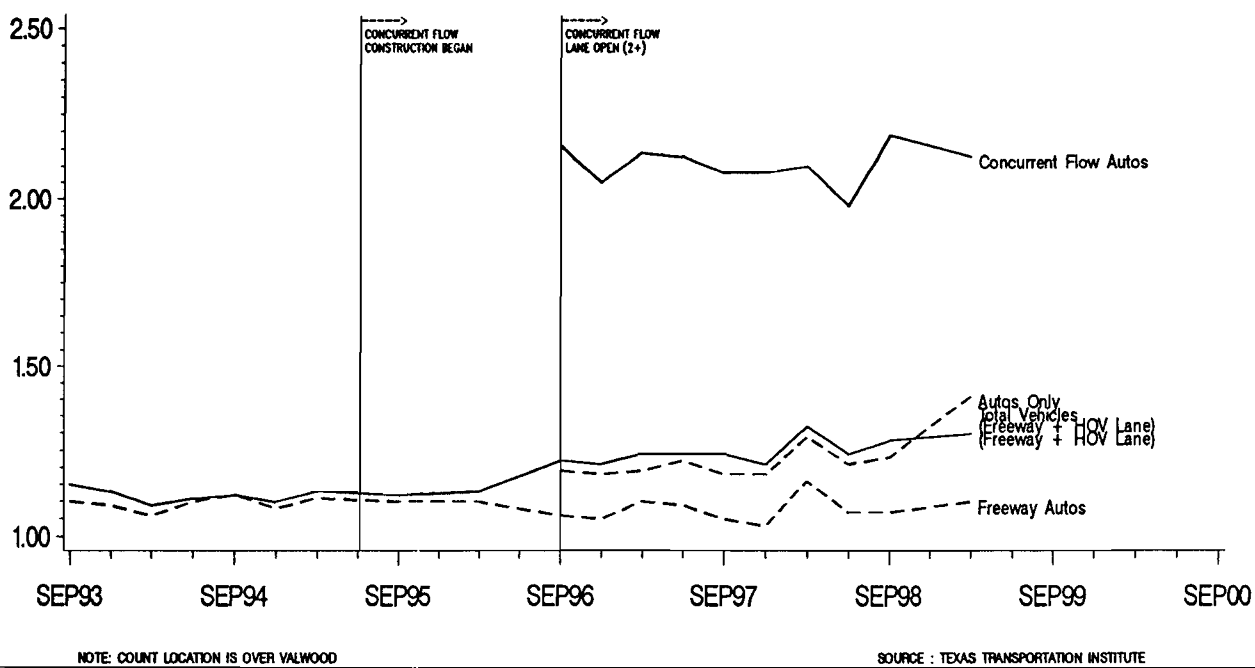
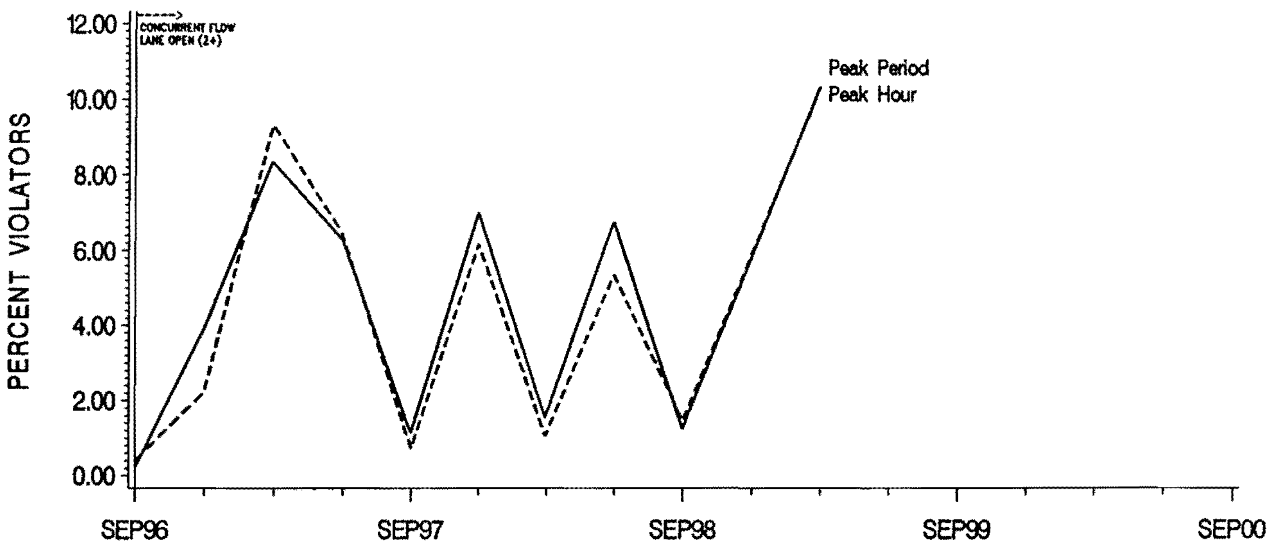


FIGURE B-15

STEMMONS (IH-35E NORTH) CONCURRENT FLOW HOV LANE
A.M. PEAK SOUTHBOUND VIOLATOR RATES

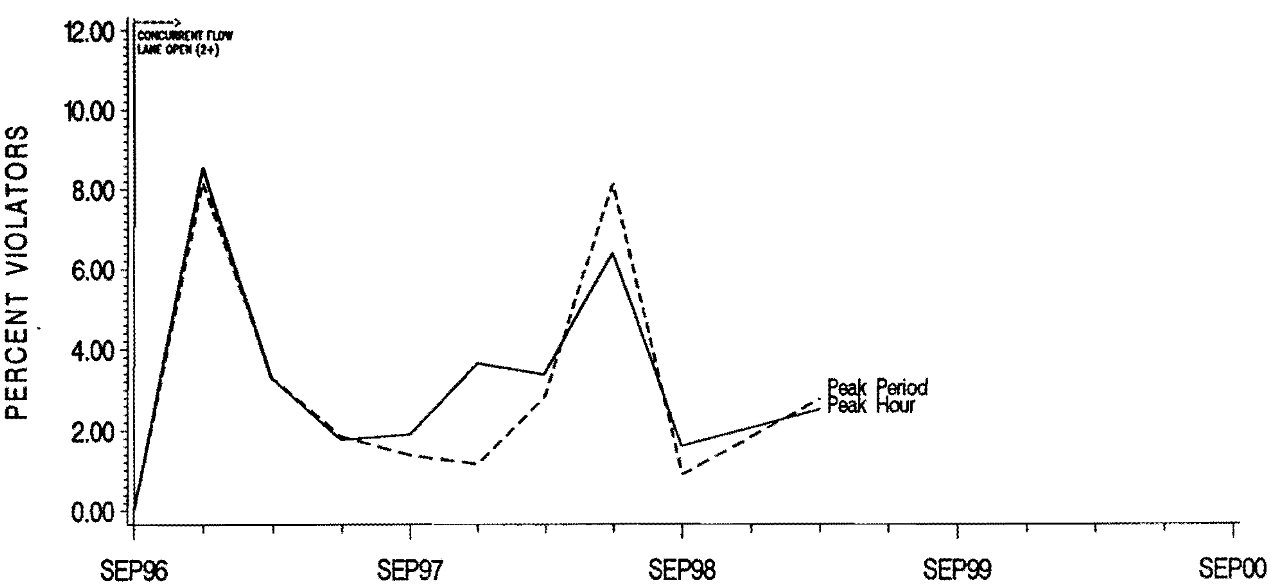


NOTE: (1) COUNT LOCATION IS SOUTH OF SANDY LAKE
(2) PERCENT VIOLATORS - (SINGLE PASSENGER VEHICLES / TOTAL VEHICLES)

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE B-16

STEMMONS (IH-35E NORTH) CONCURRENT FLOW HOV LANE
P.M. PEAK NORTHBOUND VIOLATOR RATES



NOTE: (1) COUNT LOCATION IS SOUTH OF SANDY LAKE
(2) PERCENT VIOLATORS - (SINGLE PASSENGER VEHICLES / TOTAL VEHICLES)

SOURCE : TEXAS TRANSPORTATION INSTITUTE

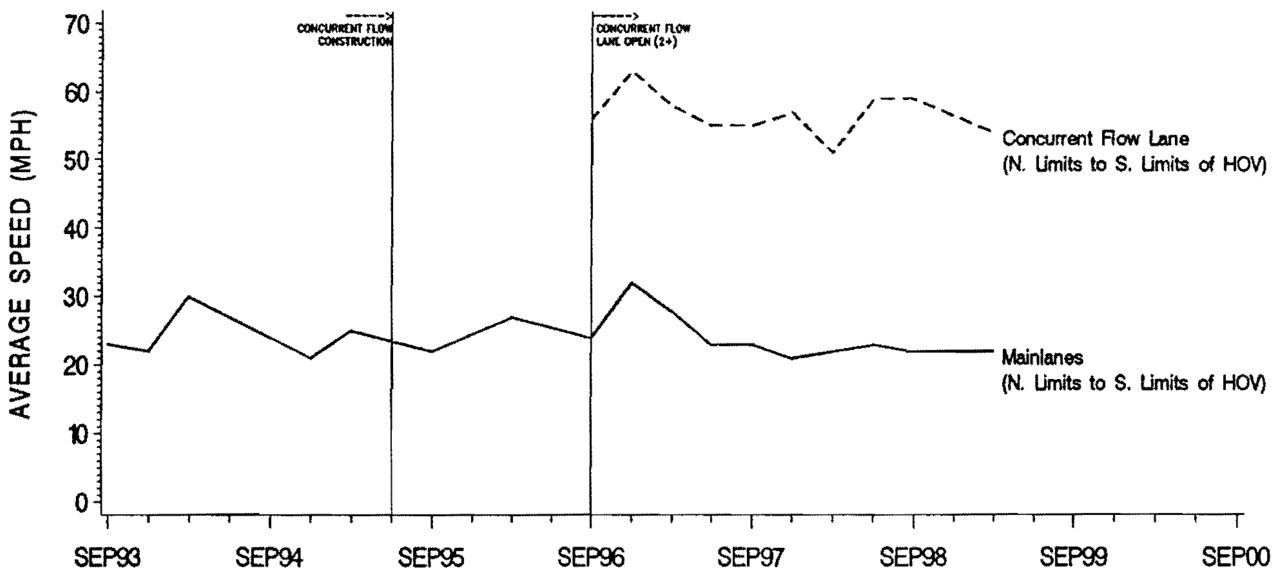
Table B-3. Stemmons Freeway (IH-35E North) Average Speeds (MPH) SH-121 to IH-635 Westbound Entrance - MARCH 1999.

Time Period	SH-121 to Northern Limits of HOV Lane (3.4 miles inbound) (5.1 miles outbound)		Northern Limits of HOV Lane to Sandy Lake (2.7 miles inbound) (1.04 miles outbound)		Sandy Lake to Valwood (2.3 miles)		Valwood to IH-635 WB Mainlanes (2.1 miles)		IH-635 WB Mainlanes to S-Ramp (0.20 miles)		**HOV Limits** Northern Limits of HOV Lane to S-Ramp (7.3 miles inbound) (5.6 miles outbound)	
	Speed (mph)	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)
PEAK DIRECTION MIXED FLOW LANES												
AM Peak Hour, SB	34	6.02	14	11.74	26	5.23	47	2.71	51	0.25	**22**	**20.18**
AM Peak Period, SB	50	4.17	26	6.01	33	4.20	49	2.59	55	0.23	**32**	**13.44**
PM Peak Hour, NB	45	6.82	30	2.05	39	3.52	28	4.55	64	0.19	**27**	**12.47**
PM Peak Period, NB	53	5.73	48	1.29	52	2.63	41	3.10	61	0.20	**37**	**9.27**
CONCURRENT FLOW LANE												
AM Peak Hour, SB	--	--	56	2.84	52	2.61	63	2.02	49	0.28	**59**	**7.36**
AM Peak Period, SB	--	--	63	2.52	60	2.28	65	1.99	50	0.28	**63**	**6.95**
PM Peak Hour, NB	--	--	56	1.11	57	2.38	47	2.72	33	0.36	**54**	**6.29**
PM Peak Period, NB	--	--	63	0.99	60	2.26	48	2.67	34	0.35	**60**	**5.64**
TRAVEL TIME SAVINGS												
AM Peak Hour, SB	--	--	--	8.90	--	2.62	--	0.69	--	-0.03	--	**12.82**
AM Peak Period, SB	--	--	--	3.49	--	1.92	--	0.60	--	-0.05	--	**6.49**
PM Peak Hour, NB	--	--	--	0.94	--	1.14	--	1.83	--	-0.17	--	**6.18**
PM Peak Period, NB	--	--	--	0.30	--	0.37	--	0.43	--	-0.15	--	**3.63**

Notes (1) Peak Direction Mixed Flow Lanes AM Peak Hour=7:00-8:00 AM; PM Peak Hour=5:15-6:15 PM.
Concurrent Flow Lane AM Peak Hour=7:15-8:15 AM; PM Peak Hour =4:30-5:30 PM.
Peak Period=6:00-9:00 AM and 4:00-7:00 PM for both types.
(2) Source: Texas Transportation Institute

FIGURE B-17

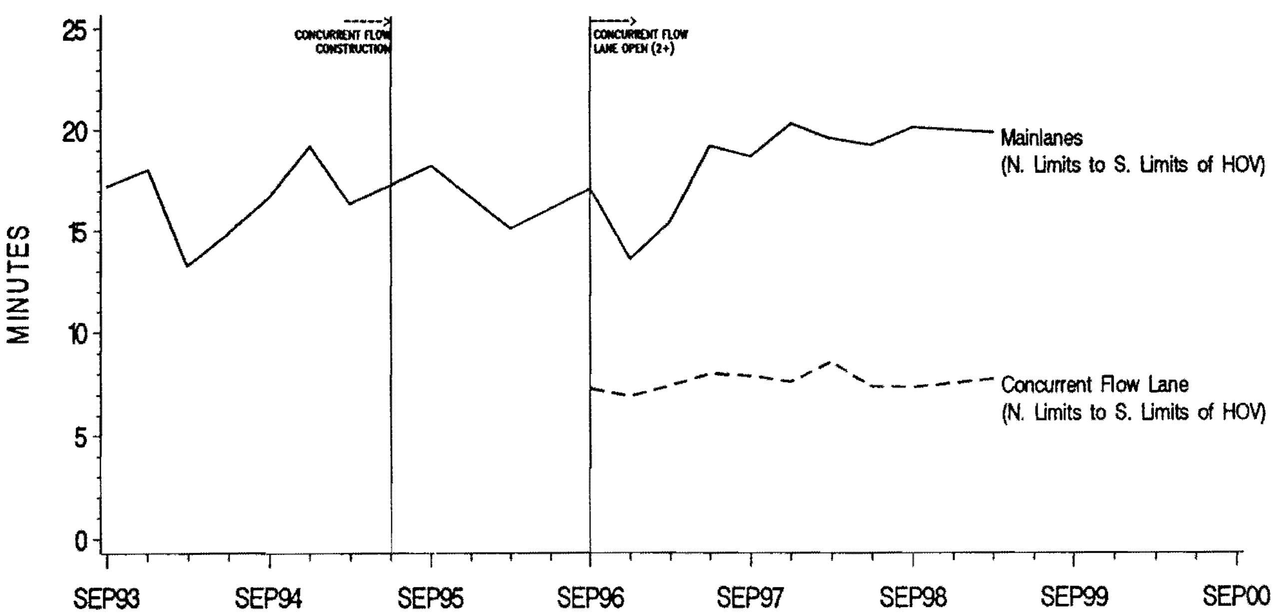
STEMMONS (IH-35E NORTH) CONCURRENT FLOW HOV LANE A.M. PEAK HOUR SOUTHBOUND AVERAGE SPEEDS



SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE B-18

STEMMONS (IH-35E NORTH) CONCURRENT FLOW HOV LANE A.M. PEAK HOUR SOUTHBOUND TRAVEL TIMES

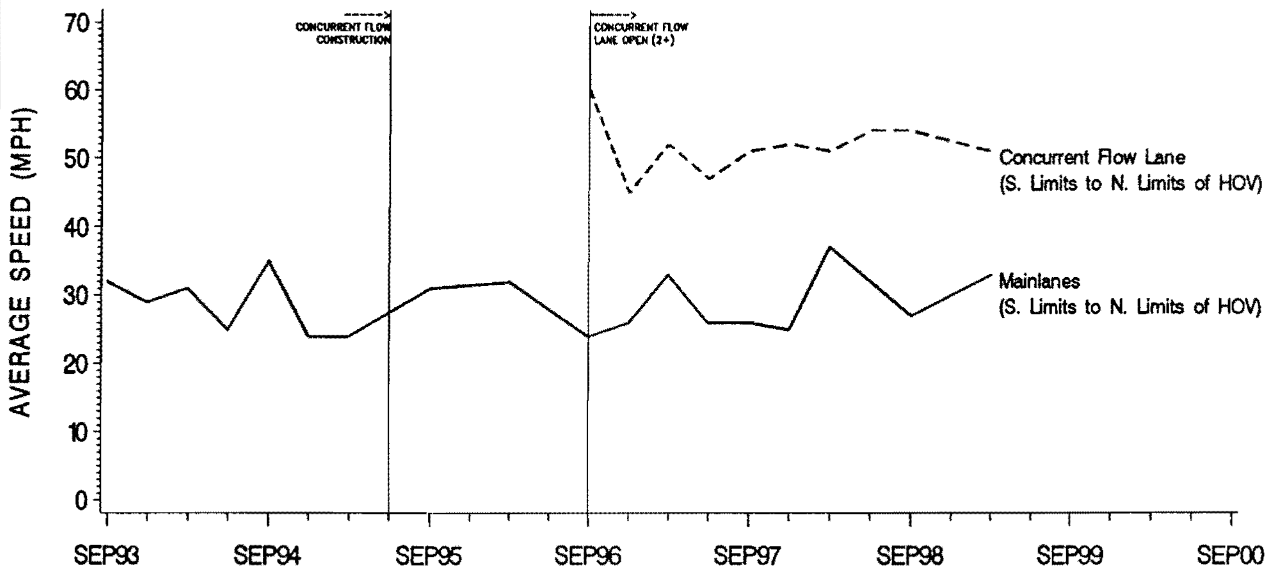


SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE B-19

STEMMONS (IH-35E NORTH) CONCURRENT FLOW HOV LANE

P.M. PEAK HOUR NORTHBOUND AVERAGE SPEEDS

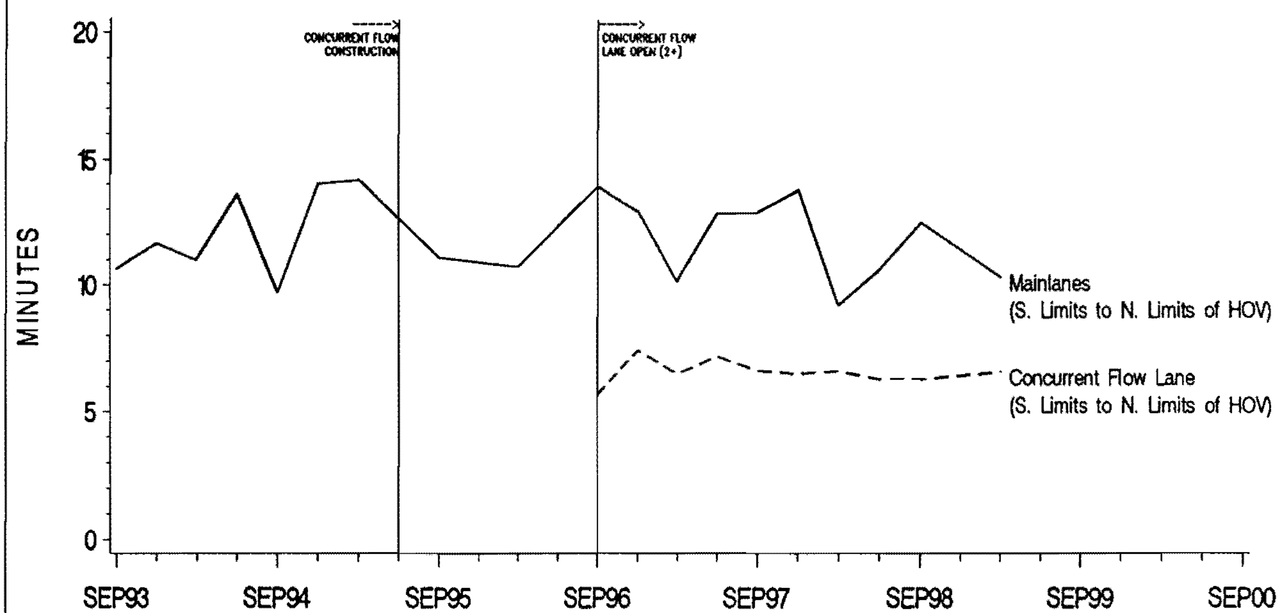


SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE B-20

STEMMONS (IH-35E NORTH) CONCURRENT FLOW HOV LANE

P.M. PEAK HOUR NORTHBOUND TRAVEL TIMES

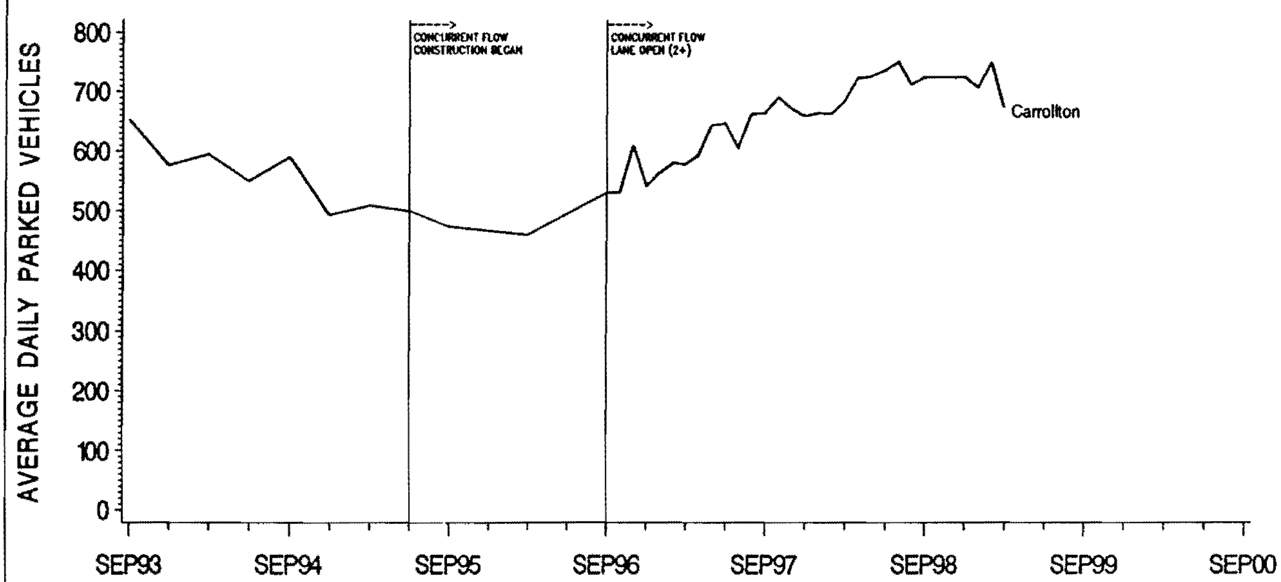


SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE B-21

STEMMONS (IH-35E NORTH) FREEWAY

PARK-AND-RIDE LOT UTILIZATION

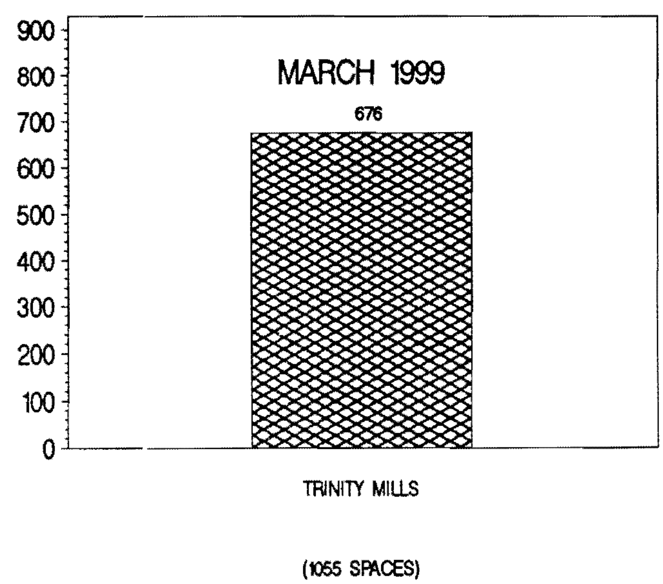


SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE B-22

STEMMONS (IH-35E NORTH) FREEWAY

CORRIDOR PARK-AND-RIDE LOT UTILIZATION



PARKING CAPACITY FOR CORRIDOR = 1055 SPACES

SOURCE: TEXAS TRANSPORTATION INSTITUTE

APPENDIX C

IH-635 (LBJ) Concurrent Flow HOV Lane

Table C-1. LBJ Freeway (IH-635) Concurrent Flow Lane Operation: Opening Dates and Vehicle Eligibility.

Operation	Limits	Length (miles)	Time	Date	Eligible Vehicles					
					Buses	Vanpools	Carpool Occupancy			MC
							4+	3+	2+	
HOV Lane Construction Began	Westbound: Hillcrest to IH-35E Eastbound: Josey to Coit Exit	5.6 6.4	NA NA	8/8/95	NA	NA	NA	NA	NA	NA
HOV Lane Opens for Operation in Westbound Direction	AM: Eastern Limits of HOV to IH-35E PM: Eastern Limits of HOV to IH-35E	5.9 5.9	24 hours	3/10/97	X	X			X	X
HOV Lane Opens for Operation in Eastbound Direction	AM: Western Limits to Eastern Limits of HOV Lane PM: Western Limits to Eastern Limits of HOV Lane	6.4 6.4	24 hours	3/17/97	X	X			X	X
WB HOV Lane Access/Egress Added Near Midway Road	NA	NA	NA	5/19/97	NA	NA	NA	NA	NA	NA

Notes (1) MC denotes motorcycles.

Table C-2. LBJ Freeway (IH-635) Westbound Operational Summary [1] - MARCH 1999.

Vehicle Type	Peak Direction Mixed-Flow Lanes						Concurrent Flow Lane						Total Peak Direction Lanes					
	AM Westbound			PM Westbound			AM Westbound			PM Westbound			AM Westbound			PM Westbound		
	Vehicles	Persons	Average Occupancy	Vehicles	Persons	Average Occupancy	Vehicles	Persons	Average Occupancy	Vehicles	Persons	Average Occupancy	Vehicles	Persons	Average Occupancy	Vehicles	Persons	Average Occupancy
DART BUSES																		
Peak Hour	0	0	0.00	4	50	12.50	2	0	0.00	0	0	0.00	2	0	0.00	4	50	12.50
Peak Period	6	20	3.33	6	50	8.33	4	10	2.50	1	20	20.00	10	30	3.00	7	70	10.00
OTHER BUSES																		
Peak Hour	1	0	0.00	5	0	0.00	21	250	11.90	3	50	16.67	22	250	11.36	8	50	6.25
Peak Period	7	30	4.29	8	50	6.25	29	360	12.41	5	100	20.00	36	390	10.83	13	150	11.54
VANPOOLS																		
Peak Hour	8	40	5.00	3	15	5.00	25	95	3.80	0	0	0.00	33	135	4.09	3	15	5.00
Peak Period	12	63	5.25	5	28	5.60	53	226	4.26	2	10	5.00	65	289	4.45	7	38	5.43
2+ CARPOOLS																		
Peak Hour	508	1,133	2.23	992	2,187	2.20	891	2,031	2.28	1,015	2,153	2.12	1,399	3,164	2.26	2,007	4,340	2.16
Peak Period	1,021	2,261	2.21	2,630	5,828	2.22	2,135	4,855	2.27	2,907	6,111	2.10	3,156	7,116	2.25	5,537	11,939	2.16
MOTORCYCLES																		
Peak Hour	0	0	0.00	0	0	0.00	3	3	1.00	5	5	1.00	3	3	1.00	5	5	1.00
Peak Period	2	2	1.00	5	5	1.00	9	9	1.00	8	8	1.00	11	11	1.00	13	13	1.00
1 PERSON/VEHICLE [2]																		
Peak Hour	7,401	7,401	1.00	5,653	5,653	1.00	48	48	1.00	43	43	1.00	7,449	7,449	1.00	5,696	5,696	1.00
Peak Period	20,727	20,727	1.00	17,030	17,030	1.00	100	100	1.00	115	115	1.00	20,827	20,827	1.00	17,145	17,145	1.00
HEAVY VEHICLES [3]																		
Peak Hour	179	179	1.00	206	211	1.02	NA	NA	NA	NA	NA	NA	179	179	1.00	206	211	1.02
Peak Period	573	583	1.02	583	598	1.03	NA	NA	NA	NA	NA	NA	573	583	1.02	583	598	1.03
TOTAL																		
Peak Hour	8,097	8,753	1.08	6,863	8,116	1.18	990	2,427	2.45	1,066	2,251	2.11	9,087	11,180	1.23	7,929	10,367	1.31
Peak Period	22,348	23,686	1.06	20,267	23,589	1.16	2,330	5,560	2.39	3,038	6,364	2.09	24,678	29,246	1.19	23,305	29,953	1.29
Peak Hour Persons/Lane	2,188			2,029			2,427			2,251			2,236			2,073		

Notes

(1) Peak direction Mixed-flow data was collected west of Marsh, Concurrent Flow Lane data was collected west of Marsh

(2) 1 Person/Vehicle on the concurrent flow lane are counted by TTI field crew and are considered violators These single occupant vehicles are included in total vehicles on the HOV lane

(3) Heavy vehicles refers to trucks over two axles These vehicles are not allowed on the Concurrent Flow Lane

