Maximizing the Benefits of HOV Facilities:

Reassessing Lane Eligibility and Hours of Operation

U.S. Department of Transportation
Federal Highway Administration

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Acknowledgments

This primer is based on the findings of the High-Occupancy Vehicle Pooled-Fund study, which was conducted in cooperation with staff from the Federal Highway Administration (FHWA) and the participating State transportation agencies. As project director, Neil Spiller, Office of Transportation Management, provided guidance throughout the study.

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Chapter One
Introduction

This primer presents basic information about high-occupancy vehicle (HOV) facilities and their ongoing management. It outlines processes for monitoring and evaluating performance, and assessing and changing the requirements for vehicle eligibility, vehicle occupancy, and lane operating hours for different lane configurations. Case studies from around the United States illustrate the guidelines presented.

Development of the Primer

The contents of the primer were drawn from the *HOV Lane Eligibility Requirements and Operating Hours Handbook*, which was developed through the HOV Systems Pooled-Fund Study group and the Federal Highway Administration (FHWA). Participating State transportation agencies include California, Georgia, Maryland, Massachusetts, Minnesota, New Jersey, New York, Tennessee, Virginia, and Washington. The handbook contains specifics on the strategies outlined in the primer, as well as a complete glossary and resource section.

The goal of the HOV Pooled-Fund Study is to assemble regional, State, and local agencies with FHWA to identify issues that are common among agencies, suggest projects and initiatives, select and initiate projects, disseminate results, assist in solution deployment, and track innovations and practice. Other handbooks of use to transportation professionals and policy makers sponsored by the HOV Pooled-Fund Study group include the *HOV Performance Monitoring, Evaluation, and Reporting Handbook*; the *HOV Lane Safety Considerations Handbook*; and the *HOV Lane Enforcement Handbook*. More about the activities and products of the Study group is available at http://hovpfs.ops.fhwa.dot.gov.

Contents of the Primer

The Executive Summary presents an overview of HOV facilities and their relationship to other elements of the transportation system. It highlights the topics presented in the primer: managing the operation of HOV lanes and assessing vehicle-eligibility requirements, vehicle-occupancy levels, and HOV operating hours. Each of these topics is addressed in a later chapter. In the final chapter, case studies that illustrate operational strategies from the preceding chapters are presented.

The primer is intended to meet the needs of agency management personnel, policy makers, and others who are interested in the effective and efficient operation of HOV lanes. Transportation professionals responsible for planning, operating, enforcing, and managing HOV facilities may also benefit from the primer.

Chapter Two
Executive Summary

A key to the successful management of HOV facilities is to involve staff from all appropriate agencies and groups in the development of an operation and enforcement plan and in the ongoing monitoring project. These participants may include FHWA, the Federal Transit Administration, public transportation agencies, law enforcement agencies, metropolitan planning organizations, regional rideshare agencies, the judicial system, and local jurisdictions. In many areas, the State Department of Transportation is the lead agency and is responsible for organizing, staffing, and chairing the multi-agency project management team.

This chapter provides an overview of HOV facilities and highlights the topics presented in the primer. The overview of HOV facilities addresses the roles of HOV lanes and the types of facilities in operation, Federal interest in HOV operations, vehicle-eligibility and vehicle-occupancy requirements, and typical operating hours.

Chapter 2 is intended primarily for agency management personnel and policy makers. It also provides a useful overview for technical staff. More detailed information and case studies related to each of the topics listed is presented in subsequent chapters.

Defining HOV Facilities

HOV facilities represent one approach used in metropolitan areas throughout the country to help improve the people-moving capacity, rather than vehicle-moving capacity, of congested freeway corridors. HOV facilities are developed and operated to provide buses, carpools, and vanpools with travel-time savings and more predictable travel times to encourage individuals to choose shared rides over driving alone. Today there are some 130 HOV freeway projects in the 31 metropolitan areas in North America. HOV facilities are usually found in heavily congested corridors where the physical and financial feasibility of expanding the roadway is limited. Supporting services, facilities, and incentives are also used to further encourage individuals to carpool, vanpool, or ride the bus.

HOV facilities on freeways or in separate rights-of-way are typically classified into four categories described below and illustrated in Figure 1:

- Busway or exclusive HOV facility with separate right-of-way—a roadway or lane(s) developed in a separate right-of-way and designated for exclusive use by HOVs.
- Exclusive HOV facility with freeway

Exclusive Flow

Concurrent Flow

Busway

Contraflow

Figure 1. Categories of HOV facilities.

right-of-way—one or more lane(s) constructed within the freeway right-of-way that is physically separated from the general-purpose freeway lanes and used exclusively by HOVs for all or a portion of the day.

- Concurrent flow HOV lane—a freeway lane in the peak direction of travel, not physically separated from the general-purpose freeway traffic lanes, designated for the exclusive use by HOVs for all or a portion of the day.
- Contraflow HOV lane—a freeway lane in the off-peak direction of travel, commonly the inside lane, designated for exclusive use by HOVs traveling in the peak direction.

Managing HOV Lanes

Federal funding is typically used to support the design, right-of-way acquisition, construction, and operation of freeway HOV lanes. FHWA provides periodic HOV program guidance to support the Federal investment in freeway HOV facilities and to help promote their effective use, while maintaining the intent of maximizing person-movement capacity. The guidance supports performance monitoring programs, which provide the information needed to make sound decisions on operating HOV facilities.

The State Department of Transportation (DOT) or the State Highway Department is usually the lead agency involved with managing the operation of HOV lanes. These agencies have overall responsibility for HOV lanes, including developing the operation and enforcement plan, conducting performance monitoring, and assessing potential changes in operations.

Assessing Vehicle-Eligibility Requirements

HOV facilities are designed and operated to provide travel-time savings and trip-time reliability to vehicles that meet occupancy requirements in order to encourage individuals to use shared rides over driving alone. In an attempt to maximize the use of HOV facilities and to meet other goals, operating agencies in some areas have expanded HOV lane use to include high-occupancy toll (HOT) vehicles, low-emission and energy-efficient vehicles, and other exempt vehicles not meeting occupancy requirements. Information from an HOV performance monitoring program can be used to identify potential issues or concerns with current vehicle-eligibility requirements.

Assessing Vehicle-Occupancy Requirements

The vehicle-occupancy requirement should be maintained at a level that will encourage use of the facility and the formation of new carpools, but that will not create a demand level that would make the lane congested. During the late 1970s and early 1980s, FHWA specified that carpools must have three or more (3+) passengers in order to travel on HOV projects funded through Federal programs. The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) defines the occupancy requirement for use of HOV lanes as no fewer than two occupants (2+) per vehicle, with exceptions for specific exempt vehicles. The majority of HOV lanes open to carpoolers have a 2+ occupancy requirement. Although no HOV facility currently requires four or more (4+) occupants, this level has been used in the past. Changes in vehicle-occupancy levels may be needed over the life of an HOV facility. Another approach is to change the HOV occupancy requirement by time of day in response to congestion that occurs in the HOV lane during peak hours.

Assessing HOV Operating Hours

Four operating-hour scenarios are typically used with HOV facilities:

- 24/7—continuous operation at all times.
- Extended hours—a major portion, but not all, of the day.
- Peak-period-only—more narrowly defined than extended hours.
- Special events–extra hours to assist with traffic management during a special event or other planned activity.

Each of the topics presented in this chapter is discussed in greater detail with explicatory case studies in subsequent chapters.

