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16. Abstract

The report summarizes the experience with HOV lanes and support facilities from Houston, Dallas, and other U.S. cities, and the relevance to issues in Fort Worth. The information is compiled from other published research efforts and presents guidelines for the implementation of HOV lanes in Fort Worth.

Several successful HOV treatments in Houston and Dallas constitute a database from which to derive recommendations regarding the potential for HOV lanes in Fort Worth. These include planning, design, and operational features, as well as institutional issues that are key to successful implementation.

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FORT WORTH HOV SYSTEM STUDY:

OVERVIEW OF NATIONAL EXPERIENCE AND LOCAL ISSUES

by

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Research Report 2902-1
Research Study Number 7-2902
Research Study Title: Highway Planning and Operations for District 2, Phase III

Sponsored by the
Texas Department of Transportation

September 1995

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

IMPLEMENTATION STATEMENT

The summary of Texas and national experience with HOV lanes and review of important local institutional issues has assisted the Fort Worth District of TxDOT in the consideration of HOV lane projects.

DISCLAIMER

The contents of this report reflect the views of the author who is responsible for the findings and conclusions presented herein. The contents do not necessarily reflect the official views or policies of the Texas Department of Transportation (TxDOT). This report does not constitute a standard, specification, or regulation.

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SUMMARY

The preliminary analysis of high-occupancy vehicle treatments in Fort Worth identified several key local issues. Any examination of HOV treatments in Fort Worth must begin with a recognition of the impact of these local conditions.

- The current North Central Texas Council of Governments (NCTCOG) Mobility Plan includes HOV lanes on I-30 and SH 183 in Tarrant County. The NCTCOG analysis indicates that these lanes will serve Dallas commuters, rather than Fort Worth commuters. There are no HOV lanes in the NCTCOG plan west of I-820.

- The operating HOV facilities in Houston and Dallas are the result of high levels of congestion which extend for several kilometers and last for 2 or more hours during each peak travel period. This type of congestion is not projected for the freeways in Fort Worth for several years. The aggressive freeway and street construction that is being completed by the Texas Department of Transportation in Tarrant County has been successful in addressing the travel needs in several corridors for the next decade or more.

- Most HOV operations in the U.S. have a significant portion of the demand served by transit. While there are HOV lanes that are operated by DOTs that are only used by carpools, this has not been the case in Texas. Planning and design of the HOV lanes have been a cooperative effort between transit and highway agencies. The transit agencies in Houston and Dallas operate the HOV lanes with review and concurrence by TxDOT for any operational or design changes. The Fort Worth Transportation Authority service area may not, however, include all of the areas in which an HOV facility may operate.

- Several Fort Worth area freeway improvement projects are in the planning or design stage. It is desirable to examine these projects to determine if design changes can be made to enhance HOV implementation either concurrent with the general freeway

project, or at a later date. Experience has shown that there are usually some opportunities to make HOV construction easier and less expensive if relatively minor changes can be incorporated during design of the freeway.

- As with any new technology, it would be desirable for the first HOV project in Fort Worth to have a high probability of success. While other factors such as construction schedules and funding have a significant impact on project construction, the first HOV project should be in a congested corridor with significant transit ridership. If the initial corridor is a success, other HOV projects that are more experimental may be viewed more favorably if usage is not high in the first month of operation.

This report, and a companion document that identifies congestion levels on Fort Worth freeways, present findings on the current situation relating to the development of high-occupancy vehicle facilities in Fort Worth. The reports do not identify specific design or operational treatments nor do they recommend HOV facilities for individual corridors. The reports should be thought of as only an initial step in the HOV planning process and a checklist of key issues that need resolution during that analysis.

I. FORT WORTH HOV SYSTEM STUDY

INTRODUCTION

In recent years, demand for freeway facilities in most major metropolitan areas in Texas has increased faster than the ability to increase freeway capacity. The construction of additional freeway lanes has been limited in many cases by restricted right-of-way availability and high construction costs. Fort Worth area freeways have been expanded in recent years, and other construction projects are underway to provide more capacity and more current design standards. Existing rights-of-way, however, are being fully utilized in this process and additional right-of-way may be more difficult to obtain.

As a result, transportation officials are faced with the dilemma of how to move increasing numbers of people through major freeway corridors without large expansions of the freeway network. This dilemma has led to the evaluation of alternative methods of maximizing the movement of people while minimizing delay to all travelers.

One alternative for increasing freeway capacity without spending large sums of money for rights-of-way and construction is high-occupancy vehicle (HOV) improvements. HOV facilities increase the people-carrying capacity of a freeway corridor by offering a travel time savings to higher occupancy vehicles. These improvements are sometimes readily implementable within existing rights-of-way at relatively minimal construction costs. HOV improvements include barrier-separated HOV lanes, contraflow lanes, concurrent flow lanes, and freeway control with priority entry.

To date, the most popular and effective of these measures in Texas are the barrier-separated HOV lanes. The HOV system in Houston is committed to almost 160 kilometers of these facilities. Other Texas cities have made plans or provisions to implement HOV improvements in the future. In some corridors, these improvements have been found to be a particularly effective way to increase the overall corridor capacity by providing priority treatment for high-occupancy vehicles.

This study was sponsored by the Fort Worth District office of the Texas Department of Transportation (TxDOT). The intent of the study was to use sketch planning methods to evaluate the HOV needs in selected Fort Worth freeway corridors to determine if and when HOV alternatives could be considered feasible to providing increased capacity for those corridors.

This report presents a summary of the Texas and national experience in design, operation and implementation of HOV facilities. It is an overview of key aspects of the process.

This study addresses one possible component of an areawide transit and highway plan—high-occupancy vehicle improvements within freeway rights-of-way. The objective of the recommendations is to present potential alternatives for using HOV technology to improve the overall transportation system in the Fort Worth area. The HOV assessment should also assist the State in meeting its responsibility to identify cost-effective approaches for operating the state roadway system.

The development, implementation, and funding of an areawide transit improvement plan should be a multi-agency undertaking. The material presented in this document was prepared for one agency—TxDOT, and addresses one possible component of the transportation system—HOV facilities. The implementation of any HOV improvement should result from agreement between all affected agencies. In fact, at the present time, all HOV projects undertaken in Texas have been joint projects between the local transit agency and TxDOT. *Therefore, consider this study as a beginning, rather than an end, to the HOV planning process.*

Descriptions of Alternative High-Occupancy Vehicle Improvements

Four general types of HOV lanes are considered applicable for Texas freeways. A general description of each is provided below. Table 1 gives examples of locations where these treatments have been implemented. Figure 1 shows representative illustrations for these alternative priority treatments.

Table 1. Examples of Alternative High-Occupancy Vehicle Improvements

Type of Priority Measure	Significant Examples
Exclusive HOV Facility	Shirley HOV Lane (I-395), Washington, D.C.
	I-66, Washington, D.C.
	I-64, Norfolk
	I-394, Minneapolis
	Katy (I-10) Transitway, Houston
	North (I-45) Transitway, Houston
Concurrent Flow Lane	I-95, Miami
	US 101, San Francisco
	SR 55, Orange County (CA)
	I-405, Orange County (CA)
	I-10, Phoenix
Contraflow Lane	Rte. 495 (Lincoln Tunnel), New Jersey
	North (I-45), Houston (replaced in 1984)
	East R. L. Thornton, Dallas
HOV Priority Entry Ramp	Los Angeles Freeway System
	Seattle Freeway System

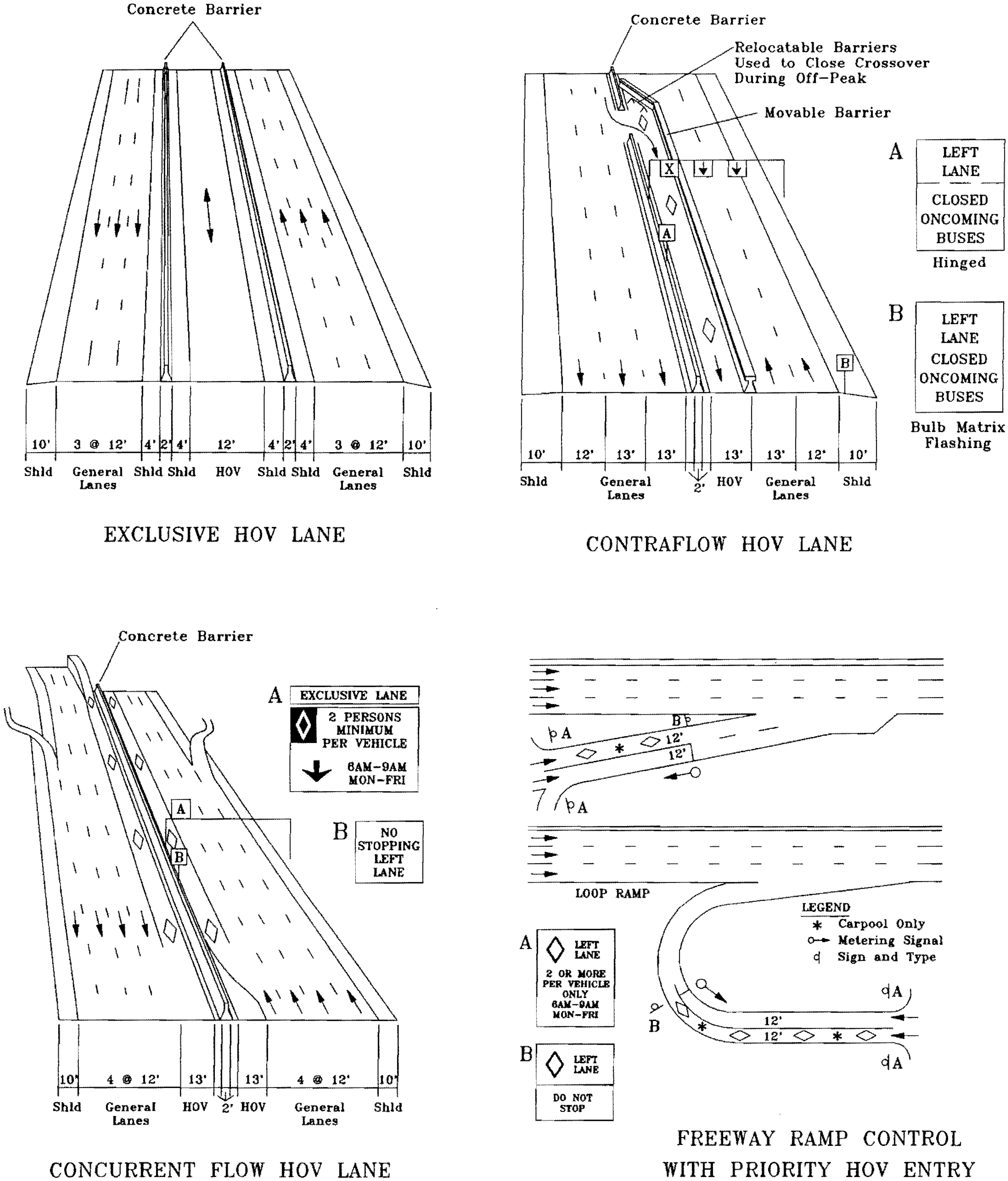


Figure 1. Illustrations of Typical HOV Treatments

Exclusive, Barrier-Separated HOV Lanes

Roadways or lanes built within the freeway right-of-way that are physically separated from other freeway lanes and are designated for the exclusive use of high-occupancy vehicles during at least parts of the day. An exclusive HOV lane can be either a reversible or a two-way facility. Exclusive lanes are considered as permanent improvements.

Concurrent Flow HOV Lane

A freeway lane in the peak-direction of flow (commonly the inside lane), not physically separated from the other general traffic lanes, and designated for use by HOVs (usually buses, vanpools, and carpools) during at least parts of the day. Concurrent flow lanes in Texas have been considered as an interim or transitional improvement.