(4) N/A=Not Applicable

(5) Source Texas Transportation Institute

FIGURE C-1

WESTBOUND LBJ (IH-635) FREEWAY

A.M. PEAK HOUR VEHICLE/PASSENGER UTILIZATION

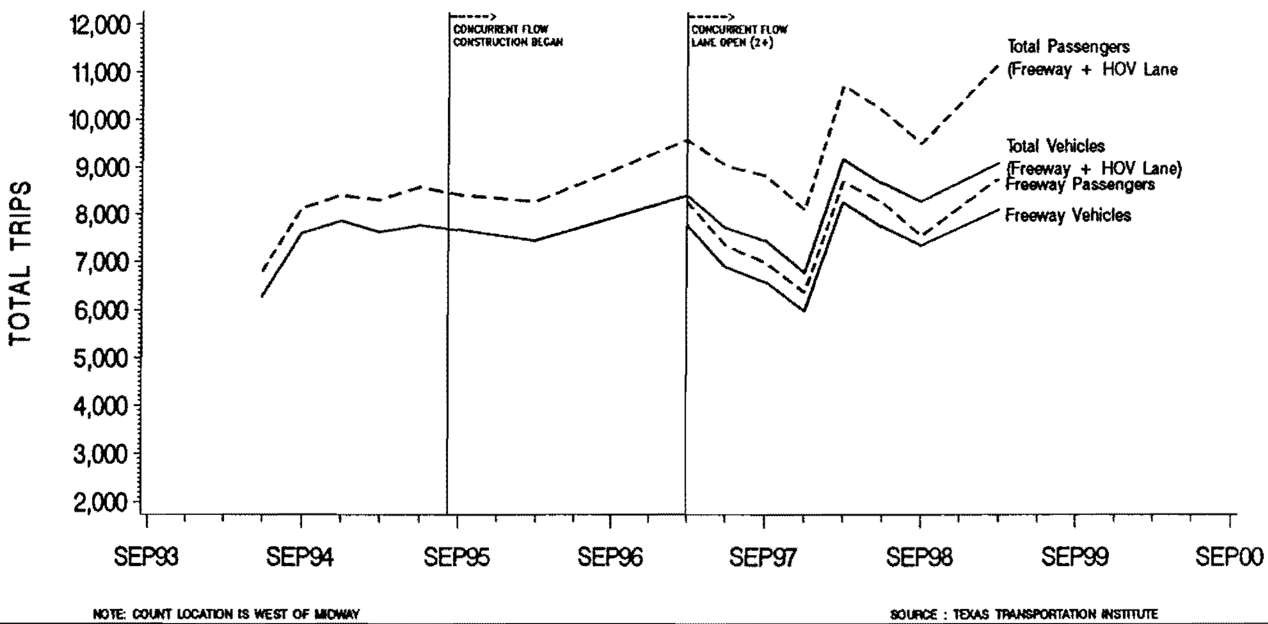


FIGURE C-2

WESTBOUND LBJ (IH-635) FREEWAY

P.M. PEAK HOUR VEHICLE/PASSENGER UTILIZATION

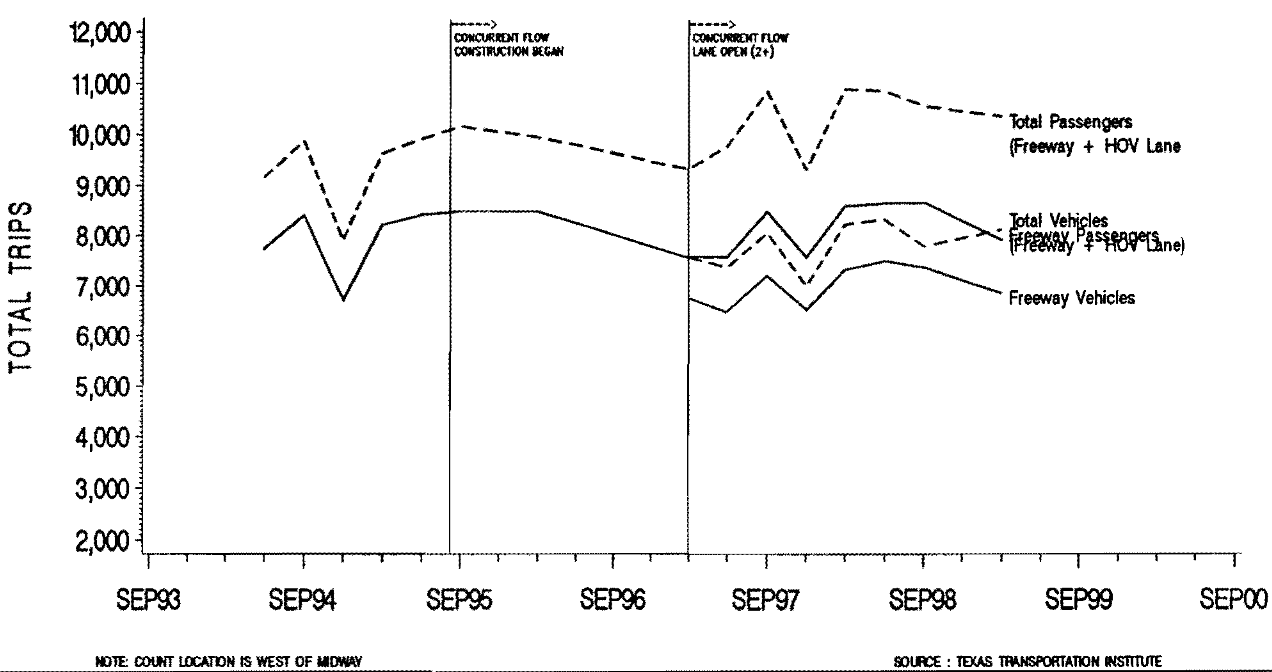


FIGURE C–3

LBJ (IH–635 WESTBOUND) CONCURRENT FLOW HOV LANE

A.M. PEAK HOUR VEHICLE UTILIZATION

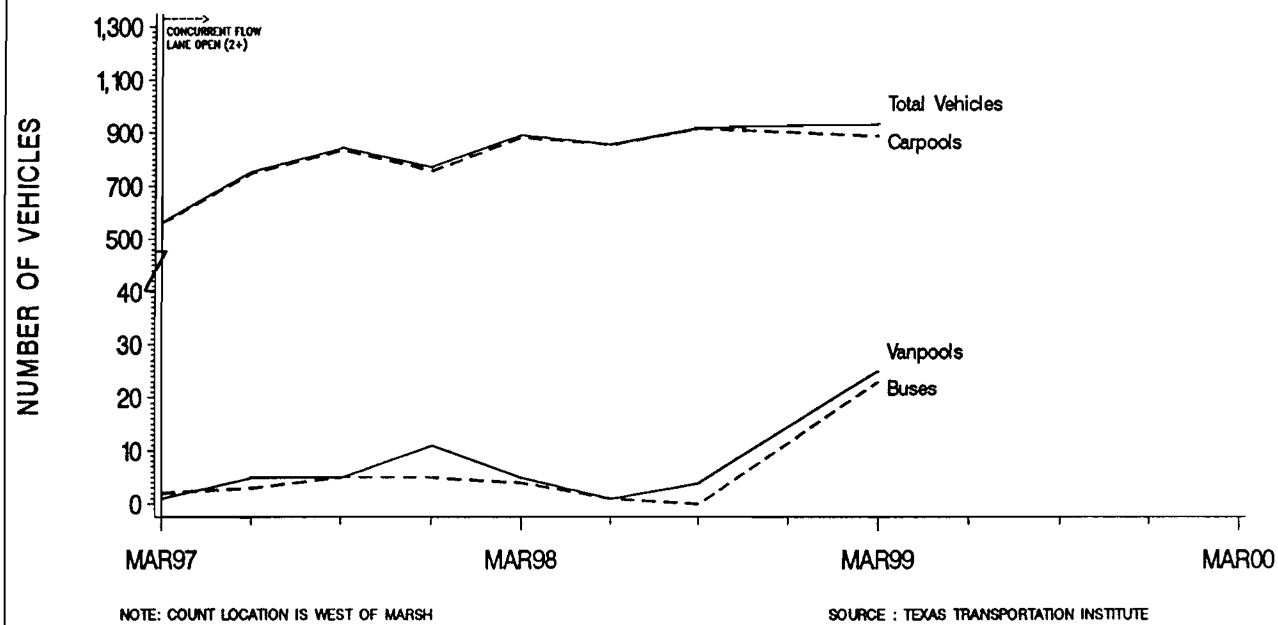


FIGURE C–4

LBJ (IH–635 WESTBOUND) CONCURRENT FLOW HOV LANE

A.M. PEAK HOUR PERSON MOVEMENT

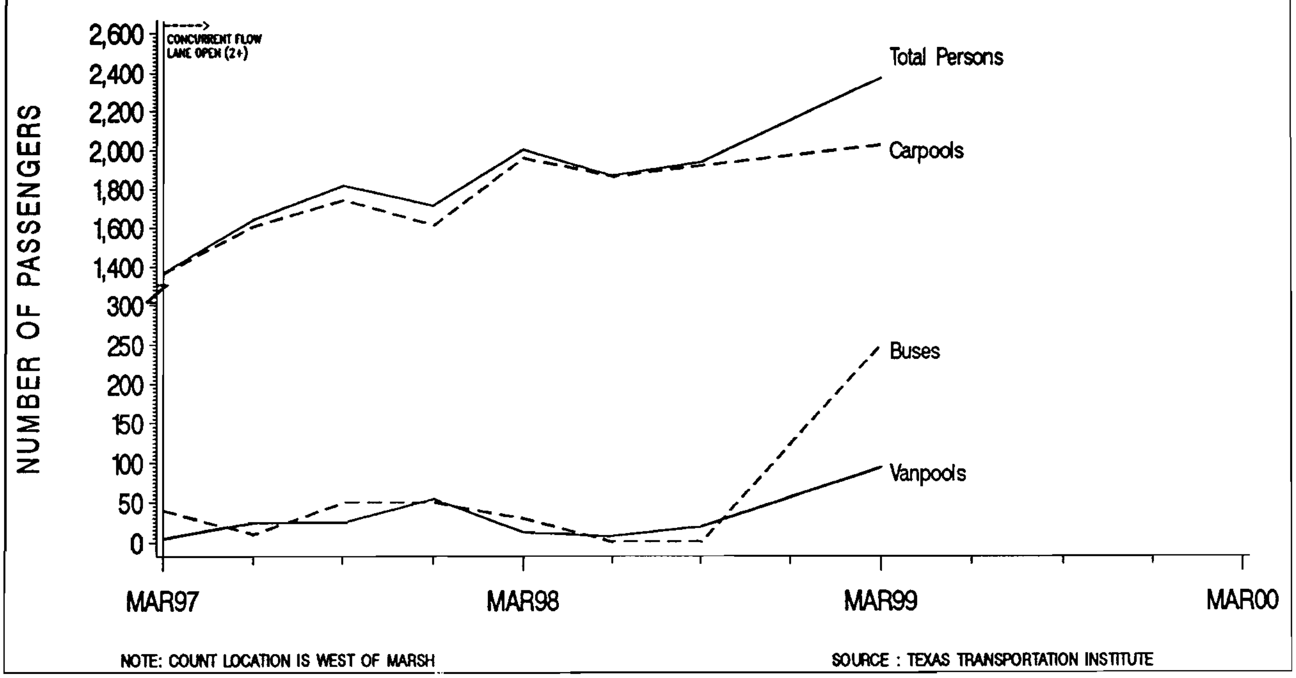
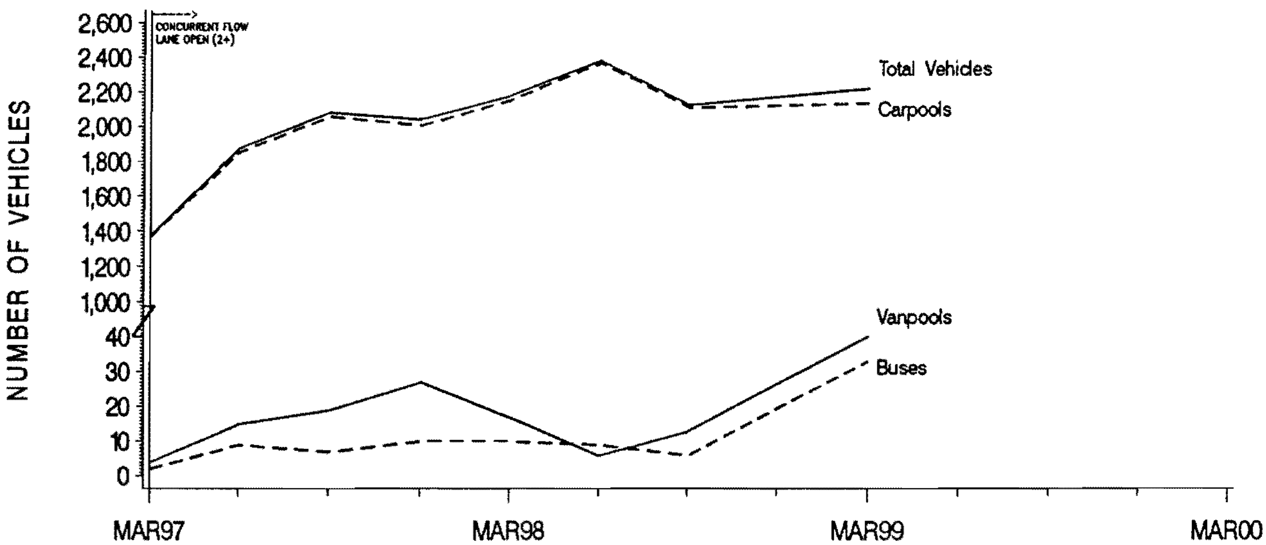


FIGURE C-5

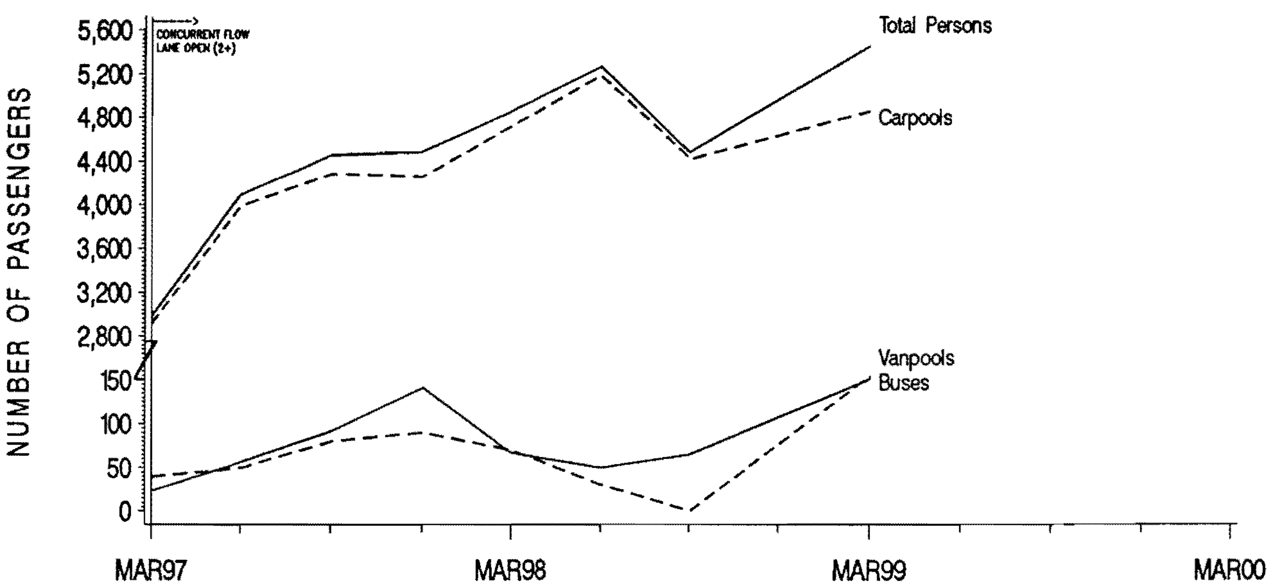
LBJ (IH-635 WESTBOUND) CONCURRENT FLOW HOV LANE
A.M. PEAK PERIOD VEHICLE UTILIZATION



PEAK PERIOD IS FROM 6:00 A.M. TO 9:00 A.M.
NOTE: COUNT LOCATION IS WEST OF MARSH
SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-6

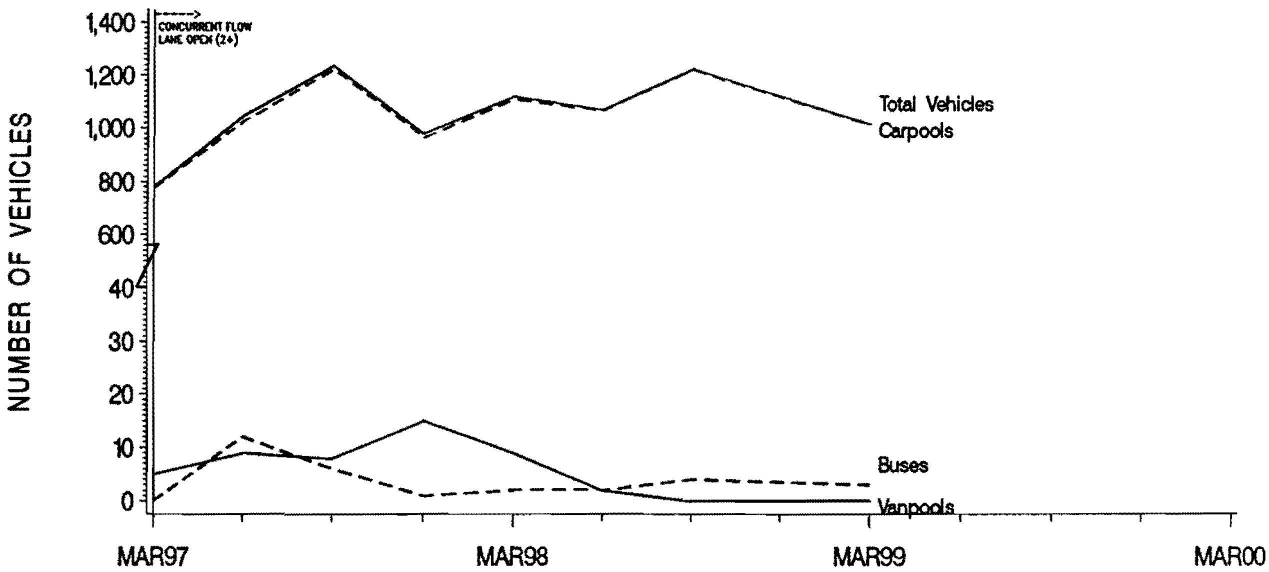
LBJ (IH-635 WESTBOUND) CONCURRENT FLOW HOV LANE
A.M. PEAK PERIOD PERSON MOVEMENT



PEAK PERIOD IS FROM 6:00 A.M. TO 9:00 A.M.
NOTE: COUNT LOCATION IS WEST OF MARSH
SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-7

LBJ (IH-635 WESTBOUND) CONCURRENT FLOW HOV LANE
P.M. PEAK HOUR VEHICLE UTILIZATION

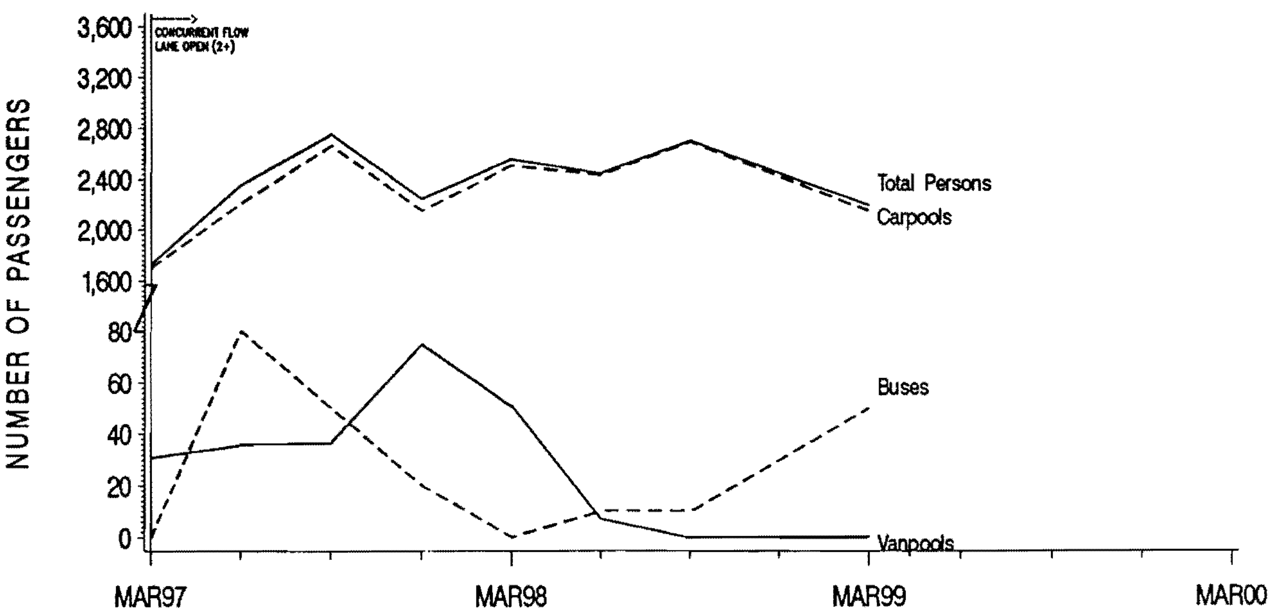


NOTE: COUNT LOCATION IS WEST OF MARSH

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-8

LBJ (IH-635 WESTBOUND) CONCURRENT FLOW HOV LANE
P.M. PEAK HOUR PERSON MOVEMENT

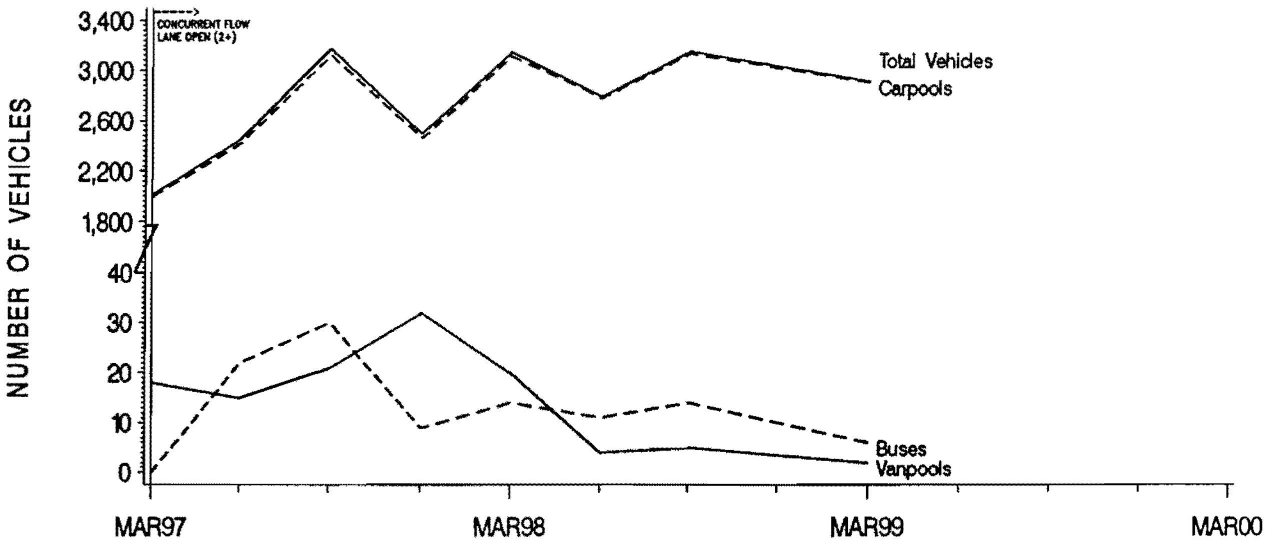


NOTE: COUNT LOCATION IS WEST OF MARSH

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-9

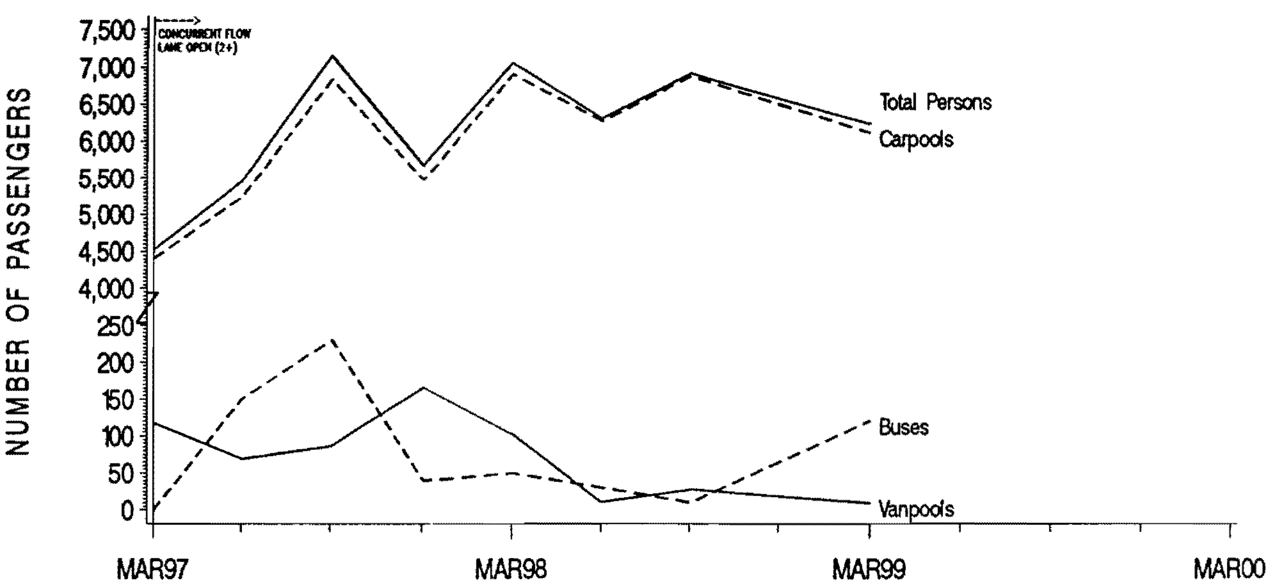
LBJ (IH-635 WESTBOUND) CONCURRENT FLOW HOV LANE
P.M. PEAK PERIOD VEHICLE UTILIZATION



PEAK PERIOD IS FROM 4:00 P.M. TO 7:00 P.M.
NOTE: COUNT LOCATION IS WEST OF MARSH
SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-10

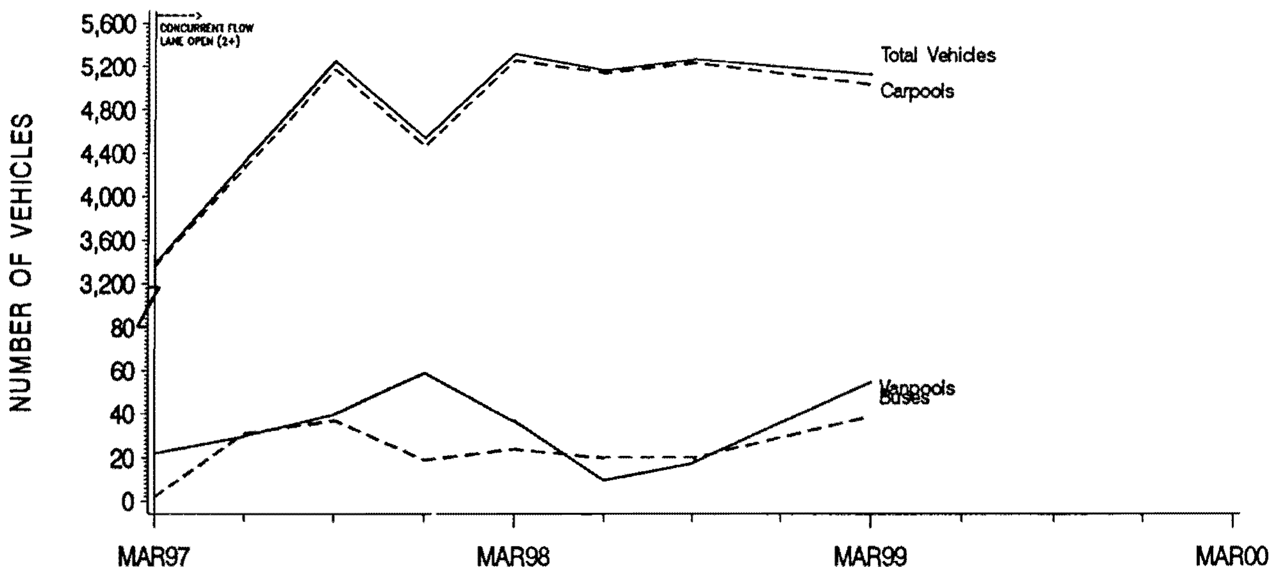
LBJ (IH-635 WESTBOUND) CONCURRENT FLOW HOV LANE
P.M. PEAK PERIOD PERSON MOVEMENT