Chapter Three
Managing HOV Lanes

FHWA provides periodic HOV program guidance to support the Federal investment in freeway HOV facilities and promote their effective use. Program guidance and other recent information on Federal activities related to HOV facilities are available on the FHWA Internet site at http://www.fhwa.dot.gov/legsregs/directive/policy/index.htm. The program guidance outlines the Federal review requirements related to air quality conformity, the State implementation plan, the congestion management system, the environmental policy process, and other issues. Additional information on HOV management can be found at FHWA's freeway management site: http://ops.fhwa.dot.gov/freewaymgmt/hov.htm.

This chapter discusses managing the operation of HOV lanes. It summarizes Federal interest in HOV operational changes and highlights the roles and responsibilities of the agencies typically involved in managing HOV lanes.

Federal Interest in HOV Operational Changes

Federal funding is typically used to support the design, right-of-way acquisition, construction, and operation of freeway HOV lanes. FHWA provides periodic HOV program guidance to support the Federal investment in freeway HOV facilities and to help promote their effective use, while maintaining the intent of maximizing the person-movement capacity. The guidance supports performance monitoring programs, which provide the information needed to make sound decisions on operating HOV facilities.

A Federal review is required when significant changes are proposed to existing HOV facilities constructed with Federal funds. Significant changes include: major alterations in operating hours and converting an HOV lane to general-purpose use. Minor modifications in operating hours and changing from different multi-person occupancy levels do not require Federal approval. FHWA program guidance requires the following information to be included as part of a Federal review:

- Original studies and plans for the HOV facility.
- Project agreements.
- Commitments made in the environmental process.
- Operational assessments.
- Analysis of future conditions.
- Examination of alternative operating scenarios.
- Possible impacts on air quality levels and plans.

In addition, SAFETEA-LU contains a number of provisions related to HOV lanes, including requirements for monitoring, evaluating, and reporting on the use of HOV lanes by certain exempt vehicles.

Agencies Involved in Managing the Operation of HOV Lanes

The State DOT or the State Highway Department is usually the lead agency involved with managing the operation of HOV lanes. These agencies have overall responsibility for HOV lanes, including developing the operation and enforcement plan, conducting performance monitoring, and assessing potential changes in operations. Public transportation agencies, law enforcement agencies, metropolitan planning organizations, local jurisdictions, rideshare organizations, and Federal agencies typically play important supporting roles in managing freeway HOV lanes and assessing possible changes in vehicle-eligibility requirements, vehicle-occupancy levels, and operating hours. The typical roles and responsibilities of these agencies are highlighted in Table 1.

Link to HOV Performance Monitoring

Managing the operation of HOV lanes requires accurate information about the performance of the lanes, the general-purpose freeway lanes, and other supporting services and facilities. Thus, there is a close link between monitoring and evaluating HOV facilities and proactively managing

Table 1. Agencies Involved in Managing the Operation of HOV Lanes

Agency or Group	Potential Roles and Responsibility – Operations
State DOTs	Overall project management. Lead in developing operation and enforcement plan. Operate facility and manage operations. Performance monitoring. Assess potential operating changes. Staff multi-agency team or committee.
Public transportation agencies	Support role or overall project management on bus-only projects. Participate in multi-agency teams. Assist with operation and enforcement plan, managing operations, performance monitoring, and assessing changes. Bus operations.
State and local law enforcement agencies	Assist with development of operation and enforcement plan. Responsible for enforcement. Coordinate with judicial personnel. Participate on multi-agency teams.
Cities and counties	Support role with freeway HOV facilities. May have overall project management with arterial projects. Develop or assist with operation and enforcement plan. Operate arterial HOV lanes. Staff multi-agency team or participating on team.
Rideshare agencies	Assist with development of operation and enforcement plan, performance monitoring, managing operations, and assessing changes. Participate on multi-agency teams.
MPOs	Assist in facilitating meetings and multi-agency coordination, data collection, and analysis. May have policies relating to HOV facilities.
Federal agencies: FHWA and FTA	Implement Federal legislation. Policies related to managing HOV lanes. Participate on multi-agency teams. Funding support.
Other groups	Judicial system – State and local courts. Emergency medical services, fire and other emergency personnel. Tow truck operations. Traffic information service providers. State legislatures and policy makers.

the operation of HOV lanes. The *HOV Performance Monitoring, Evaluation, and Reporting Handbook* provides a complete guide to developing and conducting HOV performance monitoring programs, which are critical for assessing the impacts of possible changes in vehicle-eligibility requirements, vehicle-occupancy levels, and operating hours.

HOV performance monitoring programs follow the same process used to evaluate any transportation project. As illustrated in Figure 2, the first step in the process is to identify the goals and objectives for the HOV facilities in an area. These goals and objectives should flow from those articulated in State, metropolitan, and local transportation policies and plans. Measures of effectiveness are then identified for each objective, along with the corresponding data requirements. Data collection efforts are undertaken and the results are processed and analyzed. The results of the monitoring and analysis process are reported to the various stakeholder

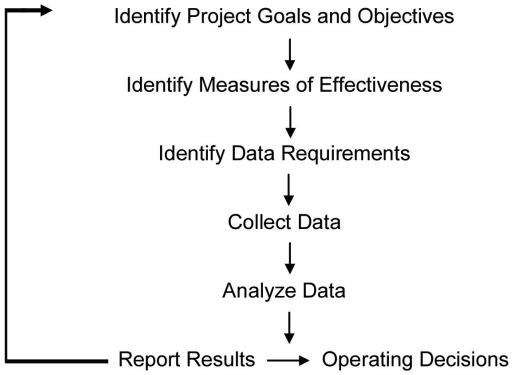

Figure 2. HOV performance monitoring programs process.

groups through a variety of methods. The results are used to make operating decisions, to determine if the project objectives are being met, and to enhance future planning activities and investment decisions.

In addition, minimum and maximum HOV lane operating thresholds may be established as part of a performance monitoring program, operations plan, or highway performance monitoring program. These thresholds provide guidance for determining if changes in the operation of an HOV lane need to be considered. Table 2 presents elements for developing guidelines on minimum and maximum operating thresholds for HOV lanes.

Link to HOV Operation and Enforcement Plans

Developing and using an HOV operation and enforcement plan, along with a performance monitoring program, forms the basis for proactively managing the operation of an HOV lane. The following elements, which are discussed in greater detail in subsequent chapters, are commonly found in an HOV operation and enforcement plan:

- HOV operational alternatives.
- Ingress and egress.

Table 2. Elements for Developing Guidelines on Minimum Operating Thresholds for HOV Lanes

Possible Elements	Comments/Possible Minimum Thresholds
Goals and objectives of project	The goals and objectives of a project may influence the minimum operating thresholds. For example, a project intended to give buses priority around a congested freeway segment could be expected to have a lower threshold than an exclusive HOV lane. Local policies on carpool definitions or other elements may also influence the operating thresholds and should be considered in developing local guidelines (see State DOT Guidelines).
Type of HOV facility	The type of HOV facility will probably have the most influence on developing local minimum operating guidelines. The following general levels provide an indication of the national experience and can be used in developing local guidelines. Separate right-of-way, bus only – 200-400 vphpl Separate right-of-way, HOV – 800-1,000 vphpl Freeway, exclusive two-directional – 400-800 vphpl Freeway, exclusive reversible – 400-800 vphpl Freeway, concurrent flow – 400-800 vphpl Freeway, contraflow, bus-only – 200-400 vphpl Freeway, contraflow, HOV – 400-800 vphpl HOV bypass lanes – 100-200 vphpl
Vehicle-eligibility requirements	Lower minimum vehicle thresholds can be expected, and are usually accepted, with bus-only facilities than with facilities open to buses, vanpools, and carpools.
Vehicle-occupancy requirements	Lower minimum vehicle thresholds can be expected with higher vehicle-occupancy requirements.
Level of congestion corridor	The minimum vehicle threshold may be higher in a heavily congested corridor than in one with lower levels of congestion. Nonusers in heavily congested areas may be much more vocal about a facility they feel is underutilized than commuters in a corridor where congestion is not at serious levels.
Local conditions and perceptions	The perceptions of commuters and the public, as well as any unique local conditions, should be considered in developing minimum operating thresholds. Regional norms are also a factor.

vphpl = vehicles per hour per lane

- Vehicle-eligibility and vehicle-occupancy requirements.
- Transit facilities and services.
- Hours of operation.
- Enforcement.
- Public information and voluntary enforcement.
- Incident management.