Contraflow HOV Lane

A freeway lane (commonly the inside lane in the off-peak direction of travel) designated for exclusive use by HOVs (usually buses only or buses and authorized vanpools) traveling in the peak direction during the least parts of the day. The lane can be separated from the off-peak direction travel lanes by insertable plastic posts or by a moveable concrete barrier. Contraflow lanes have also been considered as an interim or transitional improvement in Texas cities.

Freeway Ramp Control with Priority HOV Entry

Traffic signals at entry ramps control freeway traffic volumes with special bypass entry lanes or exclusive use of some ramps provided to HOVs during peak periods. This improvement can be considered either as a permanent or interim improvement.

II. REVIEW OF HOV EXPERIENCE

Since the opening of the Shirley Highway exclusive bus lanes in the Washington, D.C. area in 1969, numerous metropolitan areas have developed priority facilities on freeways for high-occupancy vehicles. As of January 1995, there were 79 HOV facilities in 33 metropolitan areas in operation on either freeways or in separate rights-of-way.

The priority measures for high-occupancy vehicles implemented throughout North America, while often differing in design and operation, all have similar purposes. In general, HOV facilities help maximize the person-carrying capacity of the roadway. This is done by altering the design and/or the operation of the facility in order to provide priority treatment for HOVs. HOVs are defined as buses, vanpools, and carpools.

A primary concept behind these priority facilities is to provide HOVs with both travel time savings and more predictable travel times. These two benefits serve as incentives for individuals to choose a higher occupancy mode. This, in turn, can increase the person-movement capacity of the roadway by carrying more people in fewer vehicles. In some areas, additional incentives, such as reduced parking charges or preferential parking for carpools and vanpools, have been used to further encourage individuals to change their commuting habits. *The intent is not to force individuals into making changes against their will. Rather, the intent is to provide a cost-effective travel alternative that a significant volume of commuters will find attractive.*

High-occupancy vehicle facilities have most commonly been used in roadway corridors that are either at, or near capacity, and where the physical and/or financial feasibility of expanding the roadway is limited. The continued interest in HOV facilities, and the increasing number of operating facilities, can be traced to a number of factors. First, many metropolitan areas continue to experience significant increases in traffic congestion. In most of these areas, the projected travel demands are beyond what can reasonably be served at current vehicle occupancy rates. Attempting to address these mobility problems in a time of limited financial resources and right-of-way availability has led many areas to consider pursuing a wide spectrum of potential solutions. Some of these approaches focus on increasing the person-movement capacity of roadway facilities through the use of priority treatments for HOVs. Thus, HOV facilities are becoming more accepted as both a viable transit and a viable highway alternative.

ADVANTAGES AND DISADVANTAGES OF HOV FACILITIES

When properly planned and implemented, HOV facilities can offer a number of advantages. However, HOV facilities are not appropriate in all situations, nor do their implementation eliminate the need to pursue other complementary strategies. The potential use of HOV facilities should be examined thoroughly before any such improvements are made. Listed below are some of the advantages and disadvantages of high-occupancy vehicle projects that should be considered in the planning process.

Potential Advantages of the HOV Concept

Implementation Cost

At-grade freeway exclusive HOV lanes can be constructed for $1 to $4 million per kilometer. Multi-lane elevated HOV lanes can be built for $6 to $9 million per kilometer. Limited right-of-way acquisition is required. In general, $6 million per kilometer represents a reasonable planning level cost estimate for development of HOV lanes and their associated support requirements. This is often less expensive than alternative transit technologies.

Cost-Effectiveness

Evaluation of projects in the Dallas, Houston, and San Antonio areas has shown that, on congested freeways, the benefit/cost ratio associated with HOV improvements is frequently in excess of 6.

Implementation Time

These facilities can be planned, designed, and constructed in a 3- to 8-year time frame. The construction involves well-known highway construction technology, a technology possessed by numerous firms in Texas.

Staged Opening

HOV lanes can effectively be opened in sections; the entire system does not have to be completed before benefits can be realized from the facility.

Limited Risk

Construction of HOV facilities does not require massive sums of money. If the HOV lane is not extensively used, it can be converted relatively quickly and inexpensively to other useful purposes, such as additional mixed-flow lanes or emergency shoulders. User groups can also be varied by time of day.

Multiple User Groups

In addition to transit vehicles, vanpools and carpools can utilize an HOV lane, thereby increasing total potential person movement. In general, carpools and vanpools provide 50% of total person movement on an HOV lane.

Transit Strikes

During labor disputes, vanpools and carpools can continue to use the system transporting approximately 75% of the person movement that occurred on the facility prior to the strike.

Transit Operating Cost-Effectiveness

Operating cost per passenger-kilometer for bus operations on HOV lanes is competitive with other transit technologies. Also, vanpools and carpools operate at relatively low per passenger-kilometer costs on HOV lanes and do not require a direct public subsidy.

Transit Capacity and Speed

The line-haul transitway capacity is essentially as large as the capacity for any transit technology and in excess of any demand estimated to occur in a Texas city. Average schedule speeds on the Houston HOV lanes are as high as any transit operation in the United States.

Park-and-Ride Lot Locations

Lots can be located remote from the HOV lanes on relatively inexpensive land without requiring a transfer of vehicles at the line-haul HOV lane.

Flexibility

The transit vehicles can use the existing street system for the collection/distribution function.

Potential Disadvantages of the Concept

Activity Center Distribution

The HOV lanes will function well in individual corridors. The concentration of high bus volumes within the activity centers, particularly in the downtown area, may create problems. Extensive HOV lane development may require constructing a transit mall or off-street bus terminals in the downtown area.

Trips Served

The HOV lanes do an excellent job of serving long distance commute trips occurring during peak periods. The lanes are not as effective at serving short trip lengths and off-peak trips.

Future Operating Cost

While existing operating cost per passenger-kilometer appears to be generally comparable to rail, the potential for rail technology to eliminate the use of train operators in the future offers a possible means of reducing future rail operating costs on fully grade-separated systems.

Environmental Concerns

In some highly sensitive corridors, the noise levels and pollution emissions associated with heavy bus volumes may not be acceptable.

HOV EXPERIENCE IN TEXAS

By the early 1970s, it was evident that serious congestion problems were developing in the Houston area. At the same time, experiences with HOV lanes on the Shirley Highway in northern Virginia and the San Bernardino Freeway in Los Angeles were highly successful. As a result, in the mid 1970s a joint decision was made by the City of Houston and the Texas Highway Department to test the high-occupancy vehicle lane concept in Houston. Accordingly, these two agencies developed and operated a 15-kilometer contraflow lane on the North Freeway (I-45). This contraflow lane, which opened in August 1979, reserved the inside freeway lane in the off-peak direction for exclusive use by buses and vans traveling in the peak direction during both peak periods.

This contraflow lane was successful beyond all expectations. Although it operated for only 2.5 hours during each peak period and was used by only authorized buses and vans, the contraflow lane moved over 8,000 persons during each peak period. The facility attracted transit riders who had autos available for the trip. Large vanpool programs developed.

It became evident that, under certain conditions, a significant unserved demand for high-speed, high-quality transit existed in at least some Houston corridors. The success of the relatively modest contraflow project and the emergence of Metro as a well-financed transit agency with a long-range plan dependent upon HOV lanes brought about a large-scale commitment in Houston to the HOV concept. As a result, since 1979 the Houston area has seen continuous development of barrier-separated, high-occupancy vehicle projects.

Current commitments for HOV lane development in Houston total 160 kilometers of exclusive, barrier-separated facilities in 6 freeway corridors. As of December 1994, 100 kilometers of that system were in operation on 5 freeways (Figure 2).

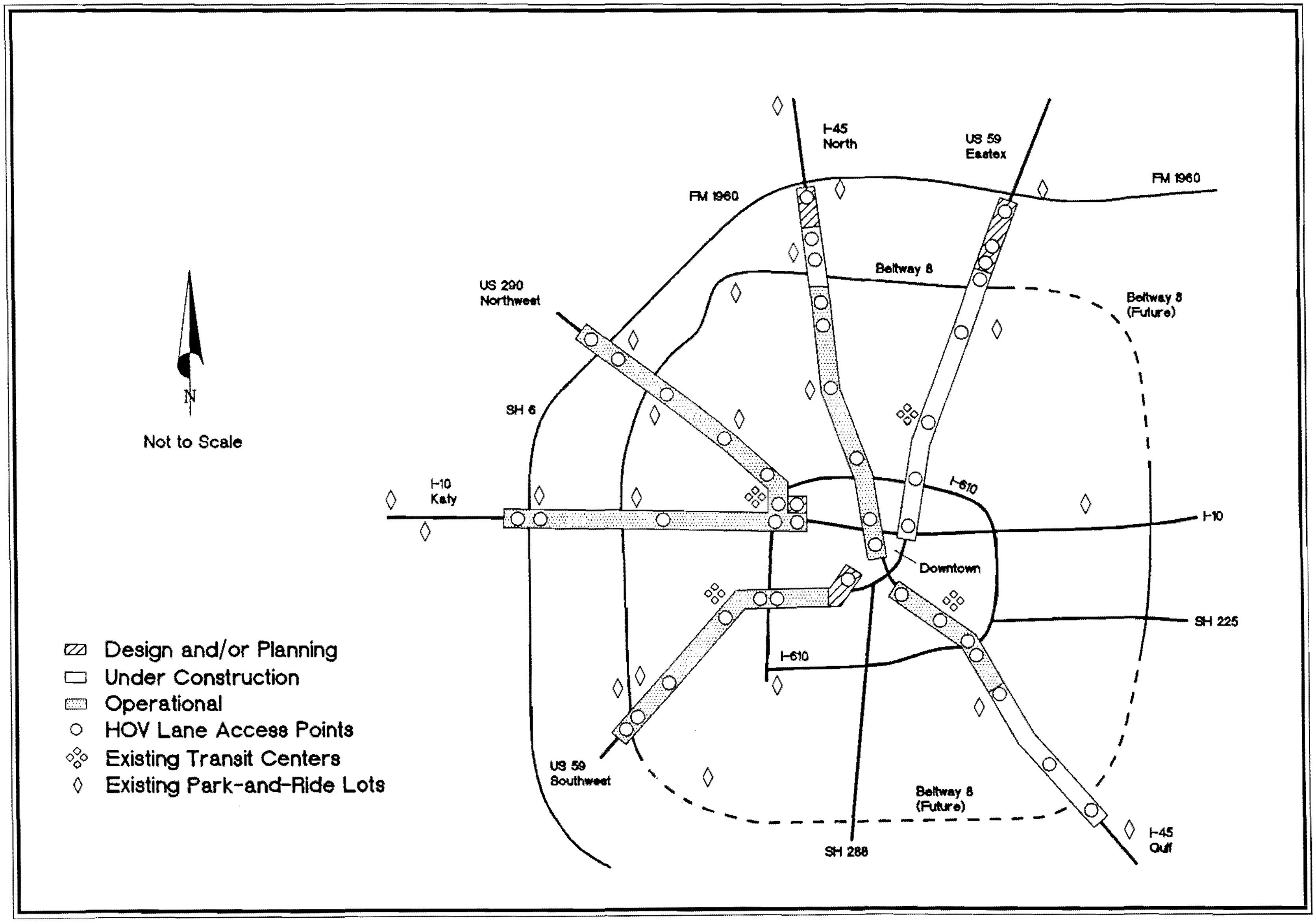


Figure 2. Status of Houston HOV Lane System, December 1994

The East R. L. Thornton Freeway Contraflow HOV lane in Dallas began operation in October 1991. The lane is open for vehicles with 2 or more persons from 6 a.m. to 9 a.m. and 4 p.m. to 7 p.m. The lane is created by taking the inside freeway lane from the off-peak direction of travel and dedicating it for HOVs in the peak direction. A movable concrete barrier is used to separate the two traffic directions and provide a relatively safe travel lane that can be used by buses and carpools. The lane is 8.4 kilometers long in the morning (westbound) and 5.3 kilometers in the evening (eastbound). HOV lanes are also in the planning or design stage in four other corridors in the Dallas area (Figure 3).