PEAK PERIOD IS FROM 4:00 P.M. TO 7:00 P.M.
NOTE: COUNT LOCATION IS WEST OF MARSH
SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-11

LBJ (IH-635 WESTBOUND) CONCURRENT FLOW HOV LANE
TOTAL PEAK PERIOD VEHICLE UTILIZATION

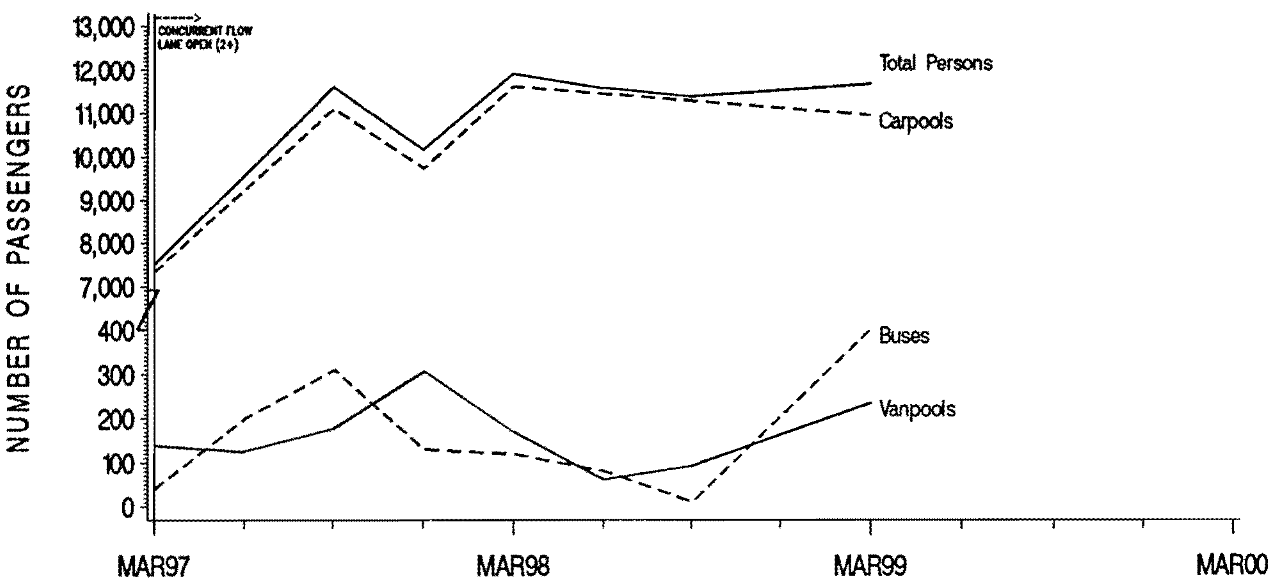


NOTE: COUNT LOCATION IS WEST OF MARSH

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-12

LBJ (IH-635 WESTBOUND) CONCURRENT FLOW HOV LANE
TOTAL PEAK PERIOD PERSON MOVEMENT



NOTE: COUNT LOCATION IS WEST OF MARSH

SOURCE : TEXAS TRANSPORTATION INSTITUTE

Table C-3. LBJ Freeway (IH-635) Eastbound Operational Summary [1] - MARCH 1999.

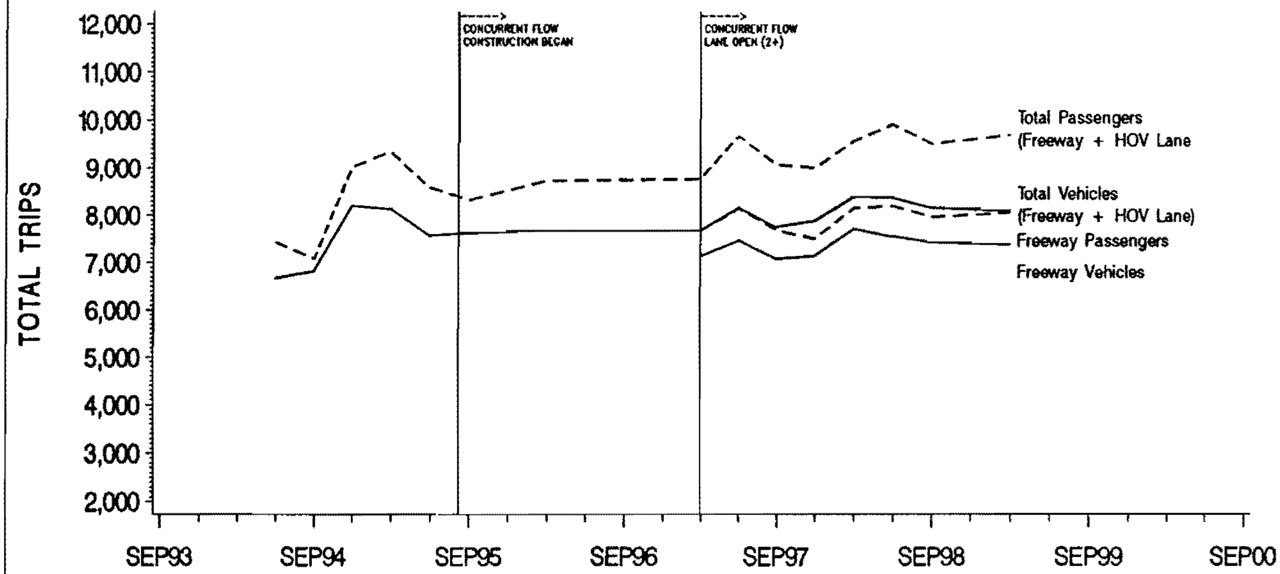
Vehicle Type	Peak Direction Mixed-Flow Lanes						Concurrent Flow Lane						Total Peak Direction Lanes					
	AM Eastbound			PM Eastbound			AM Eastbound			PM Eastbound			AM Eastbound			PM Eastbound		
	Vehicles	Persons	Average Occupancy	Vehicles	Persons	Average Occupancy	Vehicles	Persons	Average Occupancy	Vehicles	Persons	Average Occupancy	Vehicles	Persons	Average Occupancy	Vehicles	Persons	Average Occupancy
DART BUSES																		
Peak Hour	1	10	10.00	2	20	10.00	0	0	0.00	2	0	0.00	1	10	10.00	4	20	5.00
Peak Period	5	115	23.00	2	20	10.00	0	0	0.00	4	10	2.50	5	115	23.00	6	30	5.00
OTHER BUSES																		
Peak Hour	8	110	13.75	2	0	0.00	2	20	10.00	4	30	7.50	10	130	13.00	6	30	5.00
Peak Period	27	400	14.81	4	0	0.00	8	80	10.00	6	50	8.33	35	480	13.71	10	50	5.00
VANPOOLS																		
Peak Hour	10	59	5.90	3	15	5.00	15	78	5.20	5	25	5.00	25	137	5.48	8	40	5.00
Peak Period	29	166	5.72	5	25	5.00	30	165	5.50	21	96	4.57	59	331	5.61	26	121	4.65
2+ CARPOOLS																		
Peak Hour	454	946	2.08	514	1,140	2.22	644	1,411	2.19	959	2,137	2.23	1,098	2,357	2.15	1,473	3,277	2.22
Peak Period	1,762	3,729	2.12	1,395	3,087	2.21	1,661	3,591	2.16	2,575	5,728	2.22	3,423	7,320	2.14	3,970	8,815	2.22
MOTORCYCLES																		
Peak Hour	5	5	1.00	0	0	0.00	3	3	1.00	3	3	1.00	8	8	1.00	3	3	1.00
Peak Period	12	12	1.00	2	2	1.00	8	8	1.00	6	6	1.00	20	20	1.00	8	8	1.00
1 PERSON/VEHICLE [2]																		
Peak Hour	6,631	6,631	1.00	5,656	5,656	1.00	46	46	1.00	29	29	1.00	6,677	6,677	1.00	5,685	5,685	1.00
Peak Period	18,071	18,071	1.00	15,741	15,741	1.00	163	163	1.00	82	82	1.00	18,234	18,234	1.00	15,823	15,823	1.00
HEAVY VEHICLES [3]																		
Peak Hour	287	292	1.02	192	200	1.04	NA	NA	NA	NA	NA	NA	287	292	1.02	192	200	1.04
Peak Period	749	780	1.04	391	406	1.04	NA	NA	NA	NA	NA	NA	749	780	1.04	391	406	1.04
TOTAL																		
Peak Hour	**7,396**	**8,053**	**1.09**	**6,369**	**7,031**	**1.10**	**710**	**1,558**	**2.19**	**1,002**	**2,224**	**2.22**	**8,106**	**9,611**	**1.19**	**7,371**	**9,255**	**1.26**
Peak Period	**20,655**	**23,273**	**1.13**	**17,540**	**19,281**	**1.10**	**1,870**	**4,007**	**2.14**	**2,694**	**5,972**	**2.22**	**22,525**	**27,280**	**1.21**	**20,234**	**25,253**	**1.25**
Peak Hour Persons/Lane	**2,013**			**1,758**			**1,558**			**2,224**			**1,922**			**1,851**		

Notes (1) Peak direction Mixed-flow data was collected west of Marsh; Concurrent Flow Lane data was collected west of Marsh.
(2) 1 Person/Vehicle on the concurrent flow lane are counted by TTI field crew and are considered violators. These single occupant vehicles are included in total vehicles on the HOV lane
(3) Heavy vehicles refers to trucks over two axles. These vehicles are not allowed on the Concurrent Flow Lane.
(4) N/A=Not Applicable
(5) Source: Texas Transportation Institute