Possible Issues With Managing the Operation of HOV Facilities

The following are possible issues that may arise with managing the operation of HOV facilities:

- Demand exceeding capacity at a 2+ vehicle-occupancy requirement.
- Not enough vehicles at a vehicle-occupancy requirement of 3+.
- Exempt vehicle demand exceeding capacity.
- Bottleneck caused before start or end of HOV period.
- Use of lanes by unauthorized vehicles.
- Special event needs.
- Adjustments needed to operating hours.
- Access controls.

Possible approaches for addressing these concerns are identified in subsequent chapters.

Process for Assessing Possible Changes in HOV Lane Operation

The process for assessing possible HOV operating strategies should be similar to the one used to plan a project and should emerge from an established monitoring program. Information on vehicle and passenger volumes, travel speeds, travel-time savings, violation rates, and crashes should form the basis of an ongoing monitoring and evaluation program. This information can be used to identify possible problems and potential changes in the operation of an HOV facility. Figure 3 shows the key elements in the process for assessing, implementing, and monitoring possible changes in HOV operations.

Information from the ongoing monitoring program should be used to identify potential operating problems, such as facilities reaching capacity or high violation rates. A good database on vehicle and passenger volumes, travel speeds, travel-time savings, violation rates, and accidents should alert agency personnel to possible problems. Regular visual monitoring of a facility, such as personnel driving the corridor or surveillance through advanced transportation management systems (ATMS) can also help identify potential problems. The next step is to identify and evaluate possible approaches to addressing these issues. The results of the evaluation are to be discussed with key stakeholder groups so that the preferred alternative can be selected and implemented. The monitoring program should continue to track the effects of the changes made in the operation of an HOV facility. The information collected through the ongoing monitoring efforts should be used to evaluate the change and to provide a feedback loop to continue to identify possible operating problems and to ensure the efficient operation of the HOV facility.

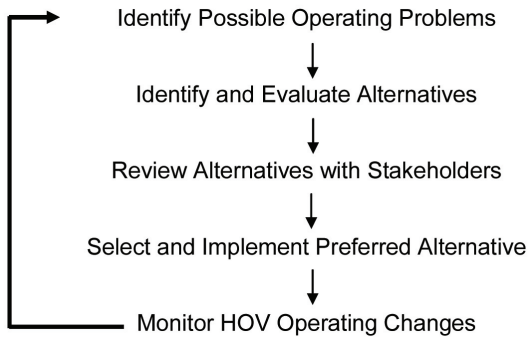

Figure 3. Key HOV operations monitoring elements.

State DOT Guidelines

Some State DOTs have developed guidelines to help identify when changes in vehicle-eligibility or vehicle-occupancy requirements may be needed. In addition, SAFETEA-LU requires that agencies responsible for operating HOV lanes conduct monitoring programs if certain exempt vehicles are allowed to use the lanes. These exempt categories include tolled vehicles and low-emission and energy-efficient vehicles. The operating agency is required to limit or discontinue use of the HOV lane by these vehicles if allowing access has degraded the operation of the HOV lane. The operation of the HOV lane is defined as being degraded if vehicles using the facility fail to maintain a minimum average operating speed 90 percent of the time over a consecutive 180-day period during the morning or evening weekday peak hour periods. The minimum operating speeds are defined as 72 km/h (45 mi/h) when the posted speed limit is 80 km/h (50 mi/h) or greater and not more than 16 km/h (10 mi/h) below a posted speed limit of 80 km/h (50 mi/h). Additional information on monitoring requirements is available in the FHWA HOV program guidance.

Chapter Four
Assessing Vehicle-Eligibility Requirements

To maximize available capacity and improve lane utilization, eligibility requirements may be expanded by, for example, permitting carpools and vanpools to use a bus-only lane or by allowing low-emission, energy-efficient, or tolled vehicles to use the HOV lane without meeting occupancy requirements.

This chapter reviews the types of vehicles usually considered for HOV facility use. Factors to consider in changing vehicle-eligibility requirements and instructions for assessing the impacts of those changes are also presented.

Vehicle-Eligibility Requirements

HOV facilities are designed and operated to provide travel-time savings and trip-time reliability to vehicles that meet occupancy requirements in order to encourage individuals to use shared rides over driving alone. In an attempt to maximize the use of HOV facilities and to meet other goals, operating agencies in some areas have expanded HOV lane use to include HOT vehicles, low-emission and energy-efficient vehicles, and other exempt vehicles not meeting occupancy requirements. Commercial vehicles or semi-trucks are not allowed to use any HOV facility in North America, regardless of the number of passengers. This restriction has been applied for safety reasons and because allowing trucks would not encourage ridesharing or reduce vehicle-miles traveled (VMT).

Table 3 summarizes the advantages and limitations associated with allowing each type of eligible vehicle to use an HOV lane.

Factors to Consider in Changing Vehicle-Eligibility Requirements

A number of factors may need to be considered in assessing possible changes in vehicle-eligibility requirements for an HOV facility. The exact factors and issues will vary by metropolitan area and by the type of change in the vehicle-eligibility requirements being considered. The following are general factors to consider:

- Project goals and objectives.
- Type and length of HOV lane.
- Design treatments or operating limitations.
- Congestion levels in the HOV lane and general-purpose freeway lanes.
- Bus operations.
- System connectivity.
- Supporting facilities and services.
- Safety.
- Enforcement.
- Perceptions of users, nonusers, and policy makers.
- Target markets.
- Impact on current users.
- Pricing alternatives.
- Cost of tolling infrastructure and strategies.
- Level and use of revenues.
- Identifying eligible vehicles.
- Potential equity concerns.
- Methods to restrict use.