Figure 4 depicts the daily ridership on the 6 HOV lanes operating in Texas. As of December 1994, there were 75,300 person trips on the 6 priority facilities. The growth in ridership has been particularly fast on the Katy and East R. L. Thornton HOV lanes. These lanes, opened as the only capacity improvement in the corridors, operate on very congested freeways. HOV lanes in the other 4 corridors were opened along with mixed-flow capacity additions which improved travel conditions for single-occupant travelers.

As of the end of 1994, the oldest of the Houston HOV lanes had been in operation for just over nine years. Until 1990, none of the high-occupancy vehicle facilities had been completed in its final form. In assessing the worth of these improvements, recognize that these facilities are being looked to as a means of helping to serve the growth in travel that will be occurring over the next 10 to 20 years. Design year demand estimates are three times greater (approximately 7,000 to 10,000 persons in the peak hour) than the current demand on some of the HOV lanes.

It is not expected that the HOV lanes will be as effective in their early years of operation as they are expected to be in future years. Consequently, in reviewing the data in this report, more emphasis should be given to the evaluations that relate to the more mature HOV facilities—the Katy and the North HOV lanes. Even then, there is reason to expect that the current level of effectiveness associated with those facilities will increase over time; this will be the case if their usage and congestion on the freeway mainlanes increase as is anticipated.

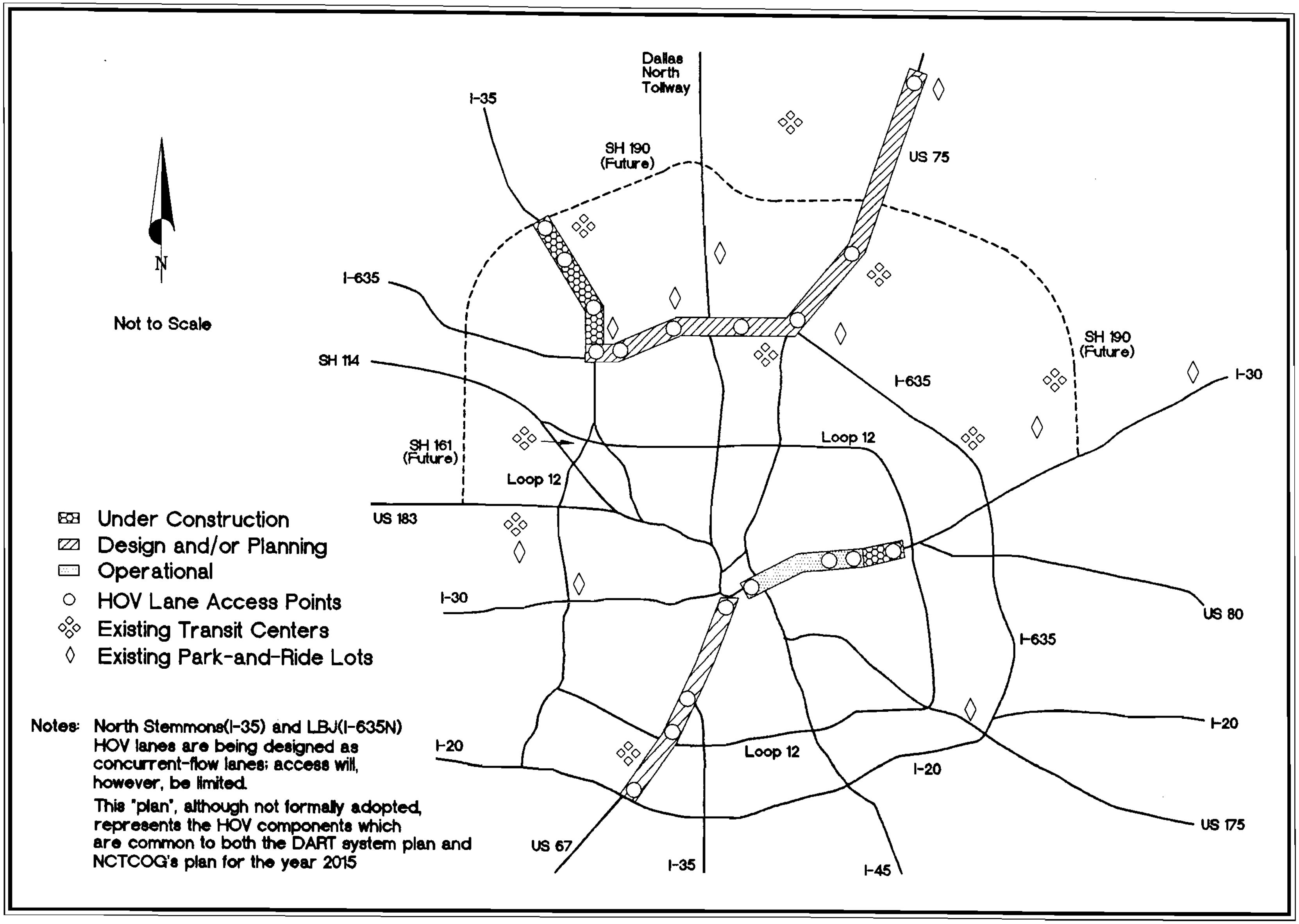
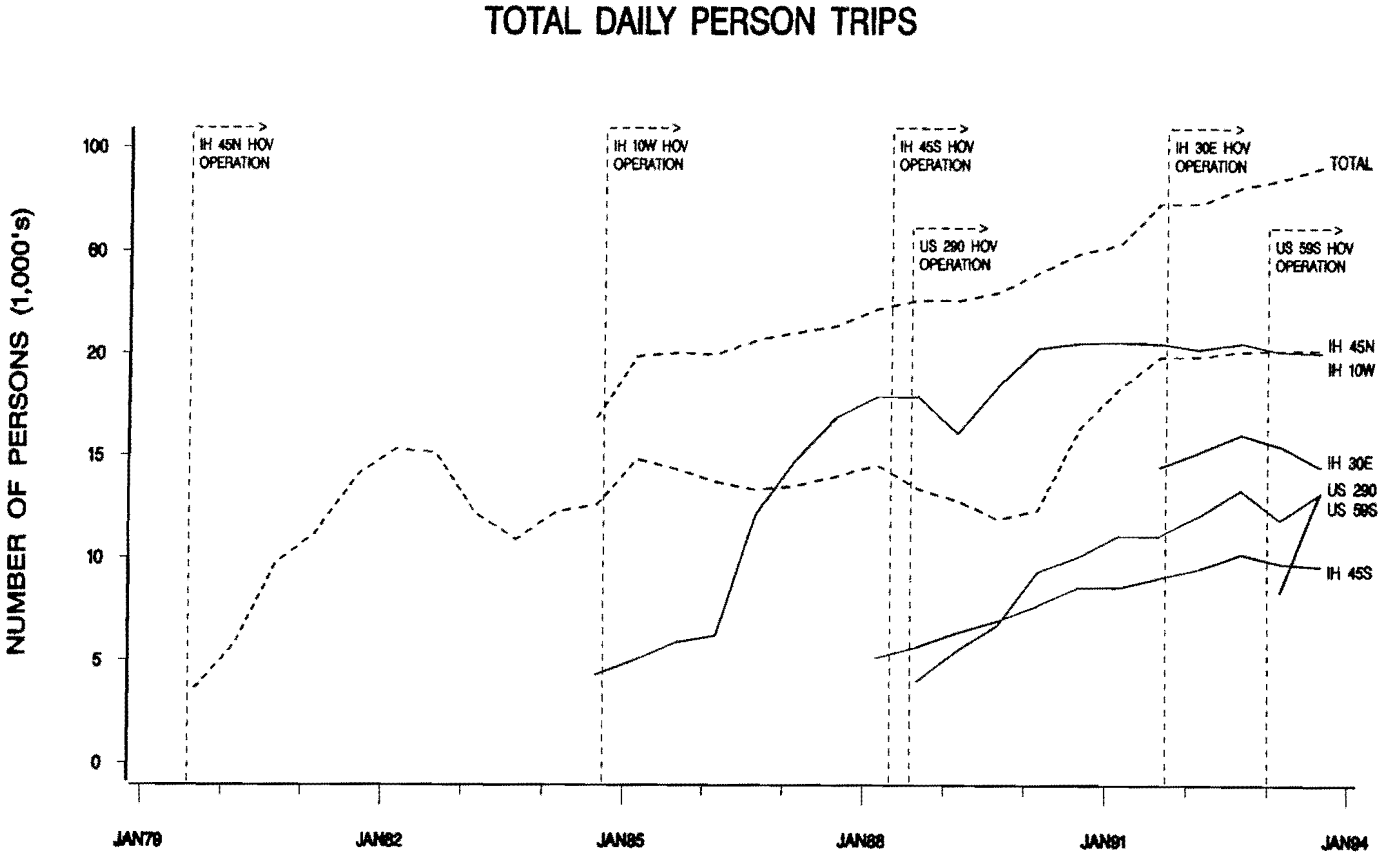


Figure 3. Status of Dallas HOV Lane System, December 1994



Source: References 1,2

Figure 4. Trends in Daily Person Trips on Texas HOV Lanes

A major intent of a TxDOT research project (1) has been to evaluate the effectiveness of the high-occupancy vehicle lanes being implemented in Houston. The commitment to developing these priority lanes is extensive, and the projects are unlike anything that has been implemented in Texas. As a result, there is a high level of interest in assessing the effectiveness of the HOV lane projects. In response to this interest, TxDOT has chosen to pursue a long-range evaluation of the high-occupancy vehicle lanes.

To a large extent, the decision to consider building HOV lanes came through the realization that it was simply not possible, either physically or economically, to provide enough street and highway lanes to indefinitely continue to serve peak-period travel demands at 1.2

persons per auto. The current round of freeway expansion being pursued in Houston, which will be largely complete by the end of the 1990s, represents, to a significant extent, the last major capacity expansion that can be added to existing corridors. However, person demand is expected to continue to increase into the indefinite future at rates of around two to three percent per year.

In concept, if the HOV lanes perform as intended, provision of the priority lanes offers a means to help accommodate some of this future growth. If design year volumes of 7,000 to 10,000 persons per hour per lane are achieved on these lanes, the person-movement capacity of the freeway will effectively have been doubled at a cost of $3 to $6 million per kilometer, and future volumes can be served acceptably. However, this will be the case only if the HOV lanes perform as expected. As a result, their performance is being closely monitored to assess the effectiveness of the improvements.

The most recent research report prepared as part of the TxDOT research project on Houston HOV lane performance (1) has focused on analyzing the data and the extent to which the HOV system is satisfying the performance objectives. The measures of effectiveness used in that study appear to be appropriate for any analysis of HOV facilities in the Fort Worth area. The discussion presented below is from the most recent final report prepared for the Houston HOV system (1) and reviews the objectives and the performance of each HOV lane relative to those objectives.

SUMMARY OF HOUSTON AND DALLAS HOV LANE PERFORMANCE

The research report (1) identifies a major reason for implementing the Houston HOV lanes is to cost effectively increase the person-movement capacity of the freeways. Achieving this should 1) enhance bus operations; 2) improve air quality; and 3) reduce fuel consumption. Implementation of the HOV lanes should not unduly impact the operation of the freeway general-purpose lanes. That implementation should have public support. This section reviews and analyzes data collected through calendar year 1993 to assess the extent to which these objectives are being attained in Houston (Table 2) and Dallas (Table 3).