FIGURE C-13

EASTBOUND LBJ (IH-635) FREEWAY

A.M. PEAK HOUR VEHICLE/PASSENGER UTILIZATION



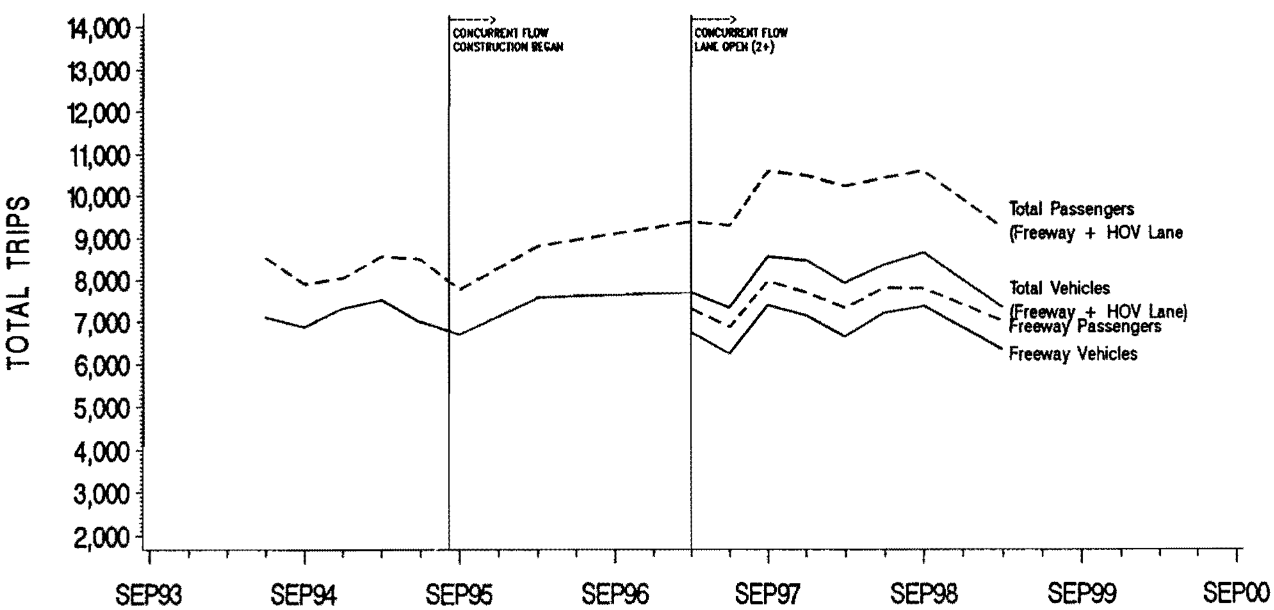
NOTE: COUNT LOCATION IS WEST OF MIDWAY

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-14

EASTBOUND LBJ (IH-635) FREEWAY

P.M. PEAK HOUR VEHICLE/PASSENGER UTILIZATION

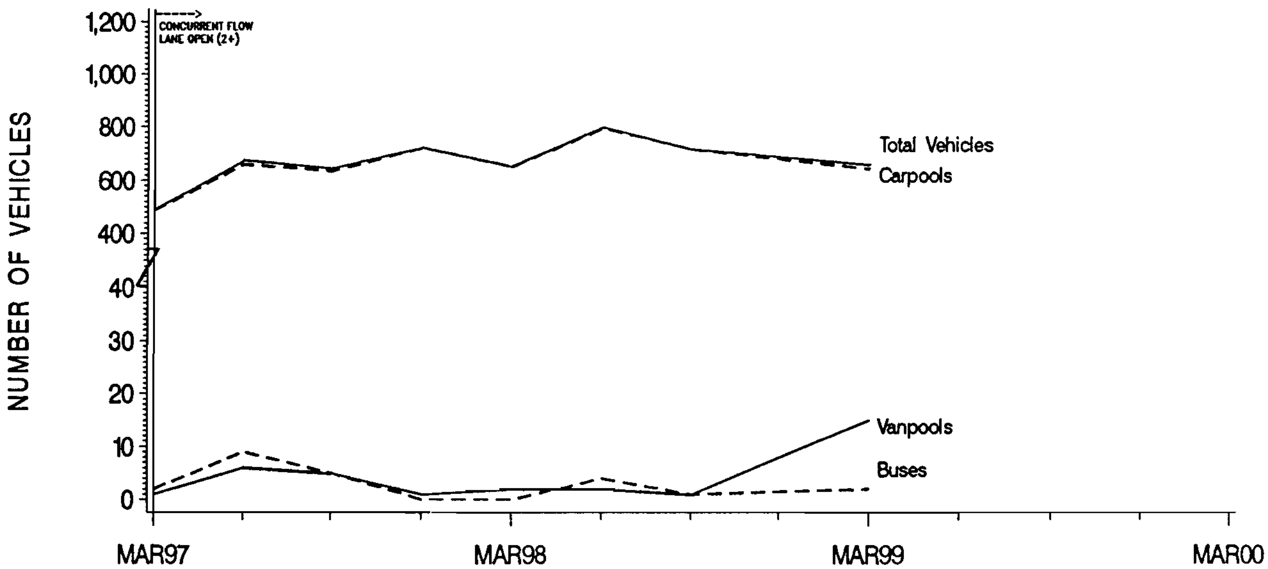


NOTE: COUNT LOCATION IS WEST OF MIDWAY

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-15

LBJ (IH-635 EASTBOUND) CONCURRENT FLOW HOV LANE
A.M. PEAK HOUR VEHICLE UTILIZATION

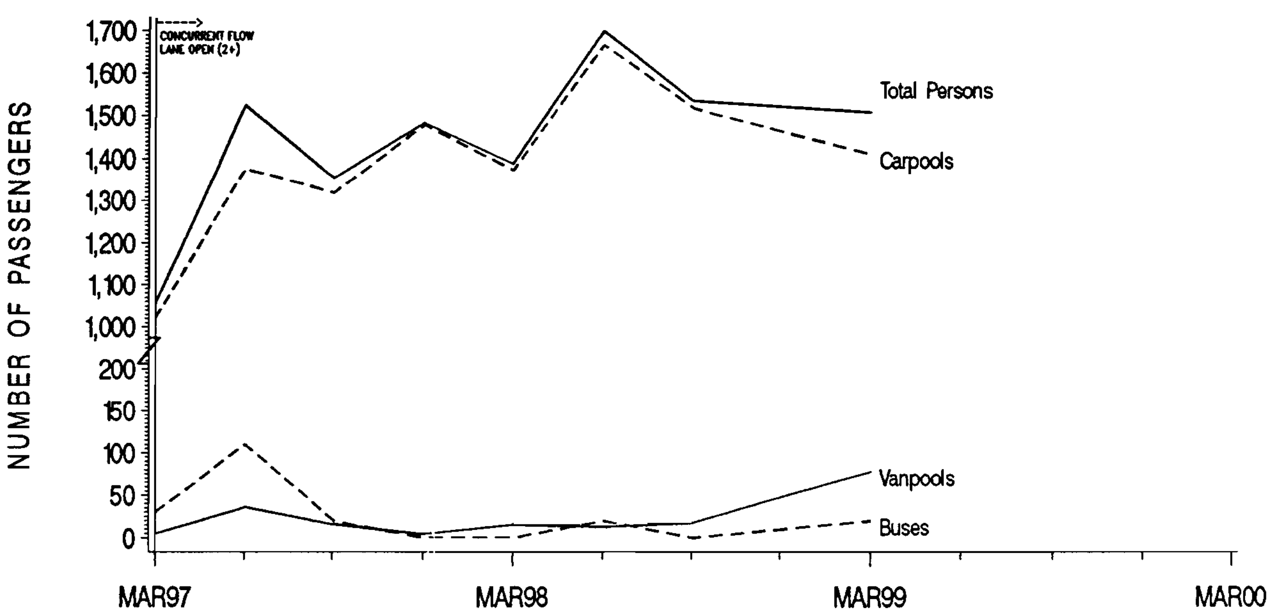


NOTE: COUNT LOCATION IS WEST OF MARSH

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-16

LBJ (IH-635 EASTBOUND) CONCURRENT FLOW HOV LANE
A.M. PEAK HOUR PERSON MOVEMENT



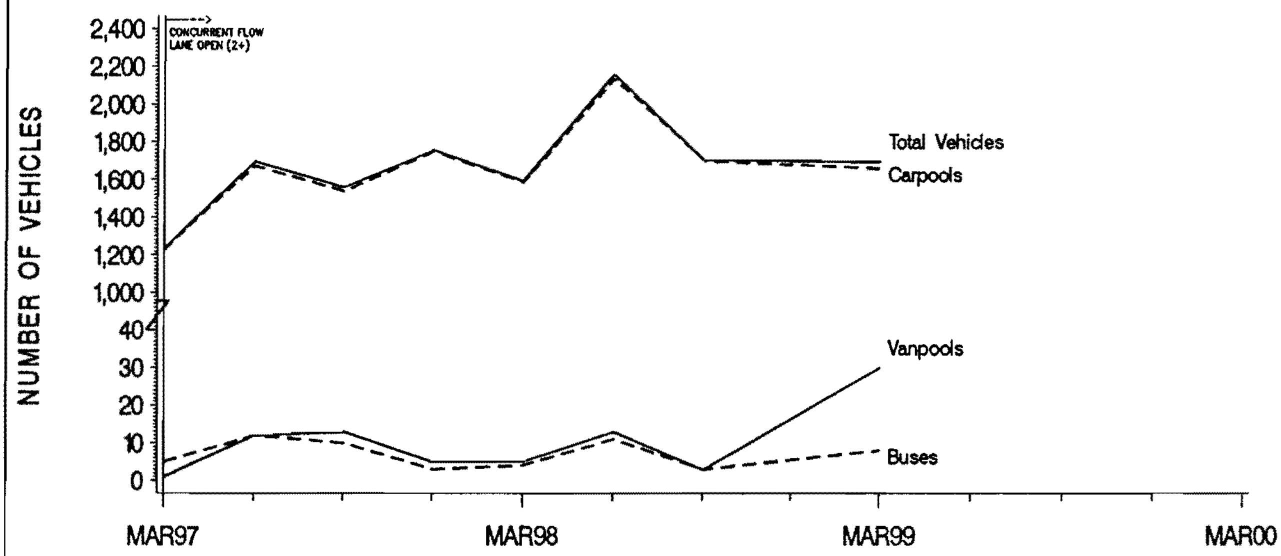
NOTE: COUNT LOCATION IS WEST OF MARSH

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-17

LBJ (IH-635 EASTBOUND) CONCURRENT FLOW HOV LANE

A.M. PEAK PERIOD VEHICLE UTILIZATION



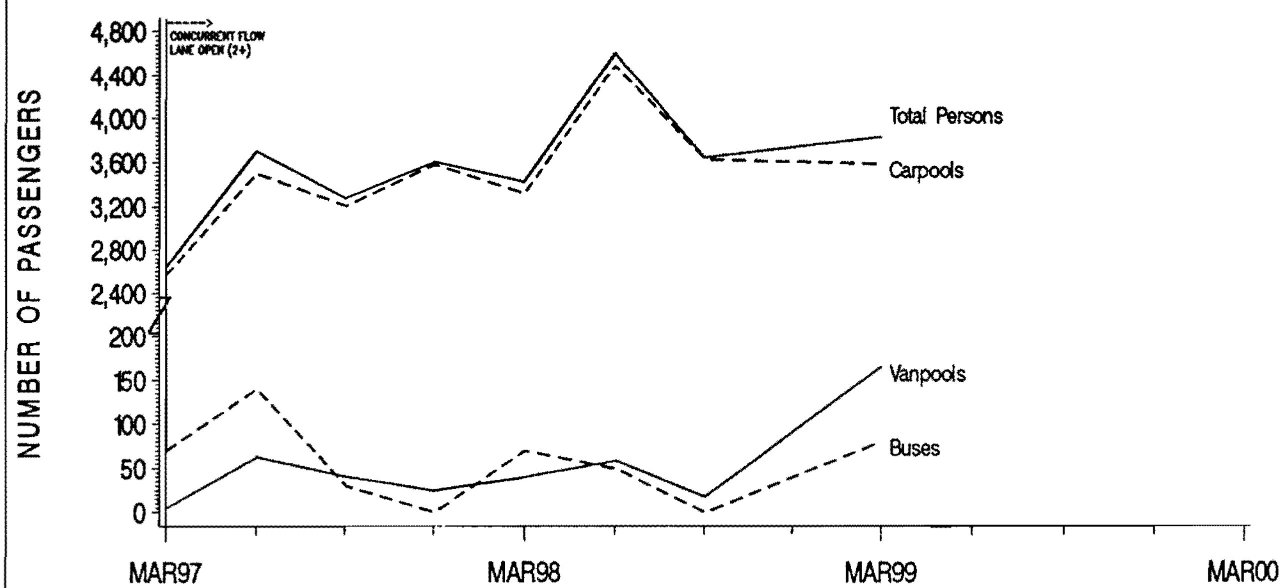
PEAK PERIOD IS FROM 6:00 A.M. TO 9:00 A.M.
NOTE: COUNT LOCATION IS WEST OF MARSH

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-18

LBJ (IH-635 EASTBOUND) CONCURRENT FLOW HOV LANE

A.M. PEAK PERIOD PERSON MOVEMENT

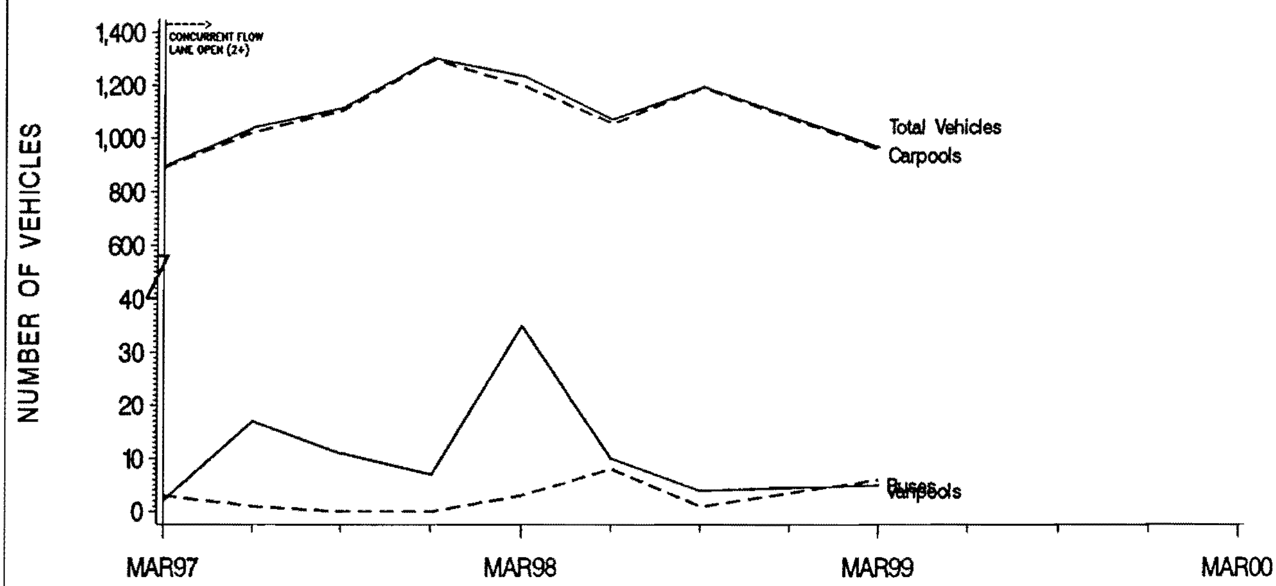


PEAK PERIOD IS FROM 6:00 A.M. TO 9:00 A.M.
NOTE: COUNT LOCATION IS WEST OF MARSH

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-19

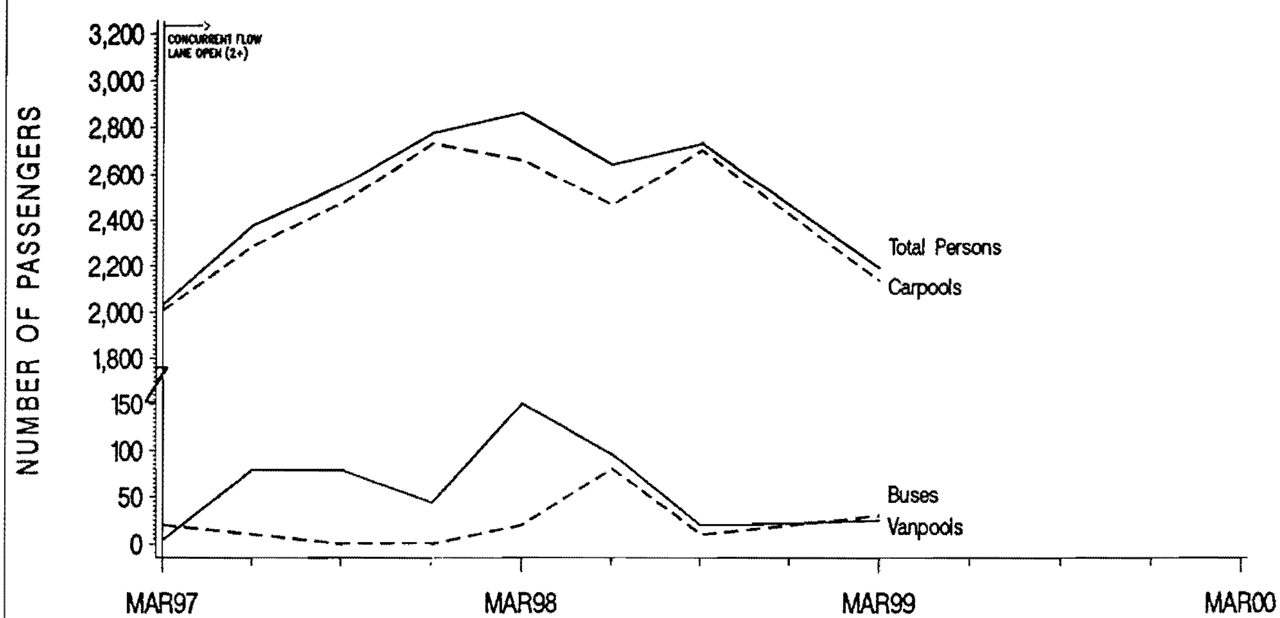
LBJ (IH-635 EASTBOUND) CONCURRENT FLOW HOV LANE
P.M. PEAK HOUR VEHICLE UTILIZATION



NOTE: COUNT LOCATION IS WEST OF MARSH
SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-20

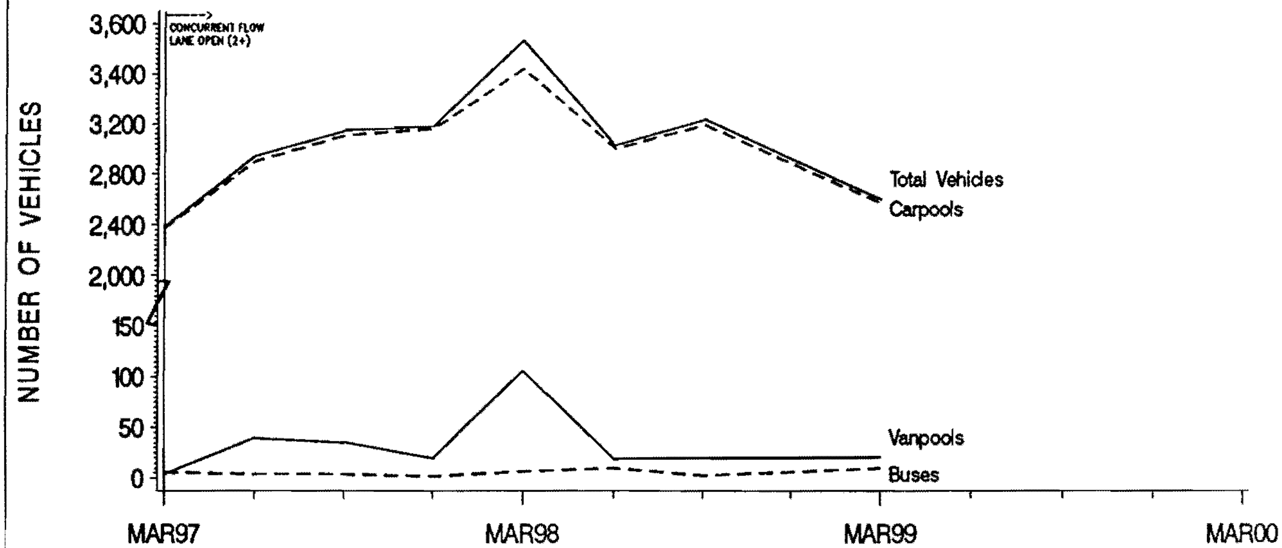
LBJ (IH-635 EASTBOUND) CONCURRENT FLOW HOV LANE
P.M. PEAK HOUR PERSON MOVEMENT



NOTE: COUNT LOCATION IS WEST OF MARSH
SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-21

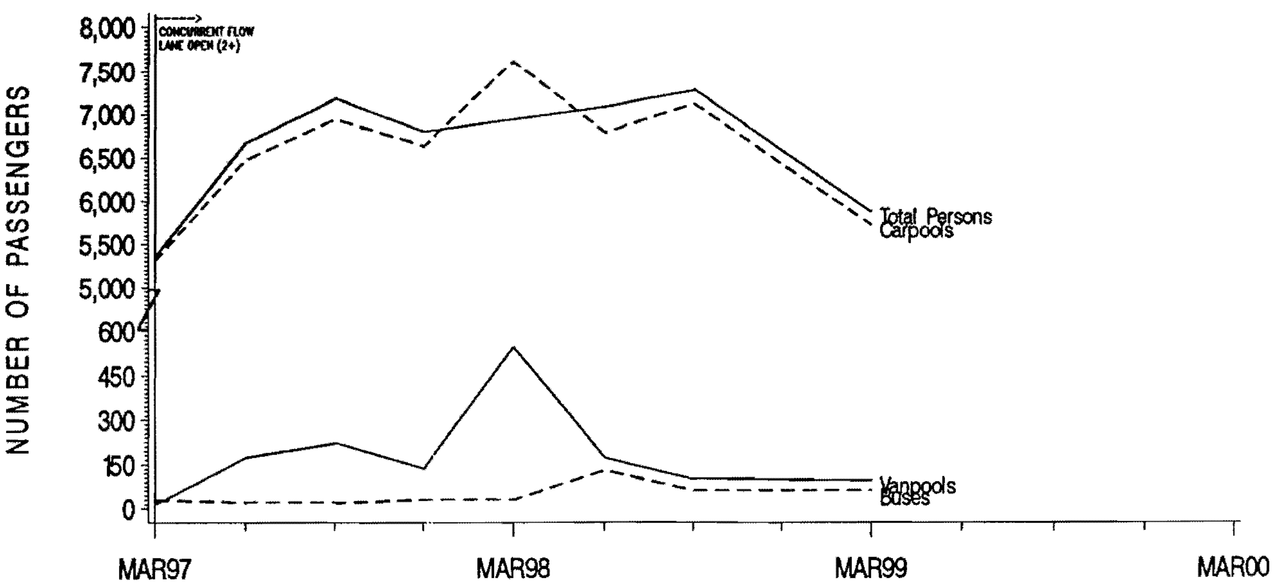
LBJ (IH-635 EASTBOUND) CONCURRENT FLOW HOV LANE
P.M. PEAK PERIOD VEHICLE UTILIZATION



PEAK PERIOD IS FROM 4:00 P.M. TO 7:00 P.M.
NOTE: COUNT LOCATION IS WEST OF MARSH
SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-22

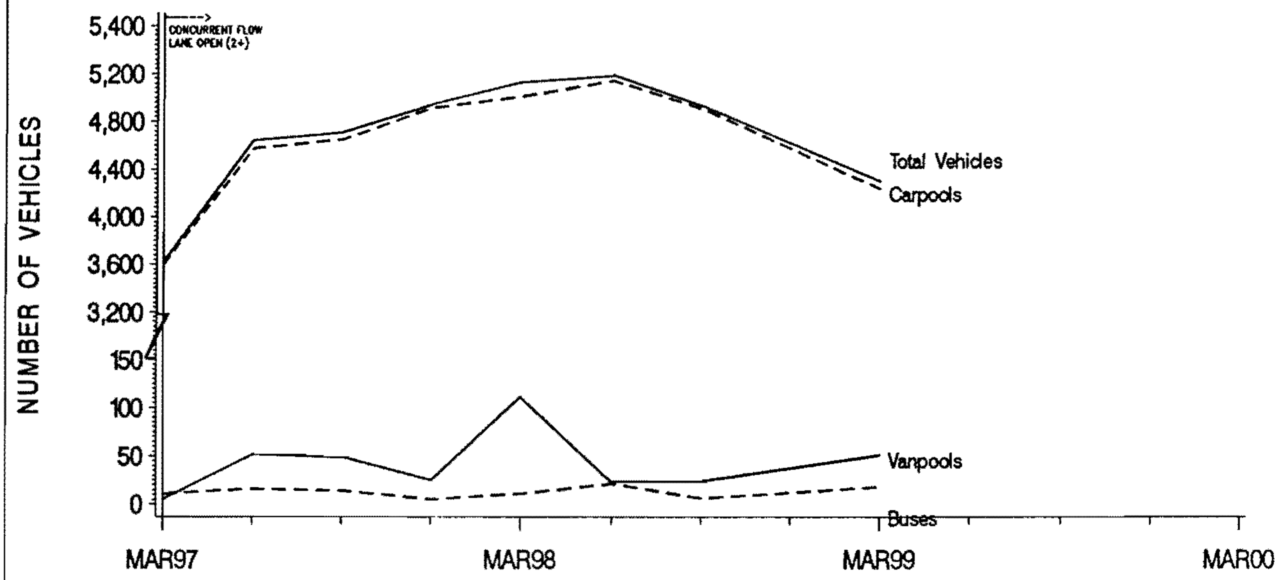
LBJ (IH-635 EASTBOUND) CONCURRENT FLOW HOV LANE
P.M. PEAK PERIOD PERSON MOVEMENT



PEAK PERIOD IS FROM 4:00 P.M. TO 7:00 P.M.
NOTE: COUNT LOCATION IS WEST OF MARSH
SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-23

LBJ (IH-635 EASTBOUND) CONCURRENT FLOW HOV LANE
TOTAL PEAK PERIOD VEHICLE UTILIZATION

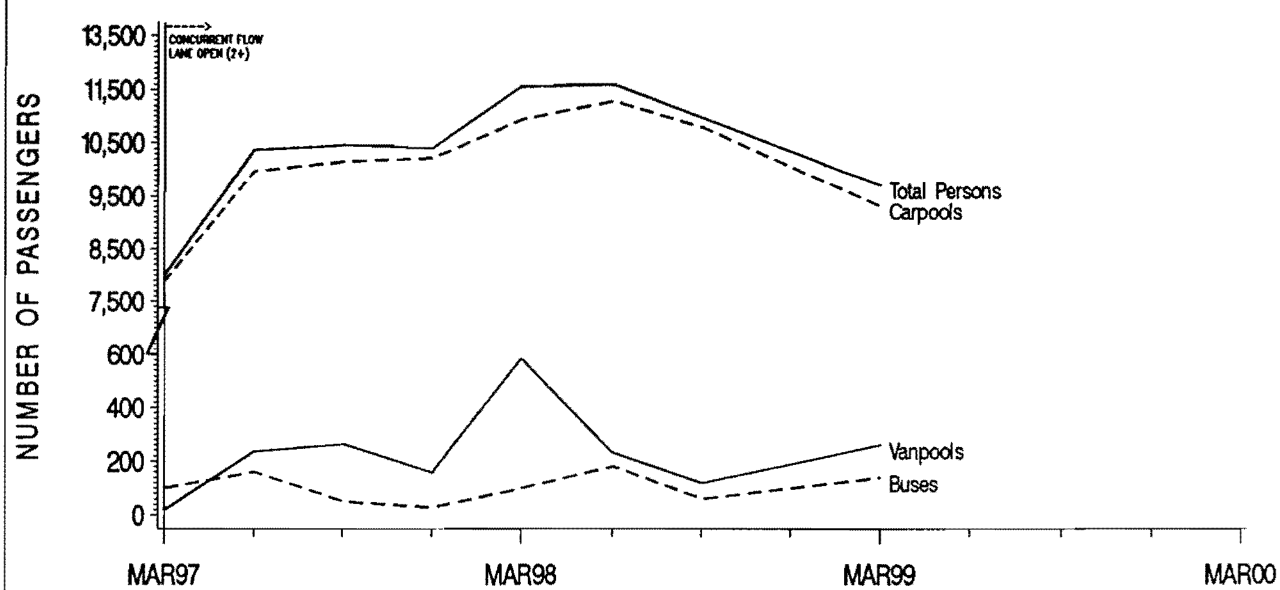


NOTE: COUNT LOCATION IS WEST OF MARSH

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-24

LBJ (IH-635 EASTBOUND) CONCURRENT FLOW HOV LANE
TOTAL PEAK PERIOD PERSON MOVEMENT



NOTE: COUNT LOCATION IS WEST OF MARSH

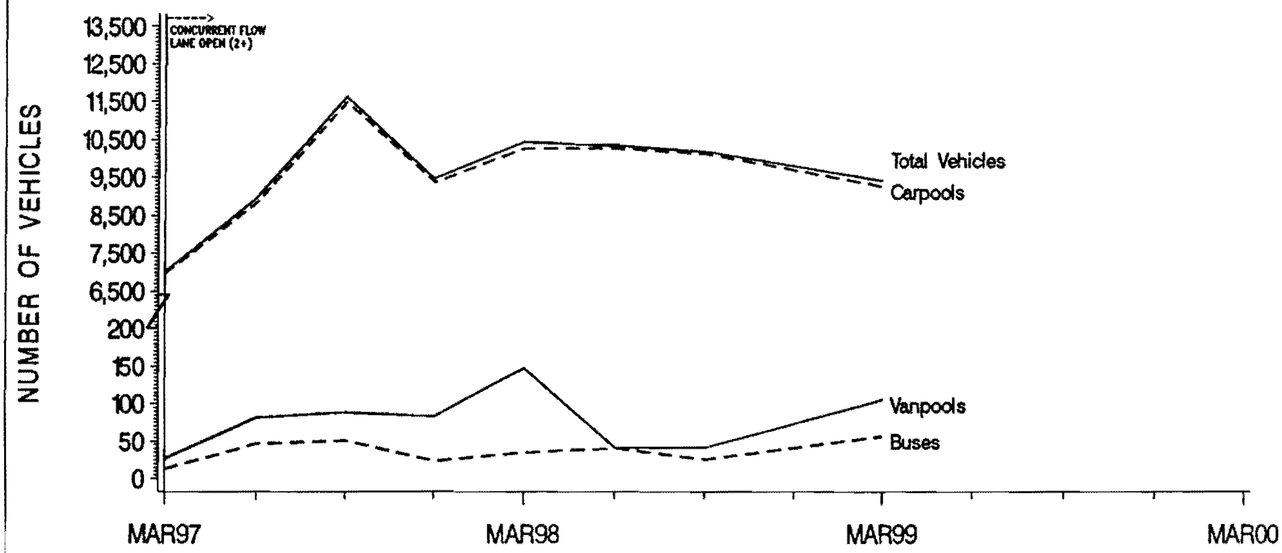
SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-25