Information from an HOV performance monitoring program can be used to identify potential issues or concerns with current vehicle-eligibility requirements. If there is more than one HOV facility in operation or in the planning stage in a metropolitan area, changes in vehicle-eligibility requirements on one facility may influence the operation of other HOV lanes. Consideration of uniform vehicle-eligibility requirements may be appropriate. Maintaining the same requirements on multiple facilities can improve public understanding and simplify enforcement. Uniform vehicle-eligibility requirements may not be appropriate if there are different types of HOV facilities in an area or if

Table 3. Vehicle-Eligibility Considerations

Vehicle Type	Advantages	Limitations
Vehicles Meeting Occupancy Requirement		
Buses	Highest person-moving capacity. Greatest potential for increasing corridor throughput.	May be difficult to establish or expand bus service depending on orientation of HOV lane. The lane will look unused unless there are high numbers of buses.
Vanpools and shuttles meeting occupancy	High person-moving capacity.	The lane will look unused unless there are high numbers of vanpools.
Carpools using automobiles and light trucks	Add users at no public cost. Add to person-moving efficiency. Help avoid having lane look empty. Expand potential user groups. Maximize available capacity.	Too many carpools may cause congestion in an HOV lane. May be safety concerns with some facilities. Potential equity issue when HOV requirement exceeds the capacity of small automobiles (e.g., 2-seater sports cars).
Exempt Vehicles Not Meeting Occupancy Requirement		
Designated public transportation vehicles with only driver	Enhances bus operation efficiencies.	Potential public perception problems if only operator is onboard.
Marked law enforcement and emergency vehicles	Travel-time savings and enhanced reliability to emergency vehicles.	Potential public perception problems if only operator is onboard. May lead to abuse by off-duty personnel or commuting in personal vehicle.
Motorcycles	Add vehicles to lanes. Maximize available capacity.	Potential safety concerns. Potential public perception problem.
Allocation process vehicles (stickers, etc.)	Maximize available capacity. Manage demand. Expand eligible user group. Address actual or perceived low use.	Enforcement more difficult. Time and cost to administer program. Possible confusion among users. May add too many vehicles to the facility resulting in congestion.
Value pricing and tolled vehicles	Maximize available capacity. Manage demand. Expand eligible user group. Address actual or perceived low use. Generate new revenues.	Enforcement may be more difficult. Time and cost to administer program/equipment. Possible confusion among users. May add too many vehicles to the facility, causing congestion. Potential public and policy maker concerns related to equity, double taxation, and use of revenues.
Low-emission and energy-efficient vehicles	May encourage purchase and use of low-emission and energy-efficient vehicles. Maximize available capacity.	Potential public perception problems. Enforcement may be more difficult. May cause congestion on the facility if too many vehicles are allowed. May be confusion among buyers, automobile dealers, and policy makers about which vehicles qualify.
Bicycles	Provide connections on arterial HOV lanes.	Safety concerns. Bicycles not allowed on Interstate system.

significantly different travel and mode share characteristics exist in various corridors.

Assessing Possible Changes in Vehicle-Eligibility Requirements

This section describes how the factors to be considered can be applied to assess possible changes in vehicle-occupancy requirements in connection with two change scenarios: adding other HOVs and adding priced or HOT vehicles. Each scenario has different impacts on different user groups.

Adding Other HOVs

This scenario focuses on allowing vanpools and carpools to use a bus-only freeway HOV lane or adding carpools to an HOV lane open to buses and vanpools. All of these user groups qualify as HOVs. This scenario may be considered if there is available capacity on an HOV lane that does not yet allow all types of HOVs (see Changes in Vehicle-Eligibility and Vehicle-Occupancy Requirements on the I-10 West HOV Lane in Houston in Chapter 7). The type and levels of support facilities and services may influence consideration of changes in vehicle-eligibility requirements. For example, the availability of rideshare programs may be an important supporting component. Ensuring that the HOV lane can be operated safely with the new vehicles is important. Improvements may need to be made in an HOV lane to accommodate the higher vehicle volumes anticipated from allowing additional user groups. However, bus operators and bus riders may experience slower travel speeds and degraded service if an HOV lane becomes congested from allowing other user groups. Examining the impact on public transportation operators and bus riders from expanding the vehicle-eligibility requirements on an HOV lane is important if buses currently represent a significant user group.

Adding Priced or HOT Vehicles

This scenario focuses on allowing lower or single-occupant vehicles to use an HOV lane for a fee. Allowing HOT vehicles to use an HOV lane may be considered for a number of reasons. These reasons may include using available capacity and managing congestion in an HOV lane with a 2+ vehicle-occupancy requirement. In this case, two-person carpools may continue to be able to use the HOV lane for a fee, while the vehicle-occupancy level for nonpaying HOVs is increased to 3+. In other cases, HOT project may be implemented to increase use on an HOV lane with available capacity, to generate revenues for transit and transportation improvements, and to provide additional travel options.

The potential market or markets being considered in changing vehicle-eligibility requirements should be considered, especially when expanding HOV lanes to include HOT vehicles or low-emission and energy-efficient vehicles are being considered. Possible target markets for HOT project include drivers of lower-occupant vehicles and single-occupant vehicles. Factors to consider when identifying the amount the target market may be willing to pay to use an HOV lane include the estimated demand at various pricing levels and the quality of service. In addition to the traditional cost-to-demand relationship, other factors to consider include the bus fares in the corridor and the cost of other transit alternatives (see HOT Projects). The impact on existing or projected HOV-lane users from allowing other user groups will need to be considered. Ideally, there should be no impact on current HOV users. However, adding priced or HOT vehicles to the HOV lane might impact the flow of traffic in the general-purpose lanes.

Hot Projects

The cost of the tolling infrastructure and the ongoing operation of an HOT project will depend on the approach and the operating strategy used for an HOT project. The two general types of approaches are a manual or static operating strategy and the use of real-time pricing based on congestion. The funds generated by a pricing project and the cost to operate and administer the program should be carefully examined, along with how any excess revenues will be spent. Findings from studies around the country indicate that public and policy maker reaction to a possible HOT project is influenced by how the revenues are anticipated to be used. Public support appears to be higher if the revenues are used for transit and transportation improvements in the corridor than if they are used for other purposes.

Chapter Five
Assessing Vehicle-Occupancy Requirements

This chapter provides an overview of possible HOV lane vehicle-occupancy requirements, potential advantages and limitations of different requirements, factors to consider in changing requirements, and a discussion of the potential impact of changes to higher, lower, and variable vehicle-occupancy requirements.

Possible Vehicle-Occupancy Requirements

The planning process for an HOV lane that permits carpools typically includes an analysis of the potential demand for a facility at different vehicle-occupancy levels and the impact these levels will have on traffic flow. The goal is to set the occupancy requirement at a level that will encourage carpooling, vanpooling, and taking the bus, but will not create a level of demand that makes the lane congested.

Changes in vehicle-occupancy levels may be needed over the life of an HOV facility. Over utilization may cause congestion, reduce trip-time reliability, and increase travel times on the HOV lane. Increasing vehicle-occupancy levels to address such congestion is not an easy change to make. Alternatively, underutilization of the HOV lane may prevent the facility from alleviating congestion on the general-purpose lanes.

During the late 1970s and early 1980s, FHWA used a 3+ definition for carpools on HOV projects funded through Federal programs. SAFETEA-LU defines the occupancy requirement for use of HOV lanes as no fewer than two occupants per vehicle, with exceptions for exempt vehicles.

The characteristics, advantages, and disadvantages of various vehicle-occupancy requirements are highlighted in Table 4.

Factors to Consider in Changing Vehicle-Occupancy Requirements

Some of the factors to be considered in assessing possible changes in vehicle-occupancy levels differ from those considered in changing vehicle-eligibility requirements, as changes in occupancy levels focus on carpool use of HOV facilities. Since carpools are already included in the vehicle-eligibility requirements, type and length of an HOV lane, design limitations, and safety are not typically considered in assessing possible changes in vehicle-occupancy requirements, unless a higher occupancy level was used to limit vehicle volumes because of design or safety concerns. Potential factors to consider in changing occupancy requirements include:

- Project goals and objectives.
- Levels of congestion in the HOV lane, the general-purpose freeway lanes, and the travel corridor.
- The number of two-person and three-person carpools.
- Bus operations.
- System or regional connectivity.
- Enforcement.
- Perceptions of users, nonusers, and policy makers.

Each of these factors is explored briefly in relation to assessing vehicle-operating hours in the following section.