Table 2. Potential Performance Measures for the Houston HOV Lanes, A.M. Peak-Hour, Peak-Direction, 1993

Performance Measure[1]	Freeway					
	Katy[2] w/ HOV Lane	North[2] w/HOV Lane	Gulf[2] w/HOV Lane	Northwest[2] w/HOV Lane	Southwest[2] w/HOV Lane	Eastex[3] w/o HOV Lane
Daily HOV Lane Person Trips (12/93)	20,462	21,645	9,628	13,161	13,200	NA
% Change in Number of Lanes[4]	+33%	+25%	NA	33%	20%	NA
% Change in Person Volume[5]	+84%	+113%	NA	+58%	+91%	-2%
% Change in Average Vehicle Occupancy[5] (persons/vehicle)	+14%	+16%	NA	+19%	+11%	-2%
% Change in 2+ Carpool Volumes[5]	+56%[11]	+140%	NA	+207%	+142%	-12%
% New Carpools Due to HOV Lane[6] (1990)	53%	46%	26%	47%	NA	NA
% Change in Peak-Period Bus Riders	+243%	NA	NA	+183%	+17%	-35%
% New Bus Riders Due to HOV Lane[7]	47%	52%	33%	47%	NA	NA
% Change in Peak-Hour Bus Speeds	+140%	NA	+63%	+83%	+80%	+12%
Annual Savings in Bus Operating Costs Due to HOV Lane (millions) (1990)	$4.8	—	—	—	—	—
% Change in Vehicles at Park-and-Ride Lots	+249%	NA	+12%	+250%	+8%	-24%
% Change, Freeway Vehicle Volumes Per Lane[8]	+42%	+18%	NA	+8%	-10%	+7%
% Change, Roadway Efficiency[9]	+130%	+198%	NA	+55%	+38%	-8%
HOV Travel Time Savings as a % of Construction Cost[10]	28%	9%	9%	3%	6%	NA

NA = Either not available or not applicable.

[1]The percent change is a comparison of current values with representative pre-HOV lane values.

[2]These freeways have operating HOV lanes as of 12/93.

[3]This freeway does not have an HOV lane and represents a basis of comparison to the freeways with HOV lanes.

[4]The HOV added one lane; this is the percent increase in the number of total lanes (freeway plus HOV) resulting from implementing the HOV lane.

[5]A.M. peak-hour, peak-direction, combined mainlane and HOV data.

[6]This is an estimate of the percent of total carpools using the HOV lane that are new carpools created as a result of the HOV lane.

[7]This is an estimate of the percent of total bus riders using the HOV lane that are new bus riders created as a result of the HOV lane.

[8]Data for freeway mainlanes. A.M. peak-hour, peak-direction.

[9]Freeway per lane efficiency is expressed as the multiple of persons moved times average speed, a.m. peak-hour, peak-direction.

[10]This is the estimated annual value of 1993 travel time savings for HOV lane users expressed as a percent of the cost of constructing the segment of the HOV lane in operation in 1993.

[11]6 a.m. to 7 a.m. volume is used for this calculation due to the 3+ requirement during both the a.m. and p.m. peak hours as of 9/16/91.

Source: Reference 1

Table 3. Potential Performance Measures for the Dallas HOV Lane, A.M. Peak-Hour, Peak-Direction, 1993

Performance Measure[1]	Freeway	
	East RLT[2] w/ HOV Lane	South RLT[3] w/o HOV Lane
Daily HOV Lane Person Trips (12/93)	14,017	NA
% Change in Number of Lanes[4]	+25%	NA
% Change in Person Volume[5]	+41%	+3%
% Change in Average Vehicle Occupancy[5] (persons/vehicle)	-1%	-3%
% Change in 2+ Carpool Volumes	+145%	-4%
% Change in Peak-Period Bus Riders	-1%	-12%
% Change in Peak-Hour Bus Speeds	+109%	+21%
% Change in Vehicles at Park-and-Ride Lots	-1%	-8%
% Change, Freeway Vehicle Volumes Per Lane[6]	+21%	+2%
% Change, Roadway Efficiency[7]	+80%	-8%
HOV Travel Time Savings as a % of Construction Cost[8]	13%	NA

NA = Either not available or not applicable.
[1]The percent change is a comparison of current values with representative pre-HOV lane values.
[2]Freeway with an operating HOV lane as of 12/93.
[3]This freeway does not have an HOV lane and represents a basis of comparison to the freeways with HOV lanes.
[4]The HOV added one lane; this is the percent increase in the number of total lanes (freeway plus HOV) resulting from implementing the HOV lane.
[5]A.M. peak-hour, peak-direction, combined mainlane and HOV data.
[6]Data for freeway mainlanes. A.M. peak-hour, peak-direction.
[7]Freeway per lane efficiency is expressed as the multiple of persons moved times average speed, a.m. peak-hour, peak-direction.
[8]This is the estimated annual value of 1993 travel time savings for HOV lane users expressed as a percent of the cost of constructing the segment of the HOV lane in operation in 1993.

Source: Reference 1

Objective: Increase Roadway Person Movement

1. Daily HOV lane ridership (measured in person trips) should be in the range of 10,000 to 15,000 or greater.

2. The HOV lane should increase peak-hour, peak-direction person volume by a percentage greater than the percent increase in directional lanes added to the roadway due to HOV lane implementation.

3. The HOV lane should increase the peak-hour, peak-direction average vehicle occupancy (persons per vehicle) of the roadway by at least 10 percent to 15 percent.

   - More than 25 percent of the total carpools using the HOV lane should be new carpools created because of the HOV lane.

   - More than 25 percent of the total bus riders using the HOV lane should be new bus riders created because of the HOV lane.

Objective: Don't Unduly Impact Freeway General-Purpose Lane Operations

1. Implementing the HOV lane should not significantly increase either freeway general-purpose lane congestion or the accident rate on those lanes.

Objective: Increase the Overall Efficiency of the Roadway

1. The absolute value of the total roadway (general-purpose lanes plus HOV lane) peak-hour per lane efficiency (defined as the multiple of person volume times speed of movement) should increase by at least 20 due to implementation of the HOV lane. Stated differently, the total roadway per lane efficiency should be greater than the freeway general-purpose lane efficiency by an amount of at least 20.

Objective: Create Favorable Energy and Air Quality Impacts

1. Compared to the alternative of either providing an additional general-purpose lane or doing nothing, implementation of the HOV lane should result in reductions in energy consumed and pollutants emitted.

Objective: Enhance Bus Transit Operations

1. Peak-hour operating speeds should be increased by at least 50 percent on the HOV lanes.

2. A safer bus operating environment should result. HOV accident rates should be equal to, or less than, general-purpose freeway lane rates.

3. Significant savings in bus operating costs should result.

Objective: HOV Projects Should be Cost Effective

1. From an extremely conservative viewpoint, the projects can be considered cost effective if the average **annual** value of time saved over the life of the project exceeds 10 percent of the initial construction cost.

Objective: Public Support Should Exist for HOV Development

1. Surveys should show that most people feel the HOV lanes are good transportation projects.

A review of the performance measures based on the HOV evaluations performed in Houston and Dallas leads to several general observations (Table 4). The performance measures suggest that, at the level of usage, both the Katy and East R. L. Thornton HOV lanes were fulfilling their intended purpose. (These are the two priority lanes where no capacity was added to the mixed-flow freeways.) The Northwest, North and Gulf HOV lanes were marginal at that time. The Northwest HOV lane was completed in final form in 1990. Less than half the length of the ultimate Gulf HOV lane was operating, and the section that is operating offers only minimal benefits; the Gulf facility was not extended until 1994. The North Freeway corridor has had additional capacity improvements with the opening of the Hardy Toll Road in 1988 and additional freeway main lanes. This has acted to hold down the growth of congestion on the freeway mainlanes.

Table 4. Comparison of HOV Lane Objectives and HOV Lane Performance, 1993

Objective, Measure of Effectiveness	HOV Facility					
	Katy	North	Gulf	Northwest	Southwest	East RLT
Increase Person Movement						
• Is daily ridership greater than 10,000	Yes	Yes	No	Yes	Yes	Yes
• Is daily ridership greater than 15,000	Yes	Yes	No	No	No	No
• Has the increase in a.m. peak-hour person volume exceeded the increase in lanes due to the HOV lane	Yes	Yes	NA	Yes	Yes	Yes
• Has a.m. peak-hour occupancy increased by more than 15%	No	Yes	NA	Yes	No	No
• Are more than 25% of the HOV lane carpools new due to the HOV lane	Yes	Yes	Yes	Yes	NA	NA
• Are more than 25% of the HOV lane bus riders new due to the HOV lane	Yes	Yes	Yes	Yes	NA	NA
Don't Unduly Impact Freeway General-Purpose Lane Operations						
• Has mainlane congestion increased due to the HOV lane	No	No	No	No	No	No
• Has the mainlane accident rate increased significantly due to the HOV lane	No	No	No	No	No	No
Increase the Overall Efficiency of the Roadway						
• Has the roadway per lane efficiency increased by more than 30 due to the HOV lane	Yes	Yes	NA	Yes	Yes	Yes
HOV Lane Should Have Favorable Air Quality & Energy Impacts						
• Has adding an HOV lane been more effective than adding a general-purpose freeway lane would have been	Yes	NA	NA	NA	NA	NA
Enhance Bus Operations						
• Peak-hour bus speeds increase by at least 50%	Yes	NA	Yes	Yes	Yes	Yes
• HOV lane accident rate less than general-purpose lanes	Yes	No	Yes	No	Yes	Yes
The HOV Lane Should be Cost Effective						
• Is the annual value of time saved by HOV lane users greater than 10% of the HOV lane capital cost	Yes	No	No	No	No	Yes
HOV Lanes Should Have Public Support						
• Do most of the persons responding to surveys indicate support for HOV lane development	Yes	Yes	Yes	Yes	NA	NA
Overall Assessment, Is HOV Facility Effective?	Effective	Marginally Effective	Marginally Effective	Marginally Effective	Marginally Effective	Effective

NA = Either not available or not applicable.

Source: Reference 1

III. DESIGN FEATURES AND OPERATION OF HOV FACILITIES

The planning, design, construction, and operation of any HOV facilities in Fort Worth will greatly benefit from the experiences in Houston and Dallas. This section provides an overview of the major design features, operating aspects and the cost of planning and operating Texas HOV lanes.

HOV LANE CROSS SECTIONS

While some sections of two-direction HOV facility are being developed, the typical Houston HOV lane is located in the freeway median, is approximately 6-meters wide, is reversible, and is separated from the general-purpose freeway mainlanes by concrete median barriers (Figure 5). In some locations, narrowing freeway lanes to 3.4 meters and reducing inside shoulder widths accomplished implementation of the HOV lane.

The East R. L. Thornton Freeway Contraflow Lane was implemented by re-striping the general purpose traffic lanes (Figure 6) and constructing crossover slip ramps in the median in 3 locations. The wider inside lanes provide a 3.6-meter wide lane for the HOV lane and the inside freeway lane when the movable barrier is positioned on the lane stripe. The contraflow lane is viewed as an interim treatment, but no decision has been made on the design of a permanent HOV lane.