LBJ (IH-635) CONCURRENT FLOW HOV LANE

WESTBOUND AND EASTBOUND

TOTAL PEAK PERIOD VEHICLE UTILIZATION



NOTE: COUNT LOCATION IS WEST OF MARSH

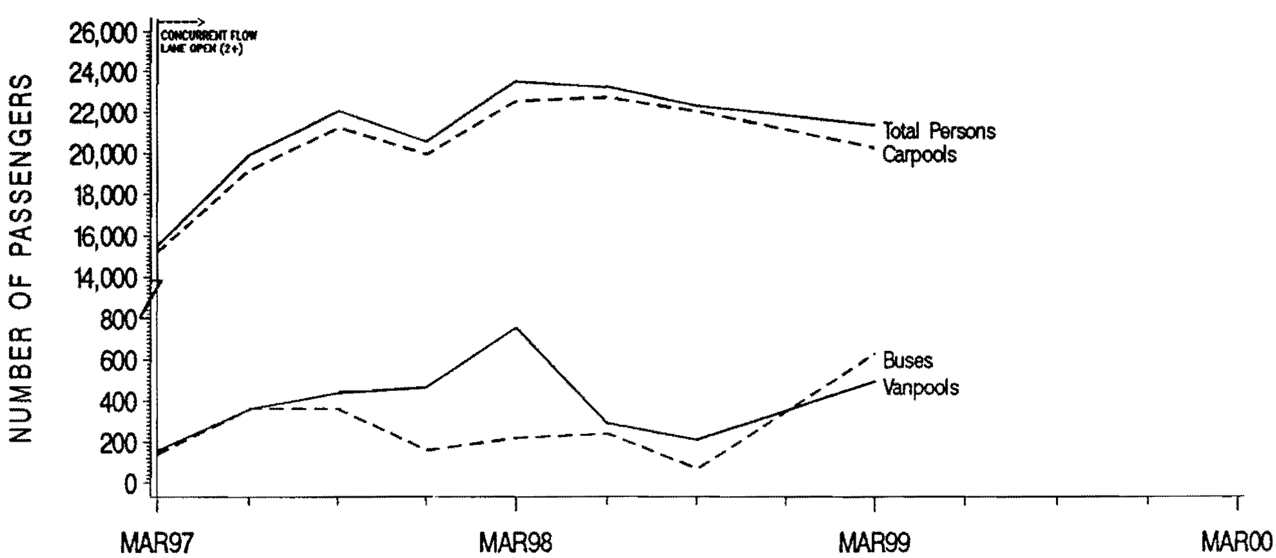
SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-26

LBJ (IH-635) CONCURRENT FLOW HOV LANE

WESTBOUND AND EASTBOUND

TOTAL PEAK PERIOD PERSON MOVEMENT



NOTE: COUNT LOCATION IS WEST OF MARSH

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-27

WESTBOUND (IH-635) CONCURRENT FLOW HOV LANE
A.M. PEAK HOUR OCCUPANCY RATES

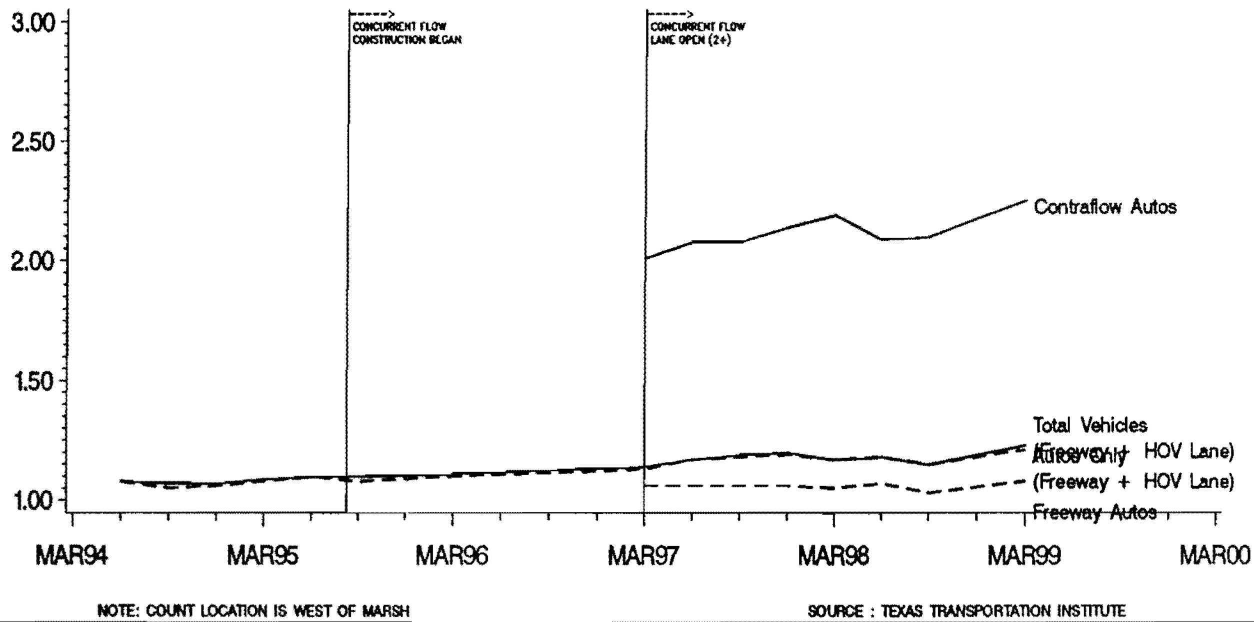


FIGURE C-28

WESTBOUND LBJ (IH-635) CONCURRENT FLOW HOV LANE
P.M. PEAK HOUR OCCUPANCY RATES

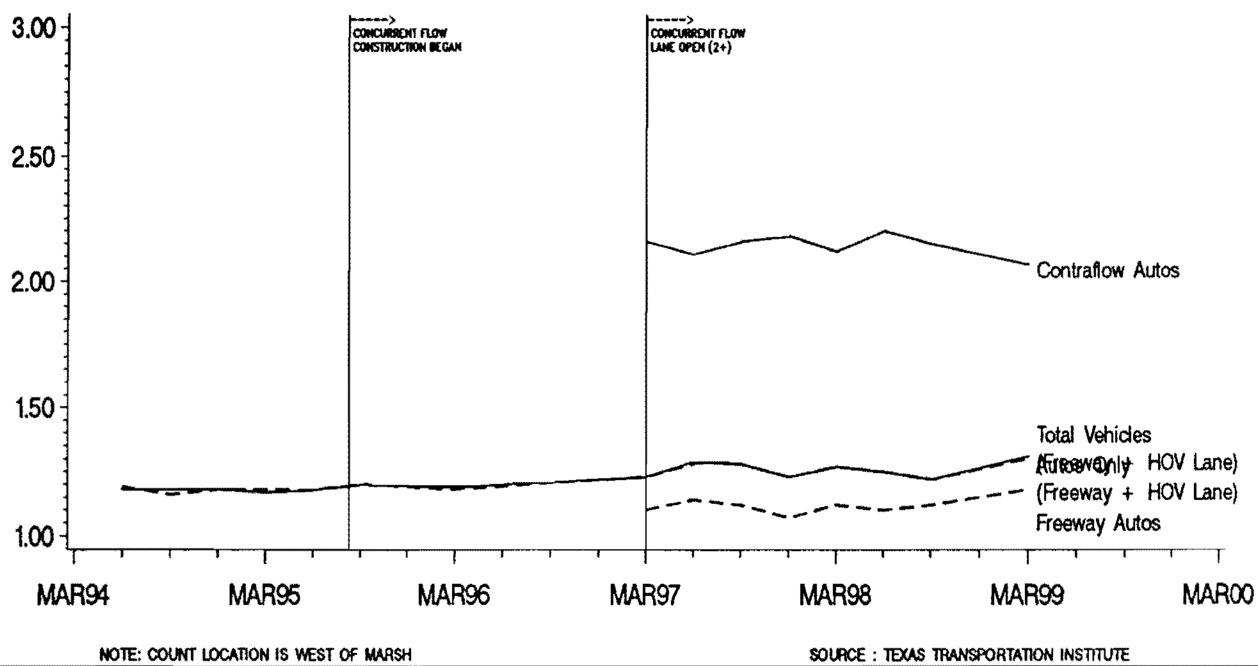
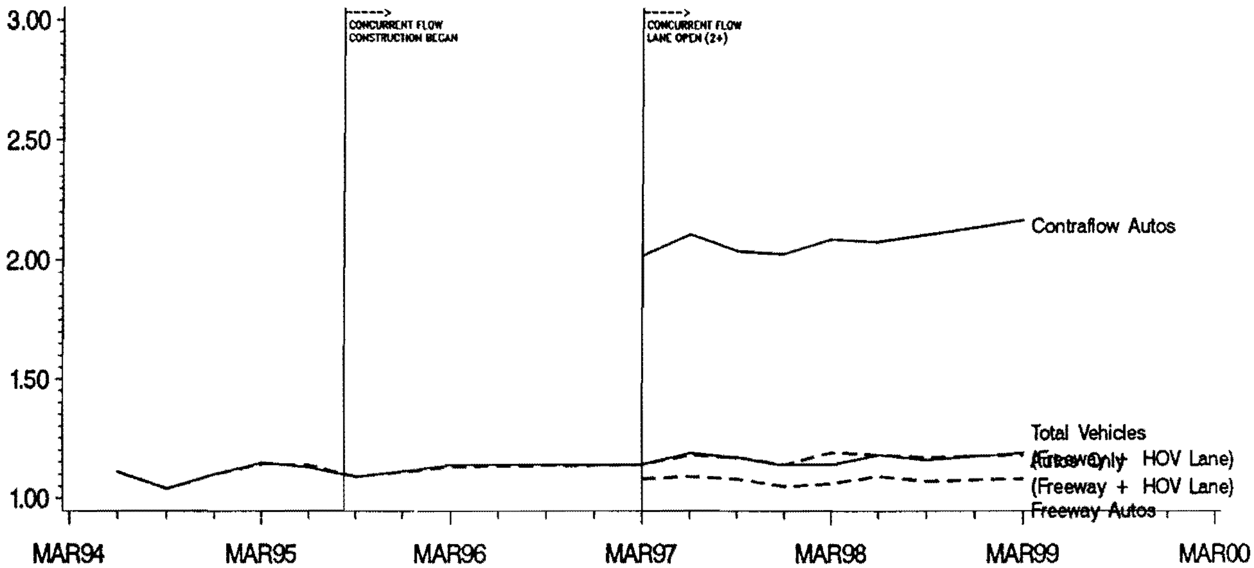


FIGURE C-29

EASTBOUND (IH-635) CONCURRENT FLOW HOV LANE A.M. PEAK HOUR OCCUPANCY RATES

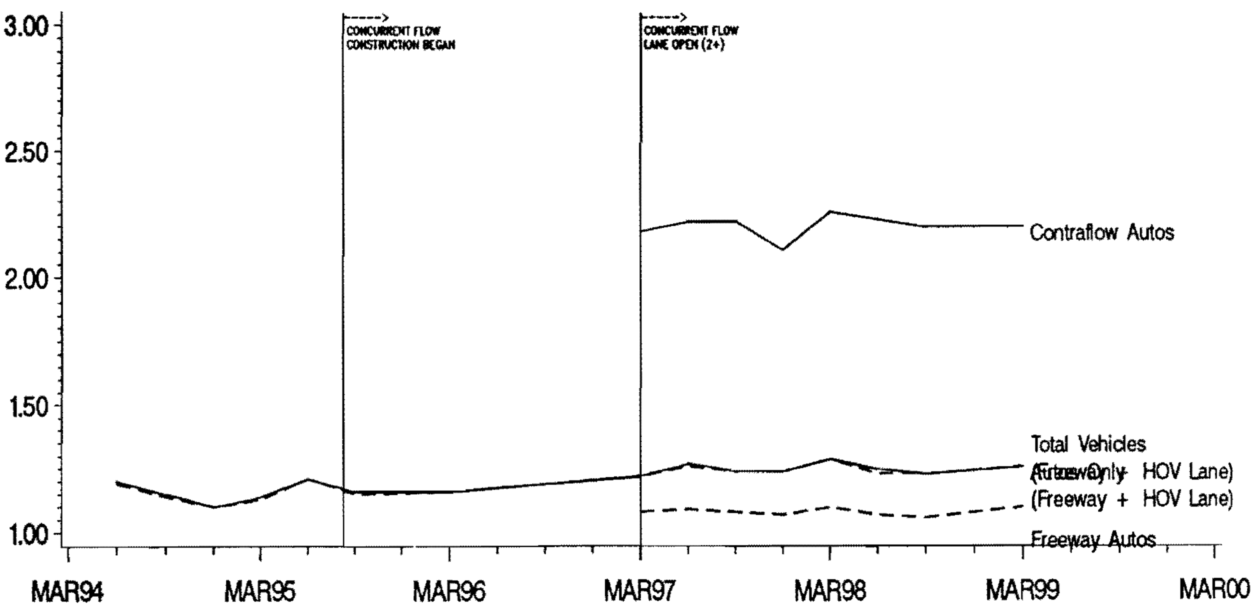


NOTE: COUNT LOCATION IS WEST OF MARSH

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-30

EASTBOUND LBJ (IH-635) CONCURRENT FLOW HOV LANE P.M. PEAK HOUR OCCUPANCY RATES

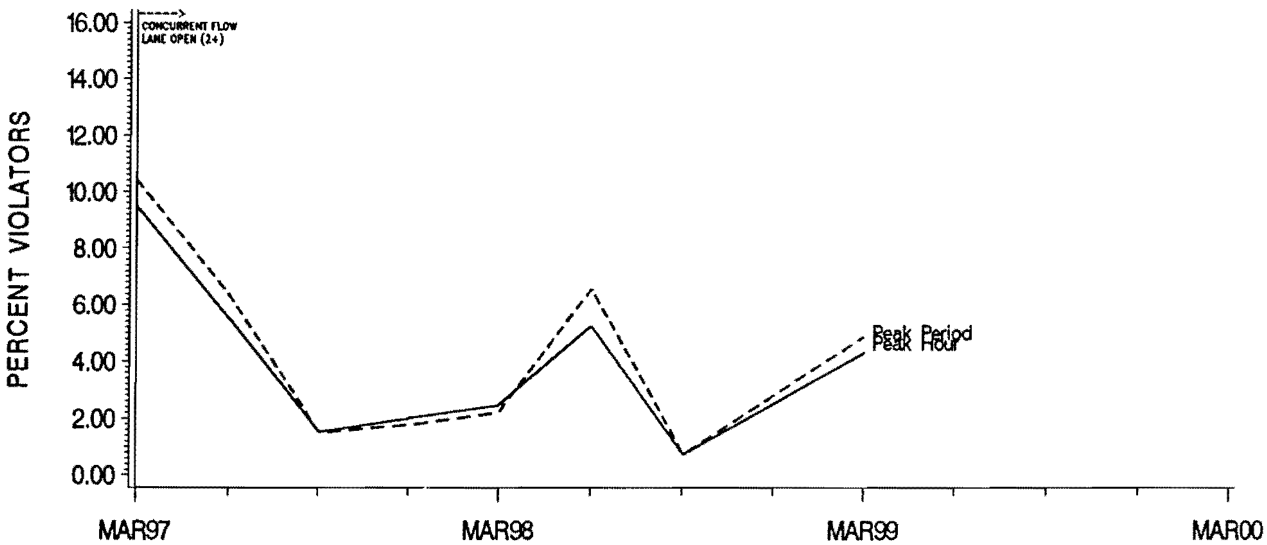


NOTE: COUNT LOCATION IS WEST OF MARSH

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-31

WESTBOUND LBJ (IH-635) CONCURRENT FLOW HOV LANE
A.M. PEAK VIOLATOR RATES

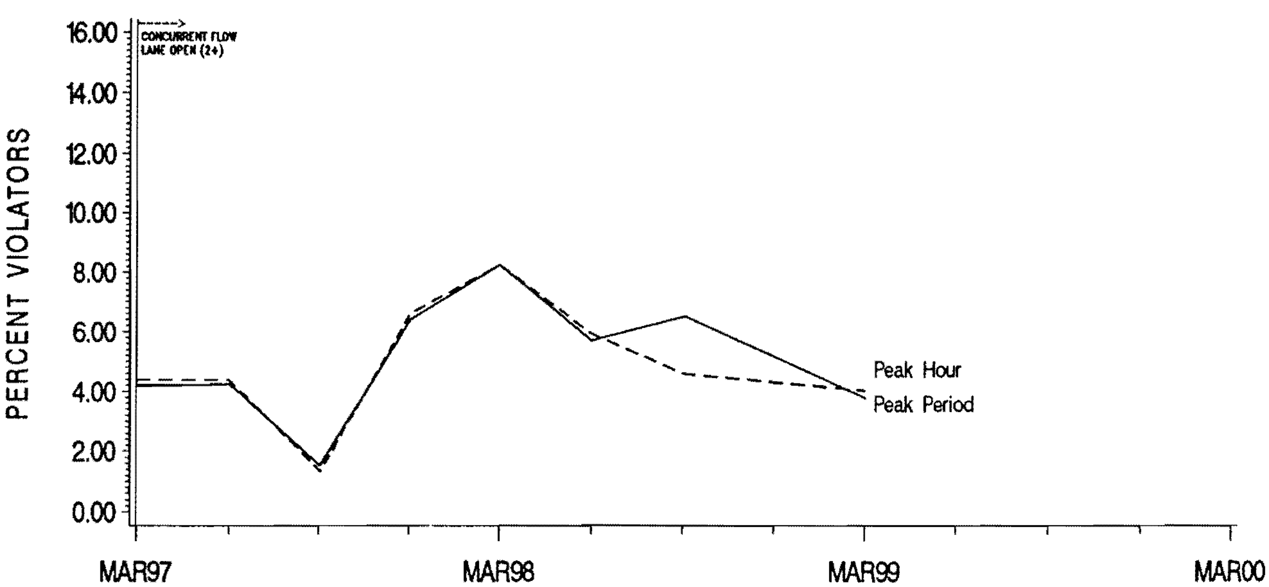


NOTE: (1) COUNT LOCATION IS WEST OF MARSH
(2) PERCENT VIOLATORS – (SINGLE PASSENGER VEHICLES / TOTAL VEHICLES)