Assessing Vehicle-Occupancy Levels

An ongoing HOV performance monitoring program provides the information needed to assess when changes may be needed in vehicle-occupancy levels to maintain travel-time savings and reliability

The goal of an HOV facility is to provide travel-time savings and reliability to buses, vanpools, and carpools. The vehicle occupancy requirement should be set at a level that will encourage use of the facility and formation of new carpools but not create a level of demand that makes the lane congested.

Table 4. Advantages and Disadvantages of Four Vehicle-Occupancy Level Requirements

Vehicle-Occupant Level	Advantages	Limitations
Two or more (2+) persons	Easiest level of carpools to form.	May be too many 2+ carpools resulting in congestion in an HOV lane.
	Often significant numbers of existing 2+ carpools in a corridor.	May not provide incentive to carpool if high number of existing 2+ carpools or help reduce vehicle trips.
Three or more (3+) persons	Can address congestion problems at the 2+ level.	Harder for individuals to form 3+ carpools.
	Higher person-moving capacity.	May not have enough 3+ carpools to make lane look used, causing the empty lane syndrome. If existing carpools cannot find an additional passenger, they may travel in the general-purpose lanes, adding to the congestion in these lanes.
Four or more (4+) persons	Can address congestion problems at the 3+ level.	Hard for individuals to form 4+ carpools.
	Higher person-moving capacity.	Harder to operate on a regular basis due to individual travel needs and schedules. May not have enough 4+ carpools to make lane look used, causing the empty lane syndrome. If existing carpools cannot find an additional passenger, they may travel in the general-purpose lanes, adding to the congestion in these lanes.
Variable requirements by time of day (3+ peak-hours, 2+ other operating hours)	Can address congestion problems during peak-periods.	May be confusing for users, especially during transition periods.
	More acceptable to users and policy makers than 3+ at all times.	May make enforcement more difficult, especially during transition periods.

for HOV users. The sketch planning and travel forecasting models used in the initial planning process for an HOV project can be used in assessing possible changes.

This section describes how the factors to be considered can be applied to assess possible changes in vehicle-occupancy requirements in connection with three change scenarios: increasing levels from 2+ to 3+, decreasing from 3+ to 2+, and implementing variable time-of-day occupancy requirements (3+ peak/2+ off-peak). Each scenario has different impacts on different user groups.

Increasing Vehicle-Occupancy Levels from 2+ to 3+

An increase in the vehicle-occupancy requirement from 2+ to 3+ during all operating hours may be considered when a 2+ HOV lane becomes congested on a recurring basis, resulting in users losing the travel-time savings and trip-time reliability they have come to expect. Typical measures that trigger considerations of increasing vehicle-occupancy levels are vehicle volumes, level of service (LOS), slower travel speeds, longer travel times, and loss of trip-time reliability. Key issues to be examined are the levels of congestion in the HOV and general-purpose lanes, the number of two- and three-person carpools, the number of buses and level of bus service on the lane, and the perceptions of HOV-lane users and policy makers. There are no case study examples of increasing the vehicle-occupancy level on an HOV lane from 2+ to 3+ during all operating periods. It appears that concerns over possible negative reactions from HOV-lane users and policy makers have limited consideration of increasing occupancy levels in some areas.

Decreasing Vehicle-Occupancy Levels from 3+ to 2+

Lowering the occupancy level on an HOV lane from 3+ to 2+ during all operating hours may be considered when volumes of HOVs at the 3+ level are low, as illustrated in the case study Changes in Vehicle-Eligibility and Vehicle-Occupancy Requirements on the I-10 West HOV Lane in Houston (see Chapter 7). Lowering the occupancy level may also be considered based on the perception that an HOV lane is underutilized (see the El Monte Busway and Virginia's I-66 case studies for examples in Chapter 7).

Variable-Occupancy Requirements (3+ Peak/2+ Off-Peak)

The use of variable vehicle-occupancy requirements by time of day may be considered in response to congestion that occurs in the HOV lane during peak hours (morning, afternoon, or both), but not at other times. The use of a variable-occupancy requirement may be more acceptable to both HOV-lane users and policy makers than increasing from a 2+ to a 3+ occupancy level during all operating hours. However, variable occupancy requirements may require higher enforcement levels, especially during the transition periods. As noted in the case studies in Chapter 7, variable occupancy requirements are in use on the I-10 West and the US 290 HOV lanes in Houston and the El Monte Busway in Los Angeles.

Chapter Six
Assessing HOV Operating Hours

Public and political support is critical for any changes in operating hours. Whether HOV operations are being expanded or reduced, HOV-lane users and other freeway users will be impacted in various ways, depending upon performance on the HOV and general-purpose lanes and the types of changes made.

This chapter outlines alternative HOV operating-hour scenarios, factors to consider in changing HOV operating hours, and the process of assessing possible changes in operating hours. Five change scenarios are presented.

Alternative HOV Operating-Hour Scenarios

Four operating-hour scenarios are typically used with HOV facilities:

- 24/7—continuous operation at all times. This operating scenario tends to be found with busways in separate rights-of-way and with freeway concurrent flow and exclusive two-way facilities. This operating scenario also allows travelers to use the HOV facility during noncommute hours.
- Extended hours—a major portion, but not all, of the day. Although the exact hours of operation vary by facility, this scenario often encompasses the time periods from 6 a.m. to 11 a.m. and 3 p.m. to 7 p.m. These times correspond to the major commuting periods, when traffic congestion is heaviest. Extended operating hours are typically used with exclusive reversible HOV lanes and contraflow lanes.
- Peak-period-only—more narrowly defined than extended hours. Peak-period operation usually encompasses the hours from 6 a.m. to 9 a.m. and 4 p.m. to 6 p.m. Some facilities use the HOV restriction only in the peak direction of travel, while others may operate only during the morning peak period in the peak direction of travel. Peak-period operation is used primarily with concurrent flow and contraflow HOV lanes.
- Special events–extra hours to assist with traffic management during a special event or other planned activity. For example, the I-394 HOV lanes in Minneapolis are open in the evening and on weekends for vehicles with two or more passengers attending sporting events at facilities in downtown Minneapolis. Vehicles using the HOV lanes must meet the 2+ vehicle-occupancy requirement. The I-279 HOV lane in Pittsburgh is open in the outbound direction after games at stadiums in the downtown area. All traffic is eligible to use the facility to exit the stadiums.

Table 5 lists the advantages and limitations of each operating-hour scenario.

HOV restrictions may also be lifted in the case of crashes, emergencies, and weather conditions that affect the operation of the overall system. In these cases, the HOV lanes may be used to help with emergency evacuations or to move traffic past a major crash.

Factors to Consider in Changing HOV Operating Hours

Factors to consider in assessing possible changes in HOV operating hours include:

- Level of congestion in the HOV lane and the general-purpose freeway lanes.
- Project goals and objectives.
- Type of HOV facility.
- Use of the lane during other times of the day.
- Bus operations.
- System connectivity.
- Safety related issues, such as enforcement and changes in signing.
- Operating costs.

Table 5. Operating-Hour Considerations

Operating-Hour Scenario	Advantages	Limitations
24/7	Around-the-clock travel-time savings and trip-time reliability.	Possible negative public perception if the facility is not well-used during off-peak hours.
	Availability of the HOV lanes for recreational and other nonwork trips, which may promote wider acceptance of the facility and lead to greater use of the lane during peak hours.	The need for ongoing enforcement.
	May eliminate potential motorist confusion as to whether or not the HOV designation is in effect, easing enforcement and simplifying signing and lane markings.	Potential safety concerns.
Extended hours	Travel-time savings and time reliability during the periods when the general-purpose freeway lanes are most likely to be congested.	Confusion on the part of motorists. The need for additional enforcement, signing, and pavement markings.
Peak-period-only	Provides priority to HOVs at critical times of the day. Addresses specific bottleneck problems.	Confusion on the part of motorists. The need for additional enforcement, signing, and pavement markings.
Special events	Improves traffic flow into and out of the sports stadium or other facility and facilitates traffic management in the area.	Confusion on the part of motorists.
	Introduces the HOV facility to nonusers and can help build public acceptance and support.	The need for additional enforcement, signing, and pavement markings.