Concurrent flow lanes are being planned for Stemmons Freeway and LBJ Freeway in the Dallas area. These HOV lanes are also planned as interim treatments. Some widening is being planned to allow a buffer between the HOV lane and the freeway lanes. The 1.2-meter buffer, shown in Figure 7, provides a significant improvement in HOV operations relative to projects without buffers. The space separation between the HOV lane and general purpose lanes decreases the potential for accidents. The 5.5-meter clear distance in the reduced cross section is the narrowest HOV lane dimension that will allow a bus to pass a disabled bus with a

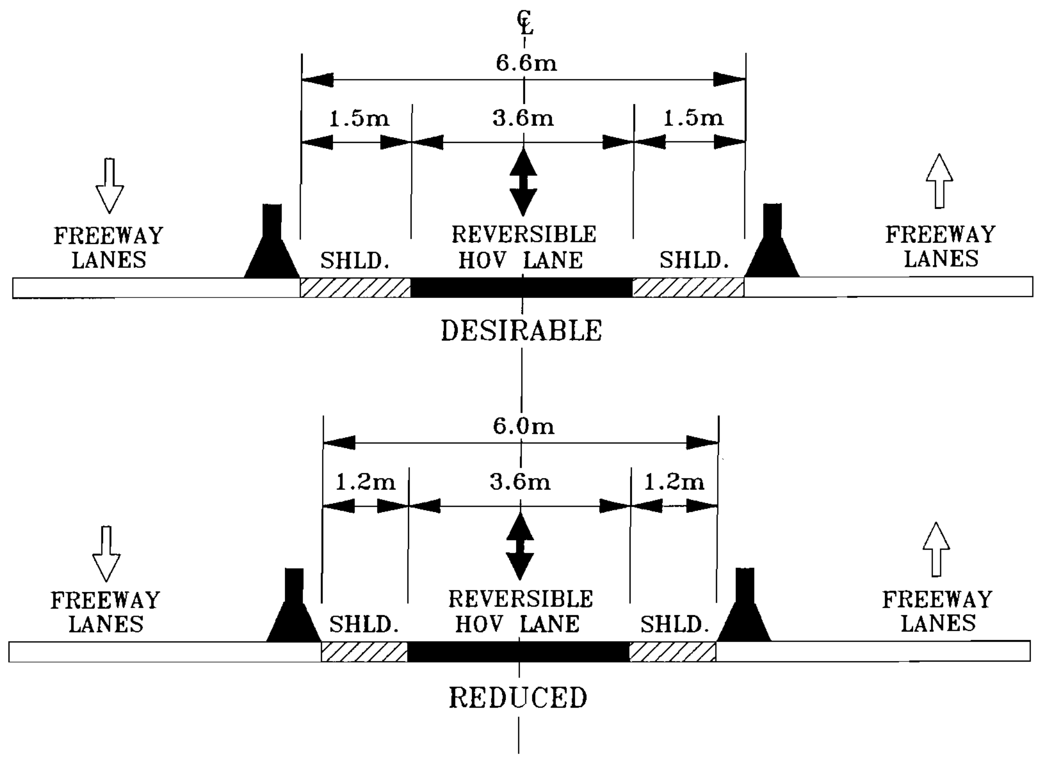


Figure 5. Example of Reversible Barrier-Separated HOV Lane

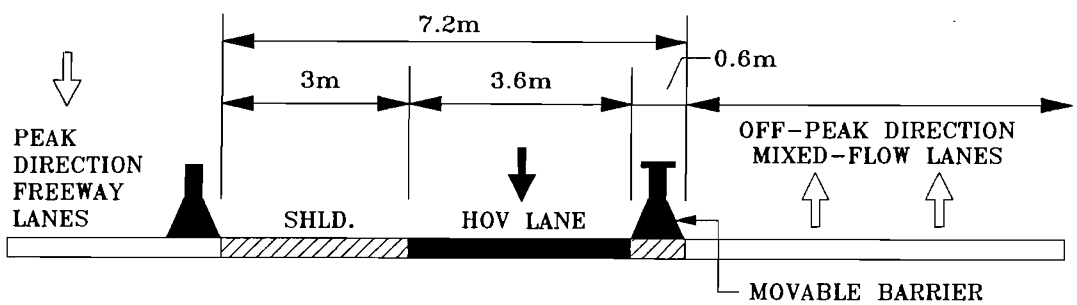


Figure 6. Example of Contraflow HOV Lane

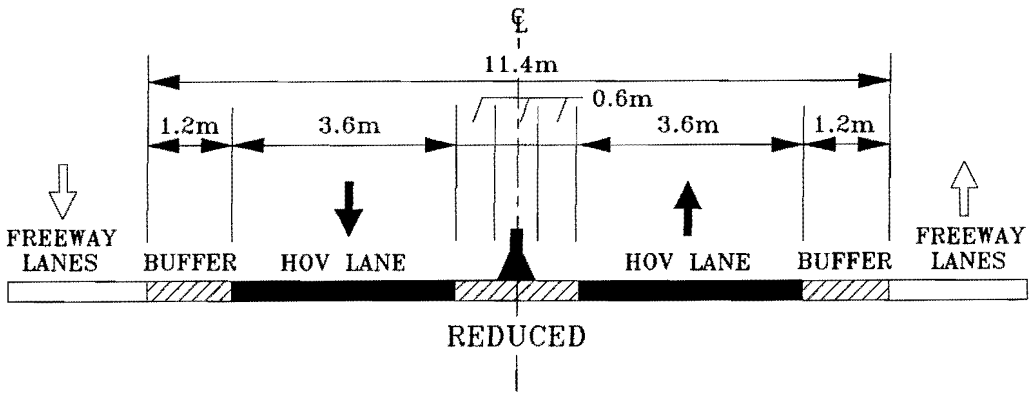


Figure 7. Example of Concurrent Flow HOV Lane

minimum encroachment on the inside freeway lane. This is important if reliable operations are to be maintained on both the freeway and HOV lanes. Many HOV projects have narrower cross sections, but there are also operating enhancements that have been used to overcome the design constraints.

HOV LANE ACCESS

Access to the HOV facilities is provided in a variety of manner. At some locations in Houston and on East R. L. Thornton, "slip ramps" are used to provide access and egress to/from the inside freeway lane (Figure 8). While these are relatively inexpensive ($500,000 to $1 million), depending on their location they may create a variety of operational problems. As a consequence, grade-separated interchanges of various designs provide most access to the exclusive HOV lanes in Houston (Figure 9). The HOV lanes become elevated in the median, and ramps go over the freeway lanes to connect with streets, park-and-ride lots, or bus transfer centers. These grade-separated interchanges are typically constructed at a cost in the range of $2 to $7 million each. Access to the HOV lanes is typically provided at 5- to 8-kilometer intervals.

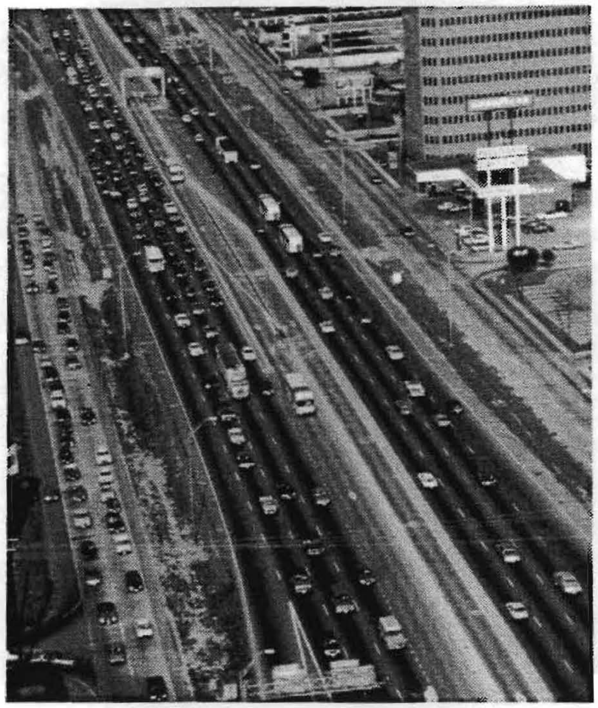


Figure 8. "Slip Ramp" Access Treatment

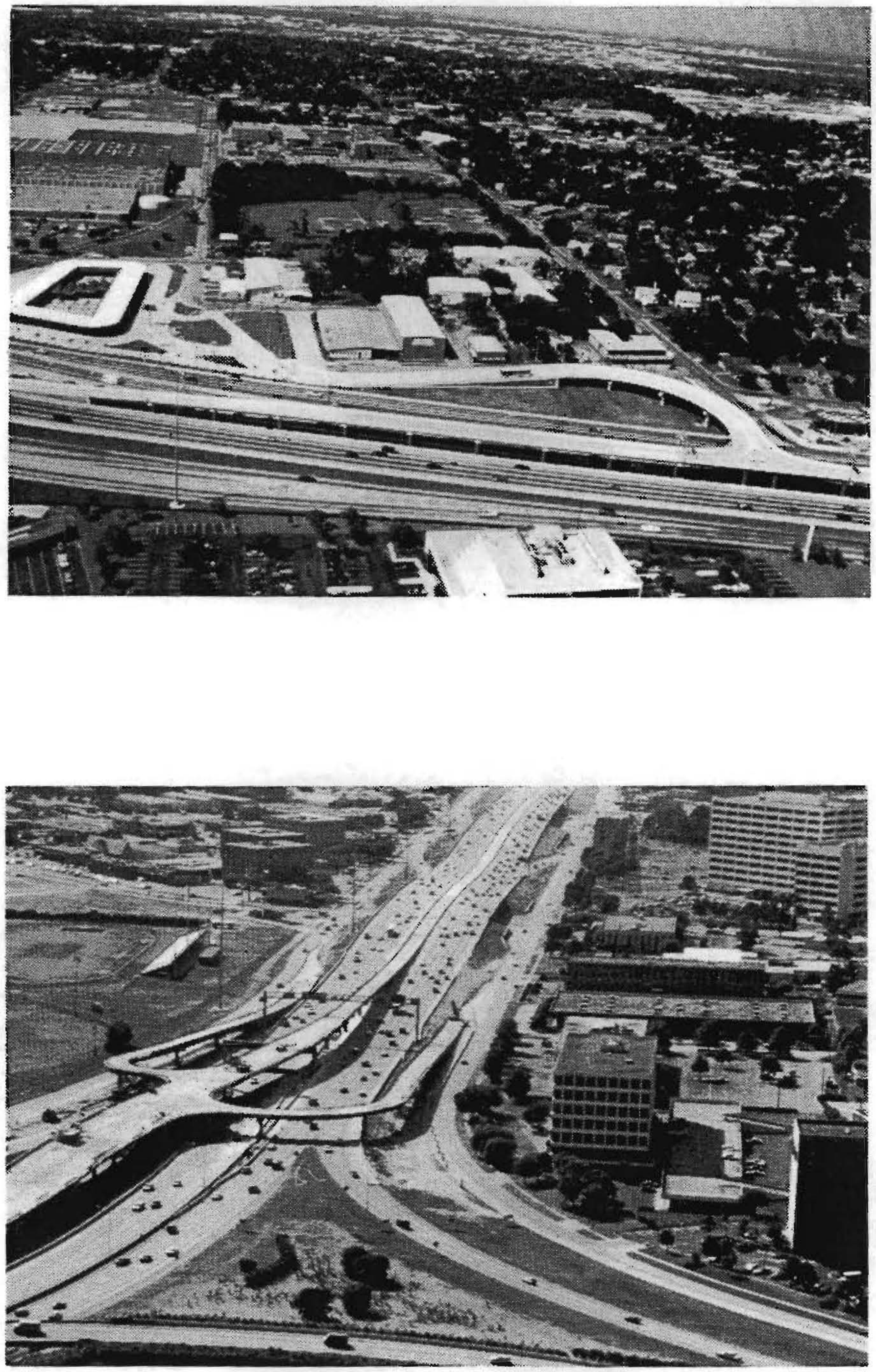


Figure 9. Grade-Separated HOV Interchanges

ESTIMATED CAPITAL COST

Since the HOV lanes have generally been constructed as part of freeway reconstruction projects, it is difficult to determine precisely the capital cost of the priority lanes. Information provided by Houston Metro, Dallas Area Rapid Transit, TxDOT and estimates from TTI are used in developing the costs shown in this section.

The exclusive HOV lanes in operation in Houston, including all access ramps, have typically been built at a cost of less than $3 million per kilometer (Table 5). An extensive system of support facilities—park-and-ride lots, park-and-pool lots, and bus transfer facilities—also have been provided in each corridor. Some of these facilities would have been provided even if there were no HOV lanes. In total, a substantial investment, typically about $1 million per kilometer, exists in these support facilities. A surveillance, communication and control system is being installed on the HOV lanes at a typical cost of $125,000 to $185,000 per kilometer. The total cost for all project elements is in the range of $3 to $5 million per kilometer. Total capital expenditures (1990 dollars) for the operating segments have been approximately $276 million. Figure 10 summarizes current capital expenditures in the Houston HOV system.