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-32

WESTBOUND LBJ (IH-635) CONCURRENT FLOW HOV LANE
P.M. PEAK VIOLATOR RATES

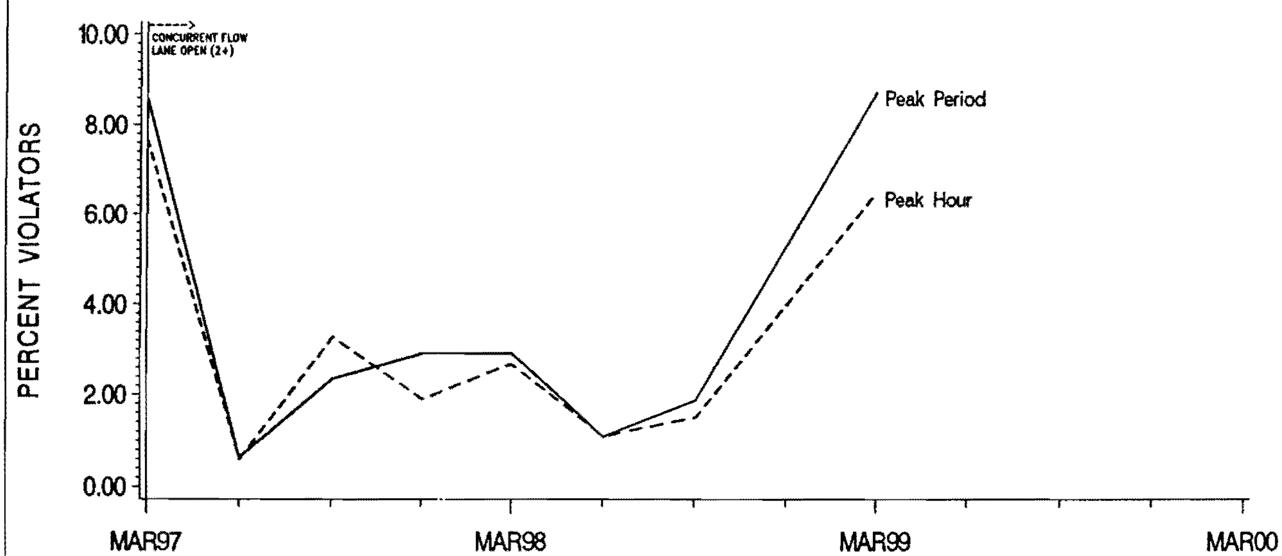


NOTE: (1) COUNT LOCATION IS WEST OF MARSH
(2) PERCENT VIOLATORS – (SINGLE PASSENGER VEHICLES / TOTAL VEHICLES)

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-33

EASTBOUND LBJ (IH-635) CONCURRENT FLOW HOV LANE
A.M. PEAK VIOLATOR RATES

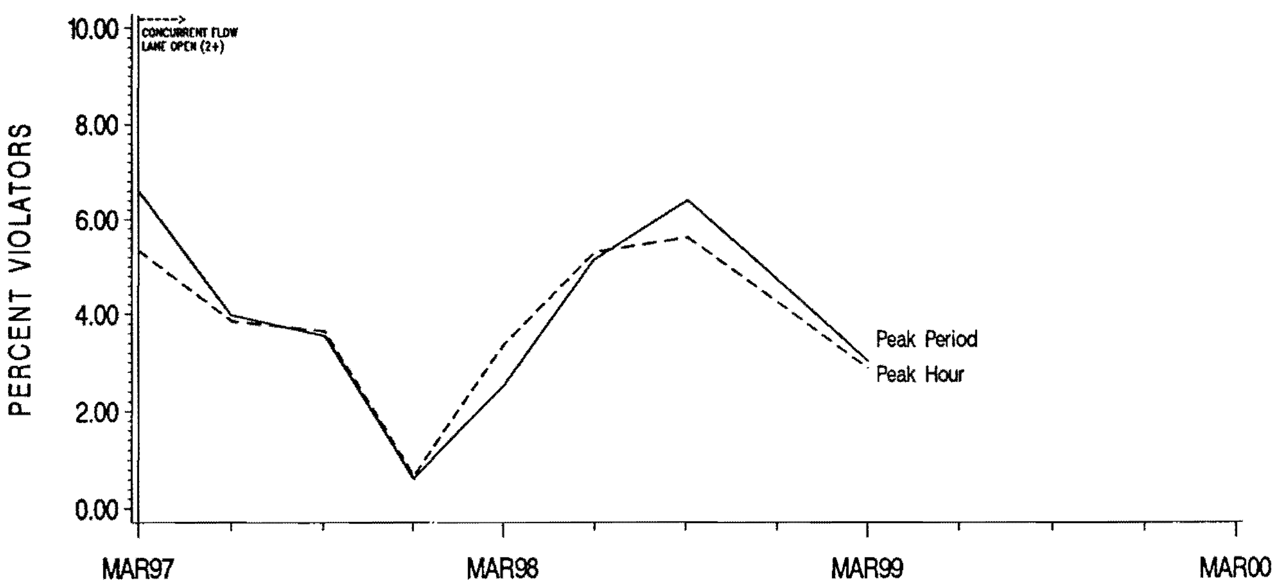


NOTE: (1) COUNT LOCATION IS WEST OF MARSH
(2) PERCENT VIOLATORS – (SINGLE PASSENGER VEHICLES / TOTAL VEHICLES)

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-34

EASTBOUND LBJ (IH-635) CONCURRENT FLOW HOV LANE
P.M. PEAK VIOLATOR RATES



NOTE: (1) COUNT LOCATION IS WEST OF MARSH
(2) PERCENT VIOLATORS – (SINGLE PASSENGER VEHICLES / TOTAL VEHICLES)

SOURCE : TEXAS TRANSPORTATION INSTITUTE

Table C-4. LBJ Freeway (IH-635) WESTBOUND Average Speeds (MPH)
US-75 to IH-35E NORTH - MARCH 1999.

Time Period	US-75 to Eastern Limits of HOV (1.99 miles)		Eastern Limits of HOV to Dallas North Tollway (1.32 miles)		Dallas North Tollway to Rosser (1.67 miles)		Rosser to Webb Chapel (1.58 miles)		Webb Chapel to SB IH-35E Exit (1.37 miles)		**HOV Limits** Eastern Limits of HOV to SB IH-35E Exit (5.94 miles)	
	Speed (mph)	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)
MIXED FLOW LANES												
AM Peak Hour, WB	27	4.36	54	1.46	23	4.41	17	5.45	33	2.47	**28**	**12.73**
AM Peak Period, WB	34	3.48	54	1.47	37	2.72	30	3.20	39	2.12	**39**	**9.13**
PM Peak Hour, WB	62	1.93	47	4.69	39	2.56	23	4.05	28	2.91	**24**	**14.96**
PM Peak Period, WB	55	2.18	54	1.46	49	2.06	39	2.41	34	2.43	**29**	**12.12**
CONCURRENT FLOW LANE												
AM Peak Hour, WB	--	--	61	1.29	63	1.56	64	1.47	54	1.49	**53**	**6.66**
AM Peak Period, WB	--	--	61	1.28	65	1.52	64	1.45	60	1.35	**58**	**6.01**
PM Peak Hour, WB	--	--	67	1.17	59	1.66	51	1.82	55	1.46	**57**	**6.12**
PM Peak Period, WB	--	--	66	1.19	63	1.57	60	1.57	59	1.37	**61**	**5.76**
TRAVEL TIME SAVINGS												
AM Peak Hour, WB	--	--	--	0.17	--	2.85	--	3.98	--	0.98	--	**6.07**
AM Peak Period, WB	--	--	--	0.19	--	1.20	--	1.75	--	0.77	--	**3.12**
PM Peak Hour, WB	--	--	--	3.52	--	0.90	--	2.23	--	1.45	--	**8.84**
PM Peak Period, WB	--	--	--	0.27	--	0.49	--	0.84	--	1.06	--	**6.36**

Notes (1) Mixed Flow Lanes AM Peak Hour=7:15-8:15 AM; PM Peak Hour=4:30-5:30 PM.
Concurrent Flow Lane AM Peak Hour=6:30-7:30 AM; PM Peak Hour =4:15-5:15 PM.
Peak Period=6:00-9:00 AM and 4:00-7:00 PM for both types.
(2) Source: Texas Transportation Institute

FIGURE C-35

WESTBOUND LBJ (IH-635) FREEWAY
A.M. PEAK HOUR AVERAGE SPEEDS

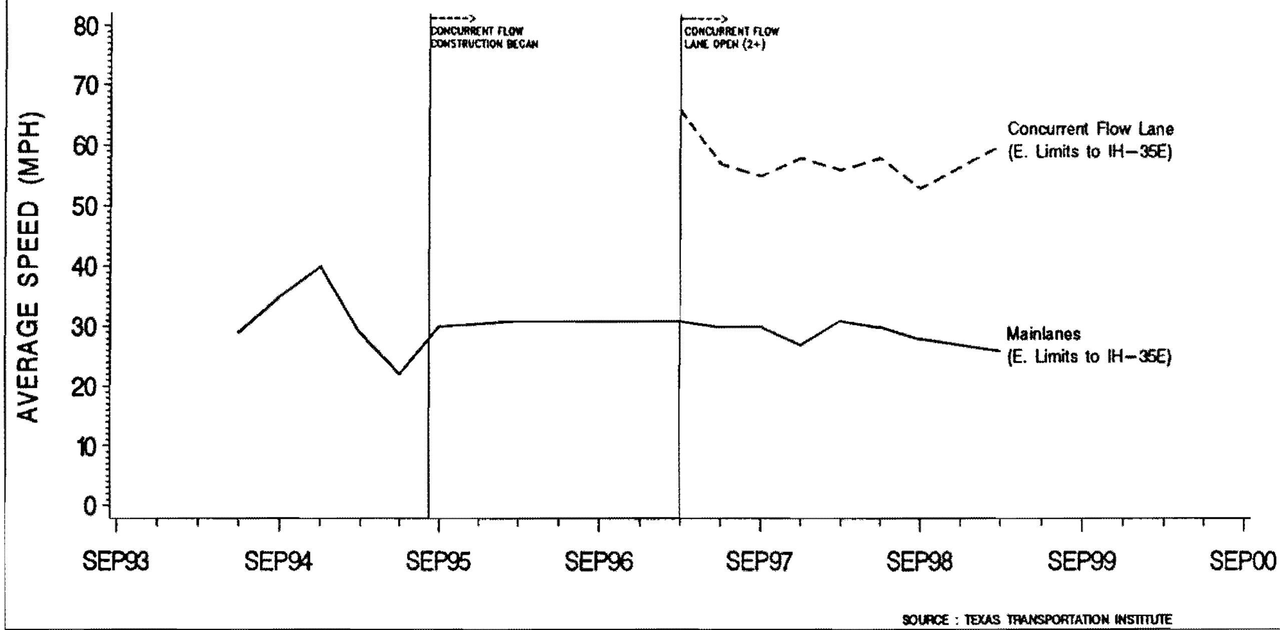


FIGURE C-36

WESTBOUND LBJ (IH-635) FREEWAY
A.M. PEAK HOUR AVERAGE TRAVEL TIMES

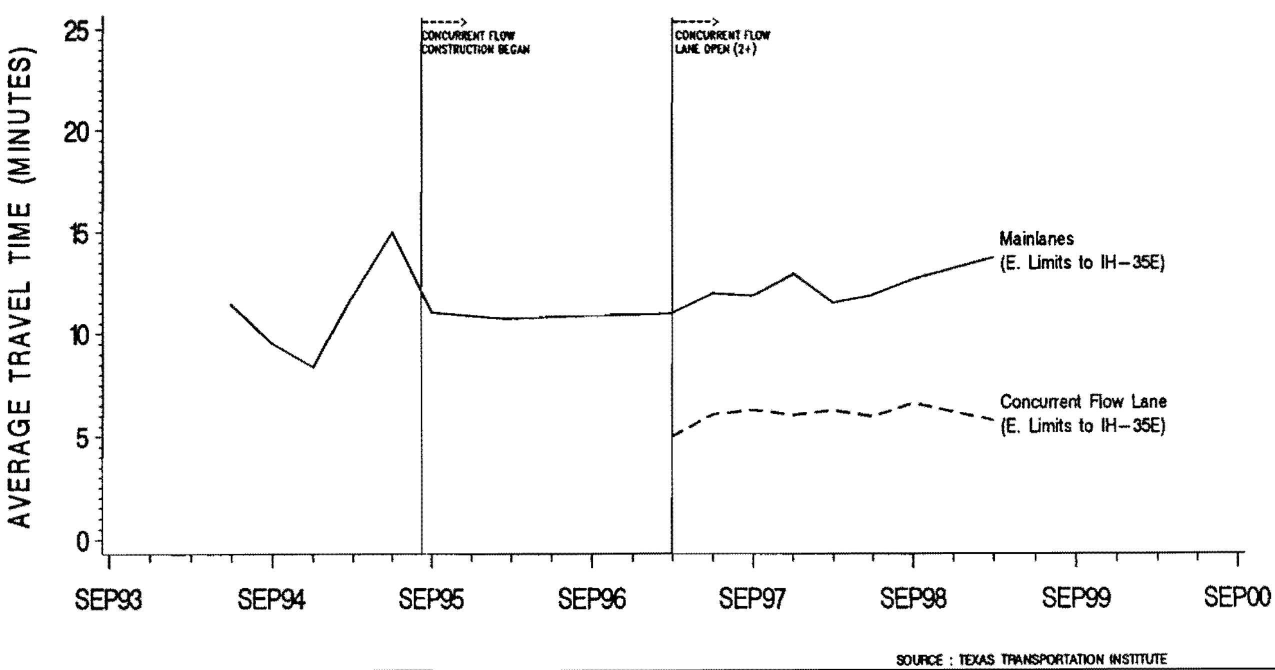
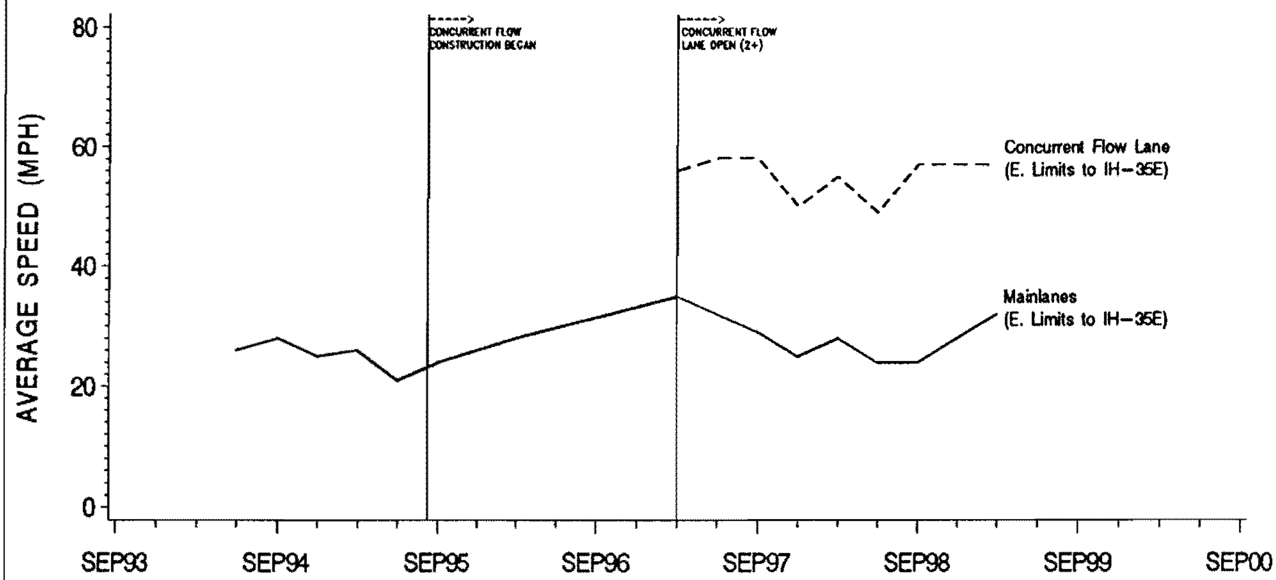


FIGURE C-37

WESTBOUND LBJ (IH-635) FREEWAY

P.M. PEAK HOUR AVERAGE SPEEDS

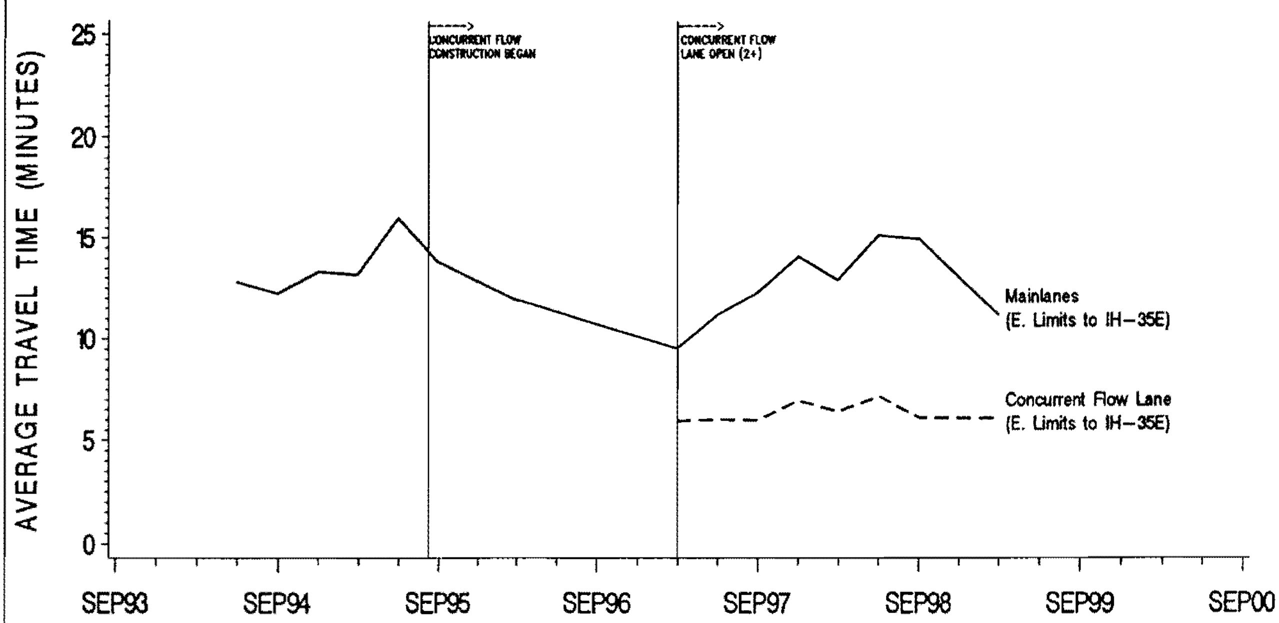


SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-38

WESTBOUND LBJ (IH-635) FREEWAY

P.M. PEAK HOUR AVERAGE TRAVEL TIMES



SOURCE : TEXAS TRANSPORTATION INSTITUTE

Table C-5. LBJ Freeway (IH-635) EASTBOUND Average Speeds (MPH)
US-75 to IH-35E NORTH - MARCH 1999.