- Benefits.
- Perceptions of users, nonusers, and policy makers.

These factors address both technical elements and public and political acceptance issues. Each of these factors is explored briefly in relation to alternative operating hours in the following section.

Assessing Possible Changes in HOV Operating Hours

This section describes how potential factors to consider can be applied to assess five possible changes in operating hours:

- Lengthening peak-period operations.
- Changing peak-period or extended HOV operations to 24/7 operation.
- Reducing peak-period or extended operation.
- Reducing 24/7 operation to peak-period or extended operating hours.
- Opening 24/7 HOV lanes to general-purpose traffic in the evenings or on weekends.

When changes in operating hours are being considered, it is important to examine the perceptions of the different groups affected by these potential changes, to assess possible impacts, and to conduct outreach efforts to various user groups and policy makers. The five possible scenarios are based on issues that might be identified through an ongoing HOV performance monitoring program.

Lengthening Peak-Period HOV Operations

The extension of HOV lane operating hours may be considered in response to increasing levels of congestion in the HOV lane at the start and the end of the current operating hours, plans to expand bus service into these time periods or initiate bus rapid transit (BRT), plans to achieve regional connectivity, and changes in travel and commute patterns due to new developments and employment locations. Extending operating time can be considered for the morning or afternoon peak periods and at the beginning or end of the periods. Depending on the type of HOV lane and current use during non-HOV operating hours, this scenario has the greatest potential to raise concerns from single-occupant vehicles and traffic in the general-purpose freeway lanes.

Changing Peak-Period or Extended Hours to 24/7 Operations

Consideration of expanding peak-period or extended HOV operating hours to 24/7 operation may arise from increasing levels of traffic congestion in a corridor over longer periods of the day and evening or from factors such as implementation of a BRT system, the location of new businesses with significant numbers of employees on different work shifts, new recreational or planned special event developments, and the adoption of policies supporting priority treatments for HOVs at all times.

The key issues in changing to 24/7 operations are primarily the same as those involved in assessing a lengthening of operations. If the HOV lane is open to general-purpose traffic during other times, the main issue will likely be addressing concerns from single-occupant drivers, the public, and policy makers. The Minneapolis case study (see Chapter 7) provides an example of how vocal opposition to the 24/7 designation with the MnPASS project on I-394 resulted in a change back to the previous peak period, peak-direction operating hours on the concurrent flow HOV lanes.

Reducing Peak-Period or Extended Operations

To reduce peak-period or extended HOV operating hours, the HOV designation may be started later in the morning or afternoon and ending earlier in the morning or evening. These options may be considered in response to actual or perceived low use levels during HOV operations. The impact of this scenario on HOV-lane users and travelers in the general-purpose freeway lanes will depend primarily on the type of HOV lane, the anticipated during the previously HOV operating hours, current vehicle volumes in the HOV lane, and the level of congestion in the general-purpose freeway lanes.

Most peak-period HOV lanes have high utilization levels throughout the operating periods, and HOV lanes with extended operating hours are also well used. HOV-lane users and public transportation services may be negatively impacted by reducing peak-period or extended operating hours. Motorists in the general-purpose freeway lanes and the public may view this change positively if they are able to use the HOV lane during the previous HOV-only operating period.

This type of change may not have a significant impact on any user group when the HOV lane was closed to all traffic during the previous HOV operating hours.

Reducing 24/7 to Extended or Peak-Period Operation

Low use levels during certain time periods or perceptions of underutilization may prompt consideration of a change from 24/7 HOV operating hours to extended or peak-period operating hours. This change represents a major shift in philosophy to an emphasis on peak-period commuter trips. There are no case study examples of changing 24/7 HOV operations to extended or peak-period hours.

Modifying 24/7 Operation to Allow General-Purpose Traffic in the Evenings or on Weekends

In some areas, policy makers and the public have expressed interest in opening HOV lanes that operate on a 24/7 basis to general-purpose traffic in the evenings and on weekends. Such interest may result from perceived or actual lower vehicle volumes in the HOV lanes during these time periods. Assessments of opening HOV lanes during these time periods have been conducted in Los Angeles in 1999 and the Puget Sound region in 2002. In Los Angeles, the study recommended that no changes be made in the operating hours (see Chapter 7). Currently, HOV lanes that operate on a 24/7 basis are primarily concurrent flow HOV lanes and two-way exclusive HOV lanes.

Chapter Seven
Case Studies

This chapter highlights case study examples related to changing vehicle-eligibility requirements, vehicle-occupancy levels, and operating hours on HOV lanes. The case studies present documented experience with expanding eligible user groups to include carpools, HOT vehicles, and low-emission and energy-efficient vehicles as well as experiences with decreasing and increasing vehicle-occupancy levels and changing operating hours.

Changes in Vehicle-Eligibility and Vehicle-Occupancy Requirements on the I-10 West HOV Lane in Houston

The I-10 West HOV lane, located on the west side of Houston, Texas, is 21 km (13 mi) in length. It is a one-lane, barrier-separated, reversible HOV lane located in the freeway median. Only buses and authorized vanpools were eligible to use the I-10 West HOV lane when it was first opened in 1984, reflecting the approach used on the I-45 North contraflow demonstration project. Approximately 50 vehicles used the lane during the morning peak hour with the bus and authorized vanpool vehicle-eligibility requirement. Due to this low level of use, the lanes were opened to carpools of 4+ passengers after 6 months of operation. This change added approximately 10 vehicles to the morning peak hour volume on the lane. The vehicle-occupancy level was lowered again after 6 months to carpools of 3+ passengers, which added approximately 100 vehicles to the morning peak hour traffic stream. In 1986 the vehicle-occupancy level was lowered to carpools of 2+ passengers and the authorization requirement was discontinued. The morning peak hour volumes increased to approximately 1,200 vehicles after this change. Morning peak-hour vehicle volumes began to regularly reach or exceed 1,500 over the next few years. The congestion resulting from these volumes, coupled with the design of the facility, reduced the travel-time savings and travel-time reliability bus riders, carpoolers, and vanpoolers had come to expect. In response to lower travel speeds in the HOV lane and complaints from bus passengers, the vehicle-occupancy requirement was increased in 1988 from 2+ to 3+ passengers between 6:45 a.m. and 8:15 a.m. Table 6 shows the changes in vehicle-occupancy requirements and corresponding vehicle volumes on the I-10 West HOV lane.

In the late 1990s, METRO and TxDOT staff began considering the potential of allowing two-person carpools to use the I-10 West HOV lane for a fee during the period restricted to 3+ passengers. This approach was viewed as a way to increase use of the HOV lane without allowing it to become overly congested as it was in 1988 when the vehicle-occupancy requirement was raised to 3+ passengers. A feasibility study and focus groups were conducted to explore the potential of a value pricing demonstration project on the I-10 West HOV lane.

The assessment indicated that METRO had the authority to charge for use of the HOV lane under specific conditions, that fines were enforceable with minor modifications, and that there were no critical policies prohibiting a demonstration. The study estimated that approximately 600 additional vehicles could be accommodated in the lane during the peak hour while maintaining free flow operations.