The construction cost for the 13.7 kilometers of contraflow lane in Dallas was approximately $12.7 million. More than half of that cost ($6.9 million) was for the movable barriers and the transfer machines. No park-and-ride lots have been constructed as a result of this project. Significant levels of signs, signals and flashing lights alert motorists to HOV operations and freeway lane closures. The $650,000 in surveillance, communication and control cost reflects that equipment; a system of cameras and higher level monitoring equipment is not yet installed.

The total Stemmons HOV lane project cost is estimated to be $16.1 million. The cost of widening the freeway and reconstructing the inside shoulder is estimated as $12.9 million, with the remaining cost due to a reversible direct connection ramp between the freeway median and a transit center.

Table 5. Estimated Capital Cost[1] of the Operational Houston HOV Lane System, 1993

HOV Lane	Operating System (kilometers)	Estimated Capital Cost, Millions[1,2]							
		HOV Lane Plus Ramps[3]		Support Facilities[4]		Surveillance, Communication and Control[5]		Total	
		Total	Per Kilometer	Total	Per Kilometer	Total	Per Kilometer	Total	Per Kilometer
Katy (I-10W)	20.9	$27.5	$1.3	$30.0	$1.4	$5.5	$0.3	$63.0	$3.0
North (I-45N)	21.7	$57.8	$2.7	$18.2	$0.8	$2.6	$0.1	$78.6	$3.6
Gulf (I-45S)	10.5	$30.5	$2.9	$12.6	$1.2	$1.9	$0.2	$45.0	$4.3
Northwest (U.S. 290)	21.7	$62.7	$2.9	$33.8	$1.6	$2.9	$0.1	$99.4	$4.6
Southwest (U.S. 59S)	18.7	$45.1	$2.4	$13.6	$0.7	$3.5	$0.2	$62.2	$3.3
Total	93.5	$223.6	$2.4	$108.2	$1.2	$16.4	$0.2	$348.2	$3.7

[1]Estimated capital costs are shown in year-of-construction dollars.
[2]Costs do not include the value of the existing freeway rights-of-way in which HOV lanes have been located. The costs of additional buses required to provide the HOV service and the bus maintenance facilities needed to serve those buses are not included.
[3]Includes the cost of the median HOV lane and the access/egress ramps serving that lane.
[4]Includes the cost of all existing park-and-ride lots, park-and-pool lots, and bus transfer centers.
[5]The cost of the surveillance, communication, and control system serving the HOV lanes.

Source: Reference 1

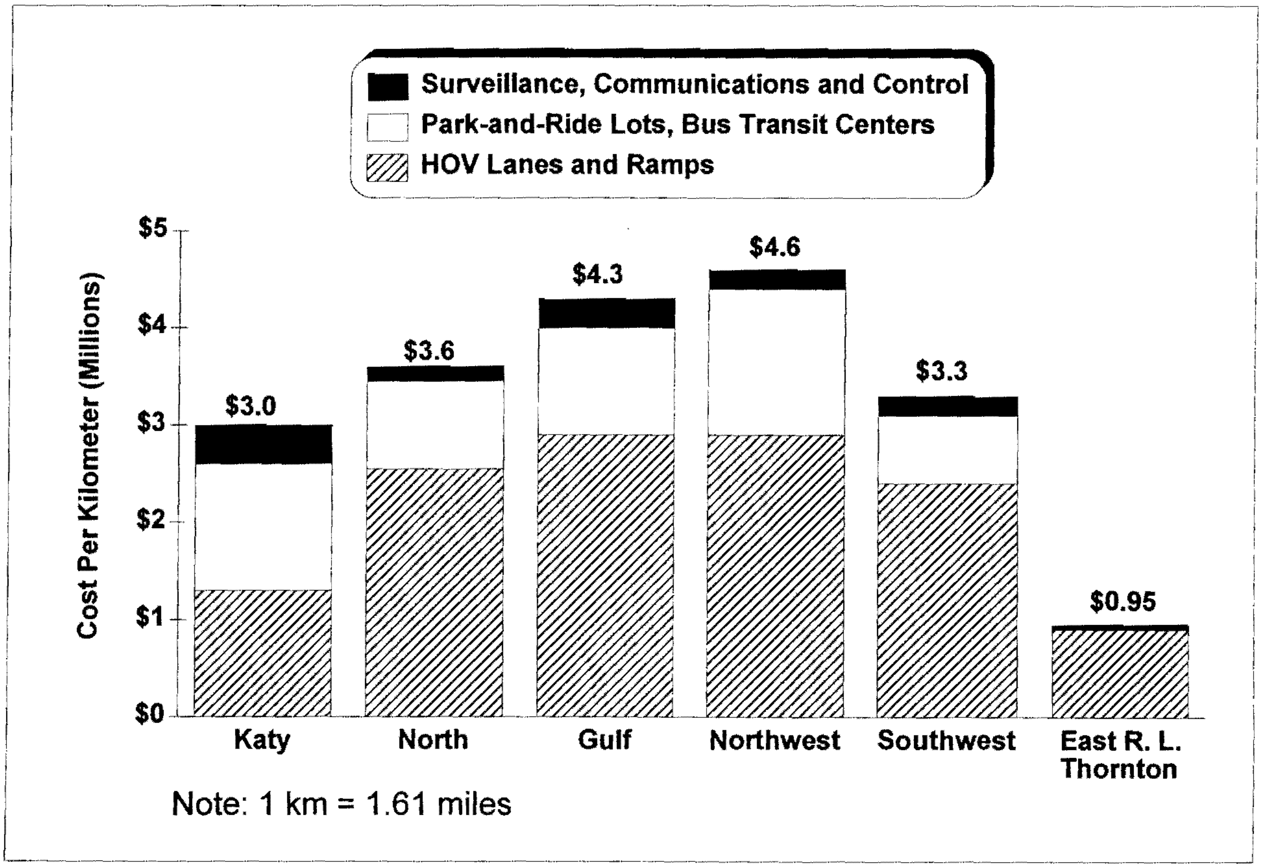


Figure 10. Capital Cost per Kilometer (Year-of-Construction Dollars) of the Operating Texas HOV Lanes

Approximately half of the ultimate Houston HOV lane system was operating in 1990. Table 6 provides an estimate of the cost of the completed Houston system and costs for the two interim Dallas facilities. The ultimate capital cost (1990 dollars) for the permanent HOV lanes and ramps will be approximately $3 million per kilometer. The HOV support facilities—park-and-ride lots, park-and-pool lots, and bus transfer facilities—will cost an additional $1.25 million per kilometer. The entire completed Houston system will cost approximately $642 million, or about $4.4 million per kilometer (1990 dollars). The two interim Dallas HOV lanes are estimated to cost an average of $ 1 million per HOV lane kilometer (1990 dollars).

Table 6. Estimated Cost[1] of the Planned Houston HOV Lane System

HOV Lane	Ultimate System (kilometers)	Estimated Capital Cost, Millions[1,2]							
		HOV Lane Plus Ramps[3]		Support Facilities[4]		Surveillance, Communication and Control[5]		Total	
		Total	Per Kilometer	Total	Per Kilometer	Total	Per Kilometer	Total	Per Kilometer
Katy (I-10W)	20.9	$ 27.5	$1.3	$29.3	$1.4	$ 4.7	$0.3	$59.1	$3.0
North (I-45N)	31.7	$104.8	$3.3	$26.6	$0.8	$ 4.1	$0.1	$135.5	$4.3
Gulf (I-45S)	25.0	$ 89.4	$3.6	$28.4	$1.1	$ 3.3	$0.1	$121.1	$4.8
Northwest (U.S. 290)	21.7	$ 62.7	$2.9	$33.2	$1.5	$ 2.9	$0.1	$ 98.1	$4.5
Southwest (U.S. 59S)	22.2	$ 66.8	$3.0	$13.6	$0.6	$ 4.1	$0.2	$84.5	$3.8
Eastex (U.S. 59N)	32.2	$119.3	$3.7	$15.0	$0.5	$ 7.3	$0.3	$141.6	$4.4
Total	153.8	$470.5	$3.1	$146.1	$1.0	$26.8	$0.2	$639.9	$4.2

[1]Capital costs which have already been incurred are shown in year-of-construction dollars.
[2]Costs do not include the value of the existing freeway rights-of-way in which HOV lanes have been located. The costs of additional buses required to provide the HOV service and the bus maintenance facilities needed to serve those buses are not included.
[3]Includes the cost of the median HOV lane and the access/egress ramps serving that lane.
[4]Includes the cost of all park-and-ride lots, park-and-pool lots, and bus transfer centers.
[5]The cost of the surveillance, communication, and control system serving the HOV lanes.

Source: Reference 1

Each of the HOV projects has been funded differently, with funding coming from a combination of federal and state highway funds and federal and local transit monies. About 80 percent of the total capital cost in Houston and 50 percent of the cost in Dallas is from transit funds. With the exception of some ramps and support facilities, the HOV facilities have been constructed in state-owned rights-of-way.

FACILITY OPERATING AND ENFORCEMENT COST

The daily operation and enforcement of the HOV lanes is the responsibility of the Houston Metropolitan Transit Authority and Dallas Area Rapid Transit. On average, this is costing just over $250,000 per HOV lane per year in Houston (Table 7). This is equivalent to less than one cent per passenger-kilometer. In 1990, approximately 225 million passenger-kilometers were served on the Houston HOV facilities. At $1,060,000 per year for operations and enforcement, this equates to 0.5 cents per passenger-kilometer. The operating cost for the

East R. L. Thornton Contraflow Lane in Dallas includes moving the concrete barriers, which is significantly more costly than operating any single HOV lane in Houston.

Table 7. Estimated Annual Cost of Operating and Enforcing the Operating Houston HOV Lanes

Cost Element	Annual Budget	
	Houston	Dallas
Daily Operations	$ 660,000	$ 340,000
Enforcement	$ 400,000	$ 70,000
Total	$1,060,000	$ 410,000
Average Per HOV Lane (unweighted)	$ 265,000	$ 410,000

Source: Metropolitan Transit Authority of Harris County and Dallas Area Rapid Transit

Special areas have been designed on the Houston and Dallas HOV facilities to enhance the ability of enforcement officials to maintain low violation rates. The barrier-separation of the Houston HOV lanes and the East R. L. Thornton contraflow lane is the most important aspect of maintaining adequate enforcement levels and high operating speeds. Designated areas at the terminal points provide a safe place for enforcement officials to divert motorists or issue citations. Enforcement issues are one area of concern with concurrent flow HOV lanes (see next section) and a combination of designated enforcement areas, more officers and use of all available technologies may be required to maintain low violation rates.

SPECIAL CONCERNS INVOLVING CONCURRENT FLOW LANES

Concurrent flow HOV lanes (lanes reserved for use by HOVs that are traveling in the same direction of flow as the mixed-flow lanes and not physically separated from those lanes) have attracted interest for the following reasons:

- These lanes can be implemented relatively quickly and inexpensively.
- Many Texas freeways have inside shoulders. Upon initial inspection, it would appear relatively easy to designate that inside space as a concurrent flow lane.

- Of those priority treatment projects implemented on freeways since 1970, the concurrent flow alternative is the most commonly implemented priority treatment.
- A 5.3-kilometer long concurrent flow lane was implemented on the North Freeway (I-45) in Houston in 1980. That lane operated during the morning peak and connected to the downstream contraflow HOV lane. It was highly successful.

These points, combined with the recognition that HOV treatments will be an important component of future freeway operations, have focused attention on the concurrent flow lane alternative as a means of providing priority treatment. This subsection is an overview of the technical considerations and concerns associated with implementing concurrent flow lanes.

Add-a-Lane Versus Take-a-Lane

To implement a concurrent flow lane, either add a lane to the existing facility or take an existing lane away from mixed-flow traffic and reserve it for use by high-occupancy vehicles. The take-a-lane concept has been highly controversial; projects have, in almost every instance, been terminated due to opposition.