Time Period	Western Limits of HOV to Rosser (2.10 miles)		Rosser to Dallas North Tollway (1.65 miles)		Dallas North Tollway to Preston (1.01 miles)		Preston to Eastern Limits of HOV (1.64 miles)		Eastern Limits of HOV to US-75 (0.67 miles)		**HOV Limits** Western Limits of HOV to Eastern Limits of HOV (6.40 miles)	
	Speed (mph)	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)
MIXED FLOW LANES												
AM Peak Hour, EB	32	3.92	51	1.95	57	1.07	61	1.63	63	0.64	**35**	**11.03**
AM Peak Period, EB	37	3.42	54	1.82	59	1.03	64	1.53	65	0.62	**45**	**8.62**
PM Peak Hour, EB	23	5.56	15	6.81	12	5.23	22	4.38	32	1.24	**19**	**19.93**
PM Peak Period, EB	27	4.70	23	4.23	17	3.55	27	3.61	42	0.95	**24**	**15.93**
CONCURRENT FLOW LANE												
AM Peak Hour, EB	49	2.53	56	1.79	57	1.05	53	1.85	--	--	**57**	**6.71**
AM Peak Period, EB	56	2.24	61	1.65	62	0.95	61	1.59	--	--	**59**	**6.41**
PM Peak Hour, EB	50	2.48	44	2.27	45	1.33	47	2.05	--	--	**47**	**8.09**
PM Peak Period, EB	53	2.34	50	1.98	49	1.21	51	1.90	--	--	**54**	**7.10**
TRAVEL TIME SAVINGS												
AM Peak Hour, EB	--	1.39	--	0.16	--	0.02	--	-0.22	--	--	--	**4.32**
AM Peak Period, EB	--	1.18	--	0.17	--	0.08	--	-0.06	--	--	--	**2.21**
PM Peak Hour, EB	--	3.08	--	4.54	--	3.90	--	2.33	--	--	--	**11.84**
PM Peak Period, EB	--	2.36	--	2.25	--	2.34	--	1.71	--	--	--	**8.83**

Notes (1) Mixed Flow Lanes AM Peak Hour=8:00-9:00 AM; PM Peak Hour=5:15-6:15 PM.
Concurrent Flow Lane AM Peak Hour=7:30-8:30 AM; PM Peak Hour =5:15-6:15
Peak Period=6:00-9:00 AM and 4:00-7:00 PM for both types.
(2) Source: Texas Transportation Institute

FIGURE C-39

EASTBOUND LBJ (IH-635) FREEWAY

A.M. PEAK HOUR AVERAGE SPEEDS

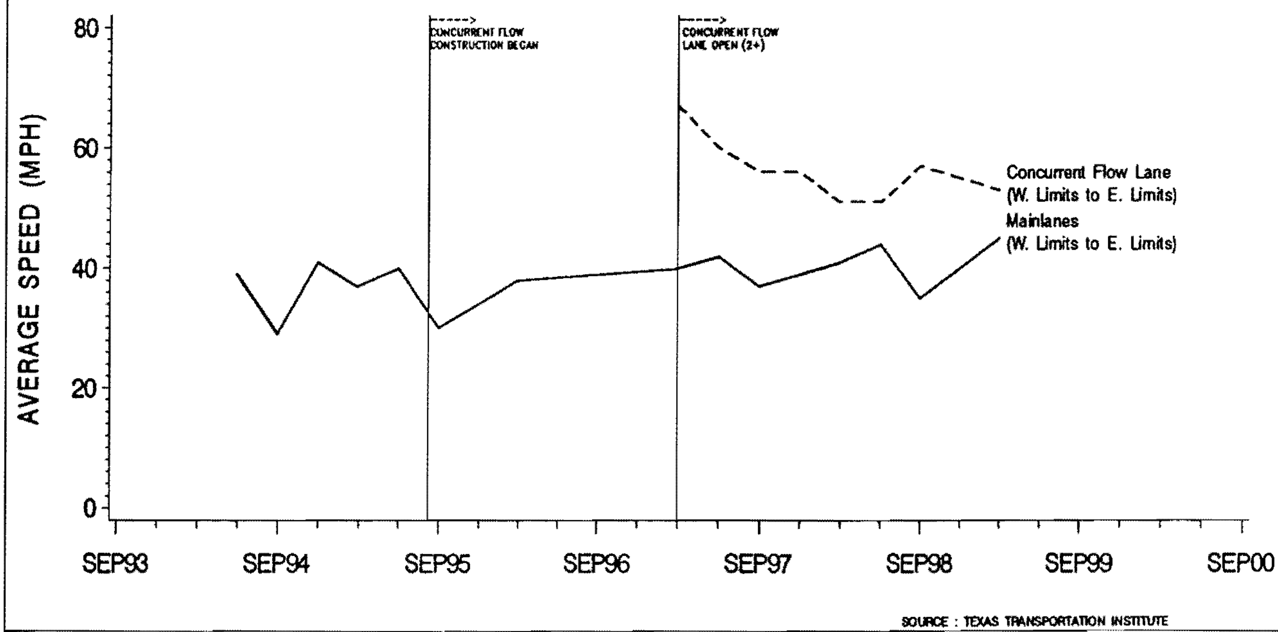


FIGURE C-40

EASTBOUND LBJ (IH-635) FREEWAY

A.M. PEAK HOUR AVERAGE TRAVEL TIMES

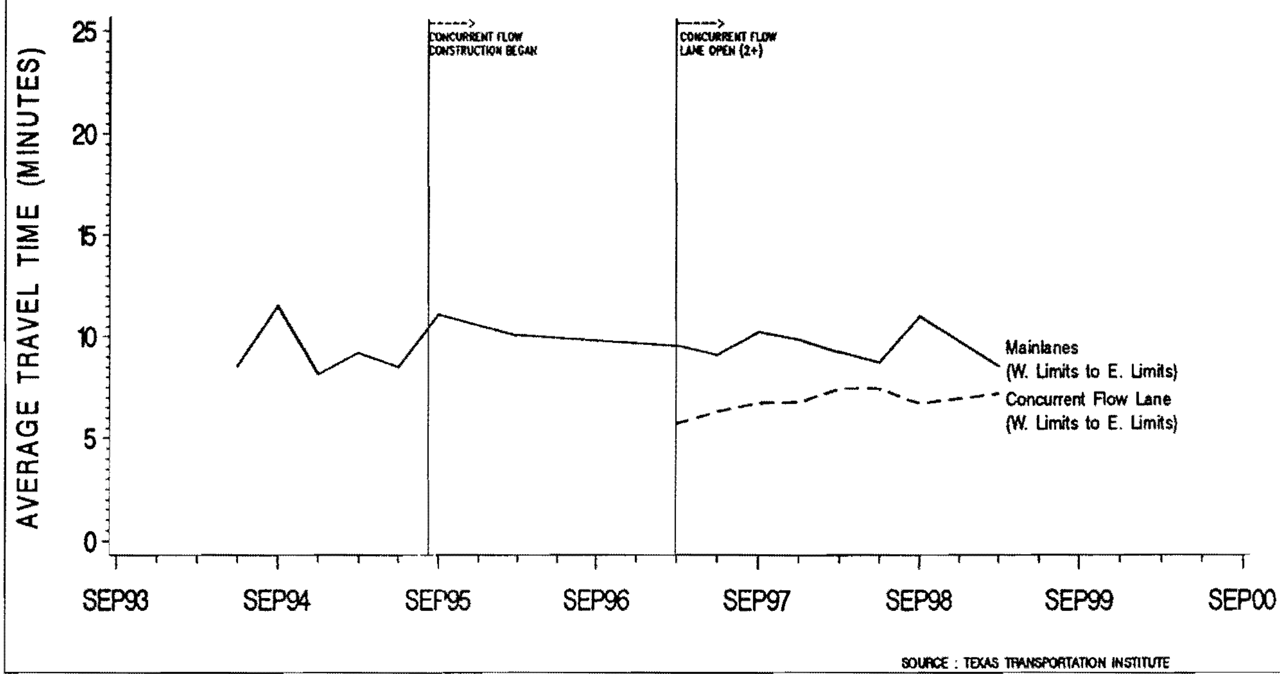


FIGURE C-41

EASTBOUND LBJ (IH-635) FREEWAY

P.M. PEAK HOUR AVERAGE SPEEDS

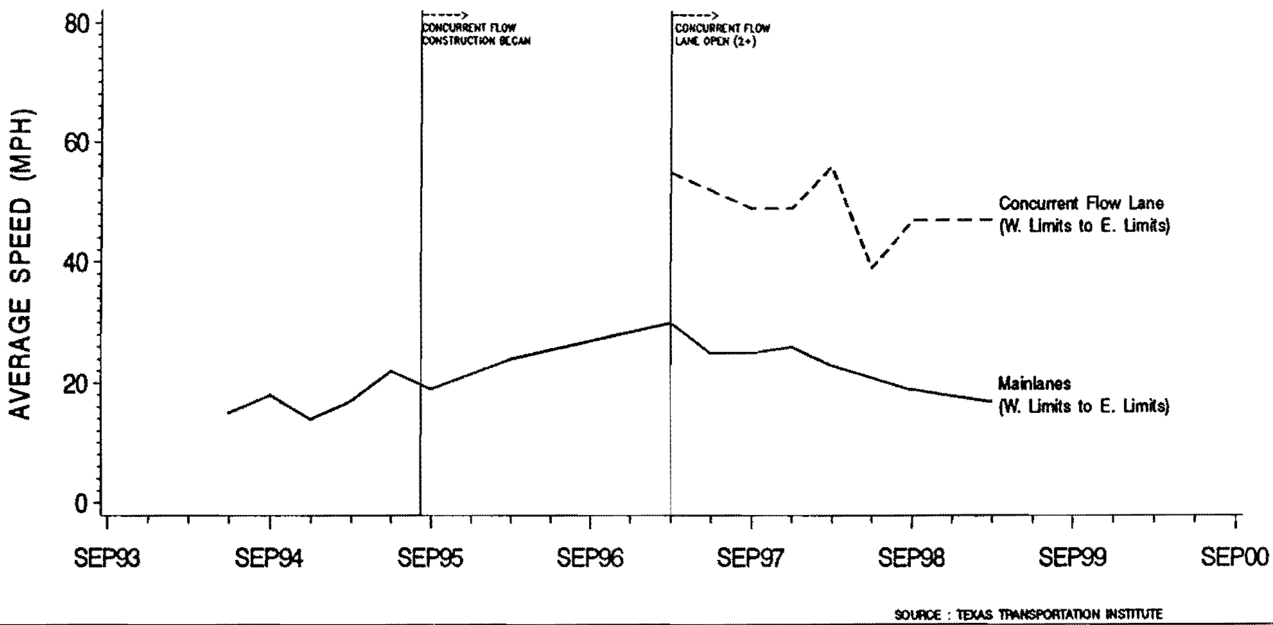


FIGURE C-42

EASTBOUND LBJ (IH-635) FREEWAY

P.M. PEAK HOUR AVERAGE TRAVEL TIMES

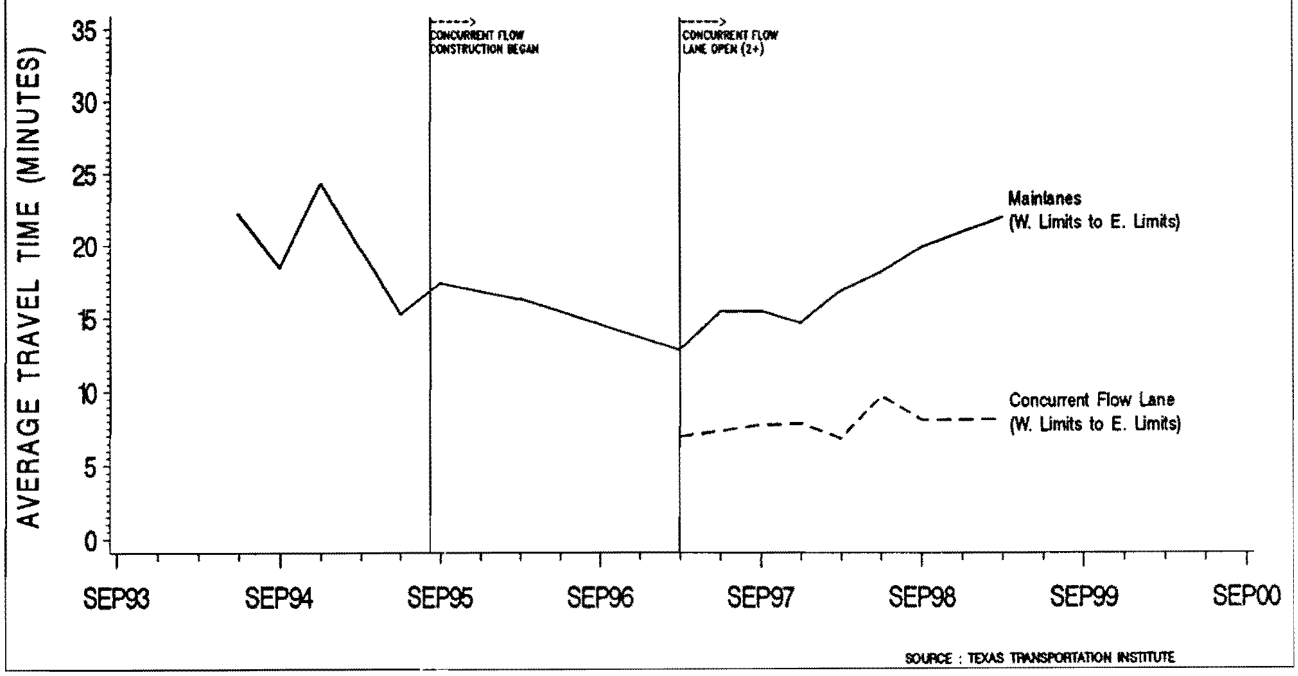
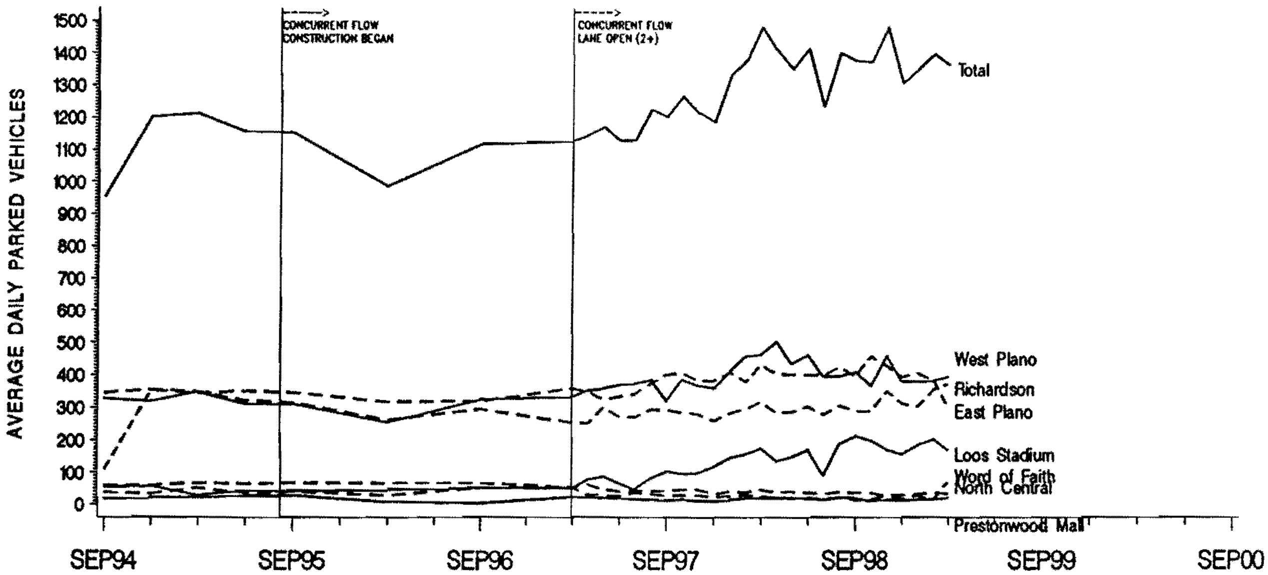
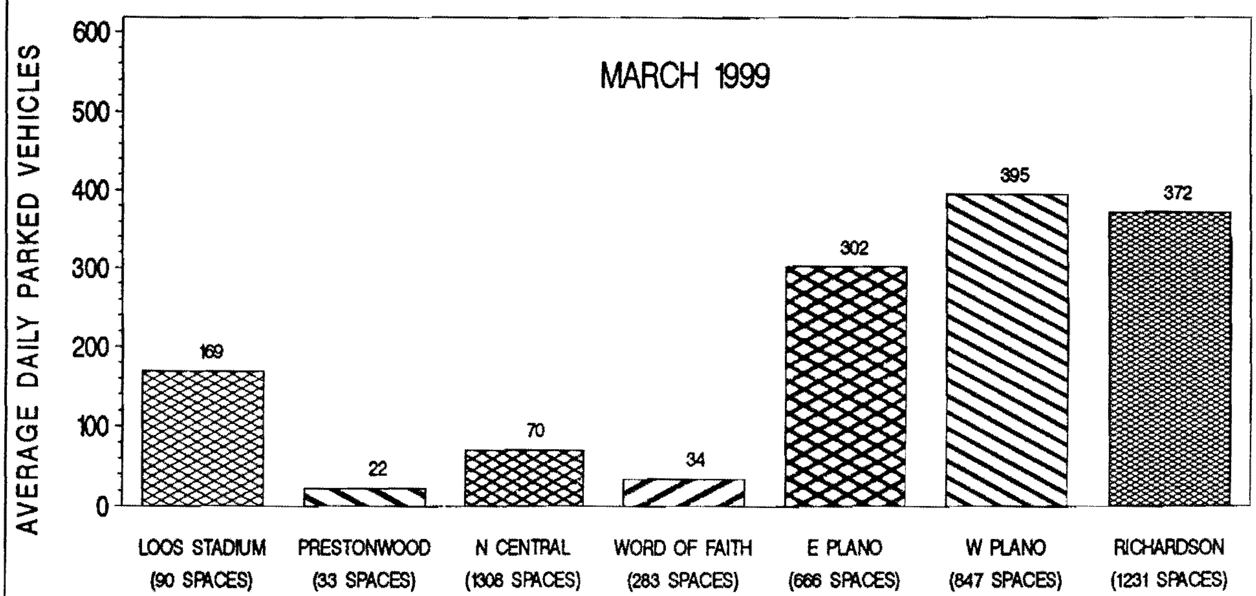


FIGURE C-43
LBJ (IH-635) FREEWAY
PARK-AND-RIDE LOT UTILIZATION



SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE C-44
LBJ (IH-635) FREEWAY
CORRIDOR PARK-AND-RIDE LOT UTILIZATION



SOURCE: TEXAS TRANSPORTATION INSTITUTE

PARKING CAPACITY FOR CORRIDOR = 4458 SPACES