Based on the feasibility study, the decision was made to implement QuickRide, a

The development and operations of HOV facilities have evolved over the years. The first freeway applications in the country were the I-395 bus-only lane in Virginia/Washington, DC in 1969, and the contraflow bus lane on the approach to the New York–New Jersey Lincoln Tunnel in 1970. As the demand for freeway capacity increases, agencies have used a variety of HOV lane and operating-hour configurations, eligibility requirements, and occupancy requirements to maximize person-movement capacity on their freeways.

Table 6. Changes in Vehicle-Occupancy Requirements and Corresponding Vehicle Volumes on the I-10 West HOV Lane

Vehicle-Eligibility and Vehicle-Occupancy Requirements	Date (Time after opening)	AM Peak-Hour HOV Lane Vehicle Volumes			
		Carpools	Vanpools	Buses	Total
Buses and authorized vanpools	Oct-84	-	66	20	86
Buses, authorized vanpools, and authorized 4+ carpools	April 1985 (6 months)	3	68	25	96
Buses, authorized vanpools, and authorized 3+ carpools	September 1985 (1 year)	53	59	31	143
Buses, vanpools, and 2+ carpools	November 1986 (2 years)	1,195	38	32	1,265
	November 1987 (3 years)	1,453	21	37	1,511
Buses, vanpools, and 3+ carpools[1]	October 1988 (4 years)	510	24	36	570
	March 1989 (4½ years)	660	28	40	728
	December 1989 (5 years)	611	19	37	667
	1996 (12 years)	858	19	33	910

[1] The requirement of three of more passengers per carpool was implemented for the period 6:45 a.m. to 8:15 a.m. in October 1988. In May 1990, the period was modified to 6:45 a.m. to 8 a.m., and in September 1991 another period was implemented, from 5 p.m. to 6 p.m.

demonstration project to test allowing two-person carpools to use the HOV lane for a $2.00 per trip fee during the periods when the occupancy requirement is 3+ people. Individuals are required to register for the program and must have an active electronic tag account. By June 1998, 468 QuickRide electronic tags had been issued. In 2000, the demonstration was expanded to include the US 290 HOV lanes, only in the morning peak hour. As of April 2003, there were 1,476 active QuickRide accounts.

Analysis of initial use levels indicated that each enrolled tag generated an average of 1 tolled trip every 4 days, producing an average of 115 to 120 total two-person carpool trips during the 1-1/4 morning hours plus the 1 evening hour. However, a survey of travelers in the general-purpose freeway lanes indicated a low level of knowledge about the program. The survey also indicated that 25 percent of the users are forming two-person carpools to participate, compared to only 5 percent of users who appear to be coming from all types of higher-occupancy modes.

Changes in Vehicle-Eligibility and Vehicle-Occupancy Requirements on the El Monte Busway in Los Angeles

The El Monte Busway was the first freeway HOV facility in the Los Angeles area. In 1999 legislation was approved that lowered the vehicle-occupancy requirement on the El Monte Busway on the San Bernardino (I-10) Freeway in Los Angeles from 3+ to 2+ passengers fulltime. Caltrans was directed to implement this change on January 1, 2000 and to monitor and evaluate the effects of the new occupancy requirement on the operation of the Busway and the freeway.

In 1999 the California legislature approved Senate Bill (SB) 63 lowering the vehicle-occupancy requirement on the Busway to 2+ persons. Caltrans District 7 was responsible for implementing the change in occupancy requirement directed in SB 63 and for monitoring the effects of the legislation. Caltrans established the SB 63 Implementation Committee, comprised of representatives from appropriate agencies, to help support and coordinate the change. The SB 63 Implementation Committee met on a regular basis to help coordinate implementation, operation, and monitoring of the vehicle-occupancy requirement change. The committee also helped coordinate the change back to the 3+ vehicle-occupancy requirement during peak period operation based on Assembly Bill (AB) 769. Caltrans monitored the effects of SB 63 on the operation of the Busway and the freeway. The results of the monitoring effort were summarized in regularly issued fact sheets and presented in an executive summary. The Caltrans monitoring effort focused primarily on vehicle volumes, person movement, travel speeds, and occupancy violation rates.

There was no significant improvement in traffic conditions in the general-purpose freeway lanes from lowering the occupancy requirement to 2+ passengers. Morning peak period travel speeds in the Busway were reduced from 105

to 32 km/h (65 to 20 mi/h. Hourly Busway vehicle volumes during the morning peak period increased from 1,100 to 1,600 with the new vehicle-occupancy designation, but the number of persons carried declined from 5,900 to 5,200.

Individuals in vanpools, 3+ carpools, and buses were vocal in their opposition to the legislatively-directed lowering of the vehicle-occupancy requirement. Bus riders noted an increase of 20 to 30 minutes in travel times, and passengers reported missing connections to other buses and rail service and being late for work, school, and daycare pickups. Individuals in existing 3+ carpools reported longer travel times and delays and being forced to adjust their schedules to leave earlier in the morning to arrive at work on time. Bus riders, individuals in vanpools and 3+ carpools, as well as others complained that the incentive for using these modes and the Busway was gone. Many of the individuals suggested the new legislation represented a step backward and was detrimental to achieving environmental, air quality, and energy goals.

Based on the operational effects that resulted from this change and negative feedback from bus riders, emergency legislation was approved increasing the vehicle-occupancy requirement back to 3+ passengers during the morning and afternoon peak periods effective July 24, 2000.

In addition to monitoring the general conditions on the HOV lanes on an annual basis, Caltrans has conducted periodic studies on different issues related to the operation of the El Monte Busway, HOV lanes in the Los Angeles area, and HOV facilities throughout the State. In 1999 Caltrans District 7 examined the feasibility and effectiveness of opening HOV lanes to general traffic on weekends and holidays. The study recommended maintaining the current 24/7 HOV designation for the following reasons:

- The HOV lanes are currently being utilized effectively on weekends.
- Opening the HOV lanes to general traffic would provide only minor improvements to overall traffic conditions.
- Opening the lanes on weekends to general traffic would compromise the trip reliability of weekend carpoolers.
- Opening the lanes on weekends to general traffic is not consistent with the objectives of the HOV program or current signing and striping of the facilities.

Use of the El Monte Busway has grown over time. Tracking this growth is somewhat difficult due to the different time periods used over the years to collect and present vehicle and passenger volumes. Table 7 highlights morning peak hour use-levels from points over the 30-year life of the facility. Peak hour use of the lane increased over the life of the facility, as has total daily use.

Expansion of the I-15 HOV Lanes in San Diego to Include HOT Vehicles

The two-lane exclusive HOV facility on I-15 was opened in 1988 with a 2+ vehicle-occupancy requirement. The I-15 HOV lane is located on the northeast side of San Diego, California and is approximately 13 km (8 mi) in length. There is one entrance and one exit. The lanes were open in the southbound direction from 6 a.m. to 9 a.m. and in the northbound direction from 3 p.m. to 6 p.m., and were closed at other times.

In 1996 approximately 1,800 vehicles were using the HOV lanes during the morning peak hour, and the lanes were operating at a level-of-service C. During the same period, the adjacent four freeway lanes were carrying 12,000 vehicles, operating at a level-of-service F.