As a result, if concurrent flow is to be implemented in Fort Worth, it should be an add-a-lane project. This would require either designating the inside shoulder as a concurrent flow lane or expanding the freeway cross section. If the shoulder is used, the result would be that no emergency refuge area would exist on the inside for either high-occupancy or mixed-flow vehicles; no space would exist for enforcement activities either. If the cross section is significantly expanded, the low implementation cost and rapid implementation time advantages may be lost.

Eligible Users

Most HOV projects in the United States allow some form of carpools (3). However, concurrent flow projects have not generated the increases in total person throughput that have been associated with exclusive HOV facilities. The concurrent flow concept has typically increased person throughput by 0 to 20 percent, whereas the exclusive lanes have increased person throughput by 50 percent or more (3). This occurrence has been attributed to the lack of permanence and reliability associated with the concurrent flow concept. Also, concurrent flow lanes have been implemented in many cities without bus service using the lanes.

It has not been possible in many cities to operate a lane successfully with a 3- or-more person (3+) definition due to utilization and enforcement problems. In several instances once the carpool definition is lowered to 2+, traffic in the priority lane can become as congested as traffic in the non-priority lanes, thereby defeating the purpose of an HOV lane.

Project Length

On the Fort Worth freeways where HOV lanes might be implemented, the lanes will be 10 to 25 kilometers in length. Most of the concurrent flow projects implemented to date, however, have been relatively short (less than 6 kilometers long) bottleneck bypass lanes.

The longer concurrent flow lanes have been much more controversial and subject to termination. Public pressure resulted in the termination of the project on the Santa Monica Freeway in Los Angeles (20 kilometers). The Southeast Expressway project in Boston (13 kilometers) was terminated as a result of public pressure, as was the Garden State project (18 kilometers) in New Jersey. The I-95 project in Miami (11 kilometers) has experienced a 30 to 40 percent violation rate after the carpool definition was reduced to 2+.

In summary, while there is some successful experience nationwide in concurrent flow lane implementation of the length that would exist on a Texas freeway, experience suggests this application of the concept warrants careful consideration.

Operational Concerns

A concurrent flow lane may result in a significant speed differential between two adjacent lanes. Research suggests that, once the speed differential exceeds 25 kph, a safety problem may result.

Concurrent flow lanes usually have continuous access and egress, with high- and low-speed traffic continuously merging with each other. Some of this activity can be managed using designated access and egress points. Openings in the painted buffer would decrease and focus the merging activity and improve operations.

A user of a concurrent flow lane, implemented on a six- to eight-lane Texas freeway, would have to weave across three to four mixed-flow lanes to enter the priority lane and then weave back across those lanes to exit the freeway. In addition to the obvious safety problems this situation poses, the vehicle would spend approximately three kilometers of its trip length simply getting into and out of the lane. Thus, the lane would only be attractive in serving relatively long trips.

Since no shoulder would remain if the lane were implemented by taking away the shoulder, enforcement of the lane can also be difficult. Violations have been an ongoing problem on all concurrent flow projects, and police have found enforcement to be difficult. Dedicated enforcement locations can provide a protected area to monitor the lane and issue citations.

A safety study conducted by the Federal Highway Administration (4) found that, of the five projects evaluated, all but one experienced an increase in accident rates following concurrent flow lane implementation. The study further concluded that concurrent flow is "one of the most hazardous priority treatments" and "it may be preferable to use other priority treatments."

Conclusions

Concurrent flow lanes can be an effective means of providing priority treatment through short (less than 6 kilometers) bottleneck areas. It is essential that an effective termination treatment be provided. The concurrent flow lane that operated on I-45 in Houston is evidence that, under special circumstances (i.e., it is connected to a separated HOV lane downstream), these lanes can be "successful."

In general, as a major line-haul priority measure, this treatment is inferior to other forms of HOV treatment. Enforcement, safety, and operational problems can be expected, and, as a minimum, at least sections of inside shoulder should exist after implementation of the lane for both safety and enforcement reasons. Of perhaps a greater concern, however, is the political and public opposition these lanes can generate. One bad experience with this type of project could "undo" much of what has been done to date to develop public support for HOV priority treatment in Texas.

The Stemmons and LBJ Freeway HOV projects in Dallas will provide an opportunity to test some of the concerns regarding long concurrent flow HOV lanes in Texas. The lanes include a relatively high level of concurrent flow lane design treatment with a 5.0 to 5.5-meter wide HOV envelope, designated access and egress locations, special enforcement sites, direct connection ramps and a buffer between HOV and general purpose traffic. The experience of these projects, which will begin operation in 1996, should be of great assistance to the planning of any similar HOV lanes in Fort Worth.

COST EFFECTIVENESS OF HOV IMPROVEMENTS

High-occupancy vehicle facility planning and operational experience indicate that two major considerations exert the greatest impact on HOV lane cost effectiveness: traffic congestion on the freeway and travel patterns on the freeway. Intense traffic congestion must exist on the freeway in order for the HOV lane to offer a significant travel time advantage. Transit is best suited for serving concentrated trip patterns to a major activity center, such as the downtown area. Thus, as the number of trips on a freeway destined to a major activity center(s) increases, potential utilization of an HOV lane also increases.

Previous research (4) has quantified some of the values associated with the cost-effectiveness for HOV improvements. Table 8 provides relative benefit/cost (B/C) ratios for various HOV alternatives when the adjacent freeway operates at a specific level-of-service. These B/C ratios emphasize that severely congested (level-of-service E or F) freeway operations are needed before HOV lanes may be cost effective. The ratios provided in Table 8 are based on a generalized analytical procedure representing typical conditions and will vary according to specific corridor characteristics. This analysis does indicate, however, that freeway corridors with adequate capacity are not candidates for significant HOV treatments.

Table 8. Typical HOV Facility Cost Effectiveness

HOV Alternative	Typical Cost per Kilometer ($1000)	Planning Level Benefit/Cost Ratio	
		LOS D	LOS E or F
Exclusive Reversible	3,100	0.7	1.7
Contraflow Lane	900	0.8	2.0
Concurrent Flow Lane	1,200	0.5	1.3
Freeway Control with Priority Entry	100	1.2	2.1

Source: Reference 4

IV. LOCAL INSTITUTIONAL ISSUES

The Texas Transportation Institute conducted an assessment of HOV projects in North America. One of the major elements of this assessment was the detailed examination of selected HOV facilities in six cities or regions including Houston, Texas; Minneapolis-St. Paul, Minnesota; Orange County, California; Pittsburgh, Pennsylvania; Seattle, Washington; and Washington, D.C./Northern Virginia. An intent of the case study analysis was to provide an examination of the history, institutional arrangements, operating characteristics, utilization rates, and impact of selected HOV projects in different parts of the country. This section presents the conclusions of the analysis of institutional arrangements performed for that research project (5). They provide a framework for the development of HOV facilities in Fort Worth.

SUMMARY OF COMMON ELEMENTS

The assessment of the history and institutional arrangements associated with HOV projects in the case study sites identified a number of common elements. While these were not present in all case studies to the same degree, the elements occurred often enough to represent common features that appear to be significant in the decision-making process and the development of HOV projects. The major similarities noted among the case study projects are outlined in this section. The first elements identify common characteristics that led to the decision to implement the HOV facilities, while the later elements relate to similarities during the development of the actual projects. Table 9 provides a summary of the characteristics common to many projects.

Table 9. Important Factors in the Development of the Case Study HOV Projects

Features Common to Multiple Projects	Case Study Sites					
	Houston	Minneapolis	Orange County	Pittsburgh	Seattle	Washington, DC
Decision Making Process						
Intense congestion in corridor	X	X	X	X	X	X
Lack of agreed upon fixed-guideway transit plan	X	X	X		X	X[1]
Planned or scheduled highway improvement	X	X	X	X	X	X
Project champion within implementing agency	X	X	X			
Legislative or policy direction		X	X			X
Implementation Process						
Lead agency in implementation	X[2]	X	X	X	X	X
Interagency Cooperation	X	X	X	X	X	X
Joint funding	X	X	X	X	X	X
Support of federal agencies, including funding	X	X	X	X	X	X
Flexibility and adaptability	X	X	X	X	X	X

[1]In the I-66 corridor, the Washington Metropolitan Transit Authority adopted a plan in 1968 which included a Metro line in the median of I-66 for a portion of the corridor.
[2]The development of the Houston transitways can best be described as multi-agency projects requiring multi-agency decisions.

Source: Reference 5

COMMON CHARACTERISTICS IN THE DECISION-MAKING PROCESS

Corridor and Areawide Characteristics

All of the case study sites are located the top 20 population areas in the United States. In addition, the HOV projects are all located in major travel corridors. In all cases, the metropolitan areas and the specific corridors were experiencing significant growth in travel demand at the time the HOV projects began to be considered. The need for major improvements had been identified in all the corridors, and, in many cases, the examination of alternatives and the development of detailed plans had been initiated. HOV facilities became one of the alternatives examined to address the anticipated travel demand, and ultimately emerged as a major element of the final recommendation.

An awareness of the need to address increasing traffic congestion problems in the corridor had developed.

Lack of a Fixed-Guideway Transit Plan for the Corridor

Another similarity among the case study sites was the lack of an agreed upon or approved long-range fixed-guideway transit plan for the corridor. An approved fixed-guideway transit plan did not exist for most of the case study corridors at the time consideration of an HOV alternative was initiated. In many instances there was disagreement among different agencies over the role transit should play in the corridor and the technology that should be used. In some cases there had been an ongoing debate over this issue.

In addition, in some instances, such as in Seattle, Houston, and Minneapolis-St. Paul, the lack of consensus over the role of transit and the technology to be used applied not just to the corridor, but to the metropolitan area as a whole. In these cases, the debate, which continues today, relates to the implementation of a rail transit component as one element of the overall public transportation system. Thus, in some areas, the HOV alternative appears to have gained support in response to the lack of consensus on rail alternatives.

No decision had been made on the development of a fixed-guideway transit system in the corridor where the HOV facility was ultimately developed.

Planned or Scheduled Highway Improvements

Some types of highway improvements were either planned or scheduled in most of the corridors where the HOV projects were eventually built. These ranged from major new freeways, such as I-394 in Minneapolis, I-66 in northern Virginia, and I-90 in Seattle, to pavement rehabilitation projects such as Katy (I-10) in Houston and Route 55 in Orange County.

Thus, consideration of the HOV project was often initiated as one approach to increasing the person-movement capacity of the roadway facility. Once the decision had been made to include the HOV element, coordinating the planning, design, and construction of both the freeway and HOV elements maximized available resources and minimized disruptions to the traveling public.

HOV projects in many of the case study sites were considered and implemented as part of highway improvement projects. These ranged from new freeway facilities to pavement rehabilitation projects. This coordination helped maximize available resources and minimize the impacts of implementation on the traveling public.

Project Champion or Champions

One individual, or a small group of individuals, was identified in most of the case studies as being instrumental in the development, promotion, and support of the HOV project. These were individuals, usually within the state transportation department, highway department or local transit agency, that had the authority and position to influence the outcome of the process. The support of these individuals was identified as a major reason for the development of the projects in many of the case study areas. These individuals reflected a willingness to try new and innovative approaches to dealing with growing traffic congestion problems and to move the projects forward. As many of the projects represented the first uses of the different types of HOV facilities in the country, some risk was associated with their implementation.

Individuals in positions of authority in highway and transit agencies supported the HOV project concept and promoted it through the project development and implementation process.

Legislative Direction and Policy Support

Legislative or policy directives supported the consideration of HOV facilities in many of the case study sites. This took the form of policy directives from the federal level on the I-66 facility in northern Virginia and the state level on I-394 in Minneapolis. In other areas, local and regional agencies, such as the metropolitan planning organization, supported the HOV concept. These legislative or policy directives assisted in ensuring that HOV facilities were one of the alternatives considered in the planning process and supported the implementation of the ultimate recommendation. The involvement of Congress and federal agencies in the many aspects of planning, design, and operation of the HOV facilities in the northern Virginia/Washington, D.C. area represents a unique feature not found in the other case study sites.