The I-15 Freeway HOV Pricing project was one of the congesting pricing demonstrations funded as a result of the ISTEA of 1991. The project included two phases to test allowing single-occupant vehicles to use the I-15 HOV lanes for a fee. The objectives of the demonstration included testing value pricing as a method of managing congestion on the freeways lane, managing demand on the HOV lanes, expanding transit and ridesharing services in the corridor, and enhancing air quality in the region.

The initial demonstration project, *ExpressPass*, began in 1996. During this phase a limited number of monthly permits were sold to motorists on a first-come, first-serve basis. Drivers with permits could use the lanes without meeting vehicle-occupancy requirement, while carpools, vanpools, and buses continued to use the lanes for free. The monthly fee was first set at $50 in December 1996, and 500 permits were sold. In 1997, 700 permits were issued, and the fee increased to $70. A permit waiting list of between 200 and 600 individuals existed over the course of this phase.

In April 1999 the FasTrak™ phase was implemented with electronic toll collection replacing the monthly passes. Variable fees for single-occupancy vehicle use of the HOV lanes are collected electronically. The fee depends on the congestion level in the HOV lanes and is recalculated every 6 minutes to maintain a level-of-service C. Fees typically range from 50 cents to $4 according to the time-of-day relative to traffic peaks, although the fee could reach as high as $8. Message signs located before the start of the lnes display the updated fee.

Table 7. Morning Peak Hour Utilization of the El Monte Busway

Year	Bus	Passengers	Carpools/Vanpools	Passengers	Total Vehicles	Total Passengers
1973 (May)[1]	21	766	-	-	21	766
1973 (Oct)[1]	67	1,526	-	-	67	1,526
1976	64	3,044	-	-	64	3,044
1988	70	3,190	765	2,610	835	5,800
1990	71	2,750	1,374	4,352	1,445	7,102
2000	84	2,980	944	2,887	1,028	5,867

[1] The requirement of three of more passengers per carpool was implemented for the period of 6:45 to 8:15 a.m. in October 1988. In May 1990, the period was modified to 6:45 to 8 a.m., and in September 1991 another period was implemented from 5 to 6 p.m.

During the first month of *ExpressPass* phase, a 12 percent increase in traffic throughput occurred. Most of this increase was the result of new carpools rather than single-occupant vehicles. Before the demonstration, weekday traffic counts included 7,900 HOVs, accounting for 85 percent of the vehicles, and 1,400 single-occupant vehicle violators, accounting for 15 percent. Weekday traffic counts during the initial months of the *ExpressPass* phase included 9,300 HOVs, accounting for 80 percent of the vehicles, 1,025 *ExpressPass* users, accounting for 10 percent, and 200 single-occupant vehicle violators, accounting for 2 percent of the vehicles.

As of March 2005, there were approximately 18,670 active FasTrak™ accounts and some 27,700 transponders in use. Annual revenue generated from FasTrak™ users is approximately $1.2 million. The revenue has been used to support operations of the system and to expand public transportation services in the corridor.

Expansion of the I-394 HOV Lanes in Minneapolis to Include HOT Vehicles

The I-394 HOV lanes are approximately 18 km (11 mi) in length. There are two different sections of HOV lanes. A 5-km (3-mi), two-lane, barrier-separated reversible 11 km (7 mi) of concurrent flow HOV lanes.

In 2003 State legislation was approved allowing a HOT project on the I-394 HOV lanes. The MnPASS project, which uses dynamic pricing based on the level of congestion in the HOV lane, was implemented in May 2005. The base toll is 25 cents and the maximum toll is $8. The project represents the first use of tolling in the Minneapolis–St. Paul metropolitan area and in Minnesota. MnPASS also represents the first HOT project on concurrent flow HOV lanes. The previous unlimited access to the I-394 concurrent flow HOV lanes was changed to five eastbound and six westbound access points.

The initial hours of MnPASS operation were 24/7 on the 11 km (7-mi) concurrent flow HOV lanes and eastbound from 6 a.m. to 1 p.m. and westbound from 2 p.m. to 5 a.m. on the 5-km (3-mi), two-lane reversible section. These operating hours represented a significant change from those used since the I-394 HOV lanes opened. After negative response from commuters in the corridor and policy makers, Mn/DOT returned the MnPASS hours on the concurrent flow section to those used with the HOV lanes from 1992 to 2005.

A total of 4,057 transponders were purchased prior to the opening of the project. As of December 2005, some 8,700

The MnPASS project, which uses dynamic pricing based on the level of congestion in the HOV lane, represents the first use of tolling in Minnesota and the first HOT project on concurrent flow HOV lanes. Photograph courtesy of the Minnesota Department of Transportation.

transponders had been purchased. The number of daily MnPASS trips on weekdays grew from 916 on the first day of operation to an average of 3,400 by the 10th week, with a 1-day high of 4,039 MnPASS trips. The maximum toll reached $8 on 4 days during the first 10 weeks of operation. The maximum toll on most days averaged between $3.25 and $4, and the weekday average toll was under $1 over the initial 10-week period.

During the morning peak hour, volumes in the HOV lane increased by approximately 316 vehicles by the third quarter of 2005. MnPASS vehicles accounted for 476 vehicles, or 16 percent, of the total 2,928 vehicles using the HOV lane. HOVs and a few violators accounted for the remaining 84 percent of vehicles using the lane. The number of HOVs declined by approximately 167 vehicles and the average vehicle occupancy declined from 3.41 to 2.88.

Low-Emission and Energy-Efficient Vehicle Use of the HOV Lanes in Northern Virginia

State legislation approved in 1993 established a clean special fuel license plate for special fuel vehicles. The legislation defines clean special fuel as any product or energy source used to propel a highway vehicle, the use of which, compared to conventional gasoline or reformulated gasoline, results in lower emissions of oxides of nitrogen, volatile organic compounds, carbon monoxide or particulates or any combination thereof. The term is defined to include compressed natural gas, liquefied natural gas, liquefied petroleum gas, hydrogen, hythane (a combination of compressed natural gas and hydrogen), and electricity.

State legislation approved in 1994 allows vehicles with clean special fuel license plates to use the HOV lanes in Virginia without meeting the minimum-occupancy requirements. In 2000, hybrid vehicles were allowed to qualify for clean special fuel vehicle license plates. Today hybrid vehicles comprise the vast majority of the license plates issued, accounting for almost 95 percent of the total. In comparison, no other type of low-emission or energy-efficient vehicle comprises more than 1.3 percent of the total.

The results from an ongoing monitoring program show that owners of vehicles with clean special fuel license plates are using the HOV lanes in northern Virginia. In the fall of 2003, clean special fuel vehicles accounted for between 2 and 12 percent of the HOV volumes during the peak periods on the different HOV facilities in northern Virginia. Counts from 6 days in October 2004 indicate that clean special fuel vehicles accounted for between 11 and 17 percent of the vehicles in the HOV lanes on I-95 during the 6 a.m. to 9 a.m. peak period in the northbound direction. These percentages translate into between some 844 and 1,422 vehicles with clean special fuel license plates using the HOV lanes during the three-hour period and the corresponding total vehicle volumes in the HOV lane ranged from 7,994 to 8,450.

HOV-lane users have been vocal in raising concerns about hybrid use of the HOV lanes. In response to these concerns, legislation based on the work of the HOV Enforcement Task Group was approved in 2006. The legislation added a $25 fee for the clean special fuel license plates. For each $25 fee collected in excess of 1,000 registrations, $15 is paid to the State Treasurer and credited to a special nonrevenue HOV Enforcement Fund for use by the Virginia State Police for enhanced HOV enforcement.

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Federal Highway Administration
400 Seventh Street St SW
Washington DC 20590
Publication No. FHWA-07-082