Legislative or agency policies and directives played an important role in the decision-making process in some of the HOV case study projects.

COMMON CHARACTERISTICS IN THE IMPLEMENTATION PROCESS

Lead Agency

In general, the agency responsible for making the decision to proceed with the development of the HOV project also had the overall responsibility for implementing the project. In these cases, the state department of transportation or the state highway department was responsible for construction of the actual facility. Transit agencies have also been involved in different aspects of many of the case study HOV projects. Thus, while the state department of transportation or highway department usually took the lead role, other agencies were actively involved in the process.

The Houston transitways can best be described as multi-agency projects requiring multi-agency decisions. The Houston Office of Public Transit, the predecessor agency to the Metropolitan Transit Authority of Harris County (METRO), was the lead agency in the initial contraflow demonstration project. However, on this and subsequent HOV projects, extensive agreements between METRO and TxDOT were used to identify the roles, responsibilities, and financial participation of the two agencies.

Most of the HOV case study projects utilized some type of project management team or coordinating group. These groups usually included representatives from the state highway or transportation department, the transit agency, the enforcement agency, and local jurisdictions.

One agency, usually the state department of transportation, or highway department, had overall responsibility for implementing the HOV project. However, transit and other agencies were often involved in some aspects of planning, designing, and, in a limited number of cases, financing the projects.

Interagency Cooperation

All of the HOV projects in the case study sites involved some degree of interagency cooperation. The exact nature and level of this involvement varied substantially between projects. Many of the HOV projects used some type of interagency coordination structure, such as a project management team. These coordinating groups were identified as an important component to ensuring that all groups were adequately involved in the implementation process.

This coordination was noted as especially important due to the unique nature of the HOV projects and the need to involve highway, transit, enforcement, and other groups in the process. In most cases, these committees were actively involved in many aspects of the planning, design, implementation, and operation of the facilities. Representatives from all the relevant agencies, jurisdictions, and groups associated with the HOV projects participated in these committees. In addition, in a number of the case study sites, the Metropolitan Planning Organization (MPO) was actively involved in the process and openly supportive of the HOV project.

Interagency cooperation, including the use of multi-agency project management groups, played an important part in the coordinated implementation of most of the case study HOV projects. Thus, on the HOV case study projects, agencies that historically may not have worked together developed close working relationships.

Joint Funding

Many of the HOV projects in the case study sites used a variety of funding sources. Different combinations of funds from the federal Highway Administration (FHWA), Urban Mass Transportation Administration (UMTA), and state and local highway and transit agencies were often used. In addition, many areas, such as Houston and Minneapolis, used a variety of funding approaches and institutional arrangements to develop the HOV projects.

Multiple funding sources and innovative financing approaches were utilized with some of the case study HOV projects.

Support of Federal Agencies

The Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) were supportive of the HOV projects in the case study sites. This involvement included providing funding for initial demonstration programs, construction of the HOV lanes and supporting elements, research and evaluation programs, participating in project management teams, providing technical assistance, and providing policy guidance.

Support from FHWA and FTA was evident, although in different degrees, in the development of many case study HOV facilities.

Flexibility and Adaptability

All the case studies seem to indicate that flexibility and the ability to adapt to change were important elements in both the development and ongoing operation of the HOV facilities. For example, almost every project has experienced some change in the operating requirements of the HOV facility. These changes have been the result of both experience and policy directives. In either case, the need to maintain flexibility to respond to changing travel demands and policies appears to be an important element of the HOV projects in the case study sites.

HOV projects provide flexibility to respond to changing travel demands, needs, and policies. Changes in operating policies have occurred in most of the case study sites.

CONCLUSIONS OF NATIONAL STUDY OF INSTITUTIONAL ARRANGEMENTS

The following ten features, common to all or most of the case studies, are significant in the development of HOV projects.

Decision-Making Process

- Corridor and areawide traffic congestion and growth in travel demand.
- Lack of agreed upon fixed-guideway plan for the corridor.
- Planned or scheduled highway improvements.
- Project champion or champions in positions of authority.
- Legislative direction and/or agency policy support.

Implementation Process

- Lead agency.
- Interagency cooperation.
- Joint funding.
- Support of federal agencies.
- Flexibility and adaptability.

SUMMARY OF FORT WORTH AREA INSTITUTIONAL ISSUES

Many of the factors identified in the case studies are also present in Fort Worth travel corridors. The following discussion represents the current state of decision-making and implementation issues related to HOV facilities in Fort Worth.

Decision-Making Process

Traffic Congestion and Travel Growth

While there are some sections of freeway with significant traffic congestion, planned construction will eliminate some of these bottleneck areas. General purpose freeway lane expansions are also necessary to handle off-peak period travel demand in some areas. A separate report of this study examines this issue in detail, but, in general, a serious traffic congestion problem is not projected on most freeways in the Fort Worth area.

Lack of a Fixed-Guideway Plan

The Fort Worth Transportation Authority (the "T") currently has no scheduled light or heavy rail project in any corridor. There will be a commuter rail line implemented in the Railtran corridor between the Fort Worth CBD and the Dallas CBD via the DFW Airport area. The lack of committed areawide transit guideway plans, however, may mean that high-occupancy vehicle facilities can be included in corridor major investment studies.

Planned Freeway Improvements

In some corridors, notably portions of I-35W South and I-30 West, the freeway has been widened and safety improvements made. There are other corridors where reconstruction activities will improve the safety and pavement condition of older freeways. These corridors may provide opportunities for HOV lanes to be constructed during the pavement and safety upgrades. There may be different time schedules for the needs of pavement or safety improvement and the need for HOV lanes to address traffic congestion problems. The challenge for transportation planners will be to identify those corridors where the needs coincide and plans for corridors where they do not.

Project Champion

The North Central Texas Council of Governments (NCTCOG) Mobility Plan identifies HOV improvements as an element of the 2010 transportation system in two corridors in Fort Worth, SH 183 and I-30. As improvement analyses move forward in these corridors, both

TxDOT and the "T" may want to identify individuals that are responsible for the development of HOV alternatives for each corridor.

Legislative Direction and Policy

The Clean Air Act Amendment requirements for the Dallas-Fort Worth area have made HOV facilities a more prominent part of the alternative analysis process in many corridors. The Intermodal Surface Transportation Efficiency Act emphasis on person movement, enhanced mobility and multimodal improvements also increases the likelihood that HOV lanes will be included in corridor designs.

Recognize, however, that most HOV lanes have been implemented in cities with greater overall congestion levels than Fort Worth. HOV improvements may, therefore, be a smaller part of the transportation system improvement program in Fort Worth than they will be in Dallas.

IMPLEMENTATION PROCESS

Lead Agency

The agency responsible for developing, designing and constructing HOV lanes in Houston and Dallas has varied by project. Usually, TxDOT is responsible for construction as part of the freeway mainlane construction, but most other roles have not been performed by the same agency in all projects. The exception to this has been operation of the HOV lanes, which has always been the responsibility of the transit agency.

The problem with extending the experience for these historical arrangements to the Fort Worth situation is the service area of the "T" and the direction of travel for long distance trips that are most conducive to HOV lane implementation. The service area of the "T" extends to the city limits of Fort Worth, but does not include the cities of Arlington, Bedford, Euless, Hurst and others which are a sufficient distance away from the Fort Worth CBD for usage of park-and-ride lots and other transit services to be successful.

Congestion in the SH 183 and I-30 corridors relates principally to travel to the Dallas CBD for the portion of these freeways east of I-820. West of I-820 there may be sufficient congestion toward the Fort Worth CBD to make an HOV lane successful, but the distance (approximately 8 kilometers) is on the low end of length needed to develop sufficient time savings.

Remedies to these problems lie in changes to the existing relationships between agencies and the jurisdictions or responsibilities of each agency. For instance, the "T" could operate park-and-ride service and HOV lanes in areas outside their service area, or TxDOT could operate the HOV lane.

Interagency Cooperation

The development and operation of a successful HOV lane requires several agencies to work together. The "T" and TxDOT might be involved in any project, but the cities and enforcement agencies should also be part of the project development team from a relatively early stage. Such working relationships are being formed in signal interconnection programs and incident management efforts. The construction and operation of an HOV lane could also benefit from this institutional cooperation.

Joint Funding and Federal Agency Support

With the ISTEA and Clean Air Act legislation and the emphasis on multimodal decision making and project funding, many projects are eligible for funding on a "cross-modal" basis. The blending of highway and transit funds that have characterized HOV projects in the past are now encouraged for a range of projects. These funds may come from the federal, state and/or local levels; the important point is that the money is available. The Clean Air Act regulations recognize HOV lanes as a viable transportation control measure that will lead to reduced vehicle travel and increased vehicle occupancy rates. These aspects are important criteria for funding and project development decisions in the Dallas-Fort Worth area.

Flexible and Adaptable

HOV lanes have been modified and expanded for almost a decade in Houston. As congestion has developed in parts of corridors, the HOV system has been extended to those portions of freeways. Improved access points and modified operations on the Katy HOV lane have addressed congestion concerns.

The same type of process is possible in Fort Worth. A relatively low cost HOV treatment with a high probability of success could be developed as the first demonstration of the HOV technology. Enhancements and additional lanes could follow as they become feasible and justified. HOV lanes can be constructed and operated in portions of corridors where mixed-flow improvements cannot alleviate congestion, without developing a dedicated roadway in uncongested portions of the corridor.

V. CONCLUSIONS AND RECOMMENDATIONS

This technical memorandum is one of two prepared for the Texas Department of Transportation Fort Worth District. This memorandum provides an overview of the HOV technology and the experience with HOV operations in Texas. The companion memorandum summarizes the analysis of corridor congestion levels. The application of this experience to Fort Worth freeway corridors leads to several recommendations for HOV development in the near future.

- The current North Central Texas Council of Governments Mobility Plan includes HOV lanes on I-30 and SH 183 in Tarrant County. The NCTCOG analysis indicates, however, that these lanes will serve Dallas commuters, rather than Fort Worth commuters. There are no HOV lanes in the NCTCOG plan west of I-820, although an extension of the SH 183 HOV lane may be constructed on north I-820. The institutional arrangements used in Houston and Dallas to operate the HOV lanes are not consistent with this situation. The "T" would have to operate an HOV lane in areas that are not in its service area or TxDOT would have to operate these HOV lanes. Neither of these approaches have been used in Texas.

- HOV lanes are dependent on freeway congestion to encourage travelers to consider bus and carpool usage. This type of congestion is not projected for the freeways in Fort Worth for several years. The aggressive freeway and street construction that is being completed by the Texas Department of Transportation in Tarrant County has been successful in addressing the travel needs in several corridors for the next decade or more.

- Several Fort Worth area freeway improvement projects are in the planning or design stage. It is desirable to examine these projects to determine if design changes can be made to enhance HOV implementation either concurrent with the general freeway project, or at a later date. Experience has shown that there are usually some opportunities to make HOV construction easier and less expensive if relatively minor changes can be incorporated during design of the freeway.

- As with any new technology, it would be desirable for the first HOV project in Fort Worth to have a high probability of success. While other factors such as construction schedules and funding have a significant impact on project construction, the first HOV project should be in a congested corridor with significant transit ridership. If the initial corridor is a success, other HOV projects that are more experimental may be viewed more favorably if usage is not high in the first month of operation.

The information contained in the reports prepared for the Fort Worth District identify the priority corridors and the important issues that need to be resolved during the project analysis and justification process. The reports do not identify specific design or operational treatments nor do they recommend HOV facilities for individual corridors. The reports should be thought of as only an initial step in the HOV planning process and a checklist of key issues that need resolution during that analysis.

VI. REFERENCES

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