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16. Abstract

This report presents a description of existing high-occupancy vehicle (HOV) facilities in operation either on freeways or in separate rights-of-way in North America. Up-to-date information is provided on the design, operations, enforcement characteristics, and current utilization rates for 40 HOV facilities in 20 metropolitan areas. The report includes general descriptions of each facility, maps showing the location of each facility, representative cross-sections and a series of tables containing detailed information in each project.

Over the last 20 years a variety of priority measures for high-occupancy vehicles (HOV) have been implemented throughout North America. While often differing in design and operation, HOV facilities are intended to 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 high-occupancy vehicles (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.

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A DESCRIPTION OF HIGH-OCCUPANCY VEHICLE FACILITIES IN NORTH AMERICA

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Technical Report 925-1
An Assessment of Freeway High-Occupancy Vehicle Projects
Technical Study 2-11-89/1-925

Sponsored by

Texas State Department of Highways and Public Transportation
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Urban Mass Transportation Administration

Texas Transportation Institute
The Texas A&M University System
College Station, Texas 77843

October 1990

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METRIC (SI*) CONVERSION FACTORS

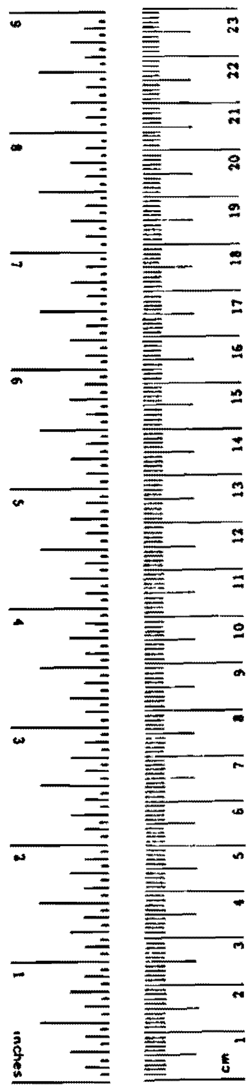
APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	2.54	millimetres	mm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
AREA				
in^2	square inches	645.2	millimetres squared	mm^2
ft^2	square feet	0.0929	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
mi^2	square miles	2.59	kilometres squared	km^2
ac	acres	0.395	hectares	ha
MASS (weight)				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
VOLUME				
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.0328	metres cubed	m^3
yd^3	cubic yards	0.0765	metres cubed	m^3

NOTE: Volumes greater than 1000 L shall be shown in m^3.

TEMPERATURE (exact)

Symbol	When You Know	Multiply By	To Find	Symbol
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
AREA				
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
km^2	kilometres squared	0.39	square miles	mi^2
ha	hectores (10 000 m^2)	2.53	acres	ac
MASS (weight)				
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T
VOLUME				
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
m^3	metres cubed	1.308	cubic yards	yd^3

TEMPERATURE (exact)

Symbol	When You Know	Multiply By	To Find	Symbol
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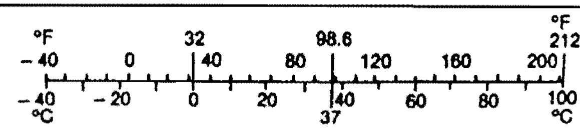

These factors conform to the requirement of FHWA Order 5190.1A.

* SI is the symbol for the International System of Measurements

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

Page

LIST OF FIGURES

Page

LIST OF FIGURES (Continued)

Page

LIST OF TABLES

I. INTRODUCTION

The Texas Transportation Institute (TTI), a part of The Texas A&M University System, is conducting an assessment of high-occupancy vehicle (HOV) lane projects located either on freeways or in separate rights-of-way in North America. The three year research study is being funded by the Urban Mass Transportation Administration through the Texas State Department of Highways and Public Transportation (SDHPT). One of the major elements of this assessment is a survey intended to describe the operating characteristics of exclusive HOV facilities. A survey of all HOV facilities in operation either on freeways or in separate rights-of-way has been completed; this updates the 1985 survey conducted by a technical committee of the Institute of Transportation Engineers (ITE). The results of this effort, which are contained in this report, provide up-to-date information on the design, operations, enforcement characteristics, and current utilization rates of HOV facilities in the United States and Canada.

Background and Purpose of the 1989 Survey

Since the opening of the Shirley Highway exclusive bus lanes in Washington, D.C. in 1969, numerous metropolitan areas have developed priority facilities for high-occupancy vehicles. A variety of treatments have been designed and implemented as one approach to dealing with increasing urban congestion problems. These facilities are referred to by a variety of names, including busways, transitways, high-occupancy vehicle (HOV) lanes, diamond lanes, commuter lanes, and authorized vehicle lanes. These names often refer to different types of facilities, both in terms of design and operating characteristics. However, the terms are often used interchangeably. In some metropolitan areas, one term is used for all types of facilities, while in others different terms are used for different types of facilities.

In 1985, a technical committee of the Institute of Transportation Engineers (ITE) conducted a survey of operating HOV lanes located either on freeways or in separate rights-of-way in North America. The survey results, which were published in 1988[1], provided detailed documentation of the design and operating characteristics of HOV lanes. A total of 20 facilities were surveyed in 12 metropolitan areas. Since 1985, a number of new HOV facilities have opened. As a result, in order to update and expand on the 1985 work, a survey was conducted of operating HOV projects in 1989.

The results of the 1989 surveys are presented in this report. Like the 1985 ITE survey, the 1989 survey focused on HOV facilities operating either within freeways or on separate rights-of-way. In 1989, a total of 40 HOV facilities were surveyed in 20 metropolitan areas. Figure 1 shows the metropolitan areas in North America with operating HOV facilities. The increase in the number of miles of HOV lanes either on freeways or within separate rights-of-way is shown in Figure 2. The number of miles of operating HOV lanes has increased from some 180 miles in 1985 to approximately 300 miles in 1989. By April 1990, 332 miles of HOV lanes were in operation.

Report Organization

A description of the different types of HOV facilities and their advantages is presented in the next section. This is followed in Chapter 3 by a discussion of the survey process, including a brief description of the HOV facilities included in the survey. Chapter 4 presents the summary of the survey results, including tables containing a variety of information on each project. Chapter 5 provides an outline of proposed HOV projects and extensions to existing facilities. Chapter 6 concludes the report by identifying issues which appear to warrant further research and other areas of concern.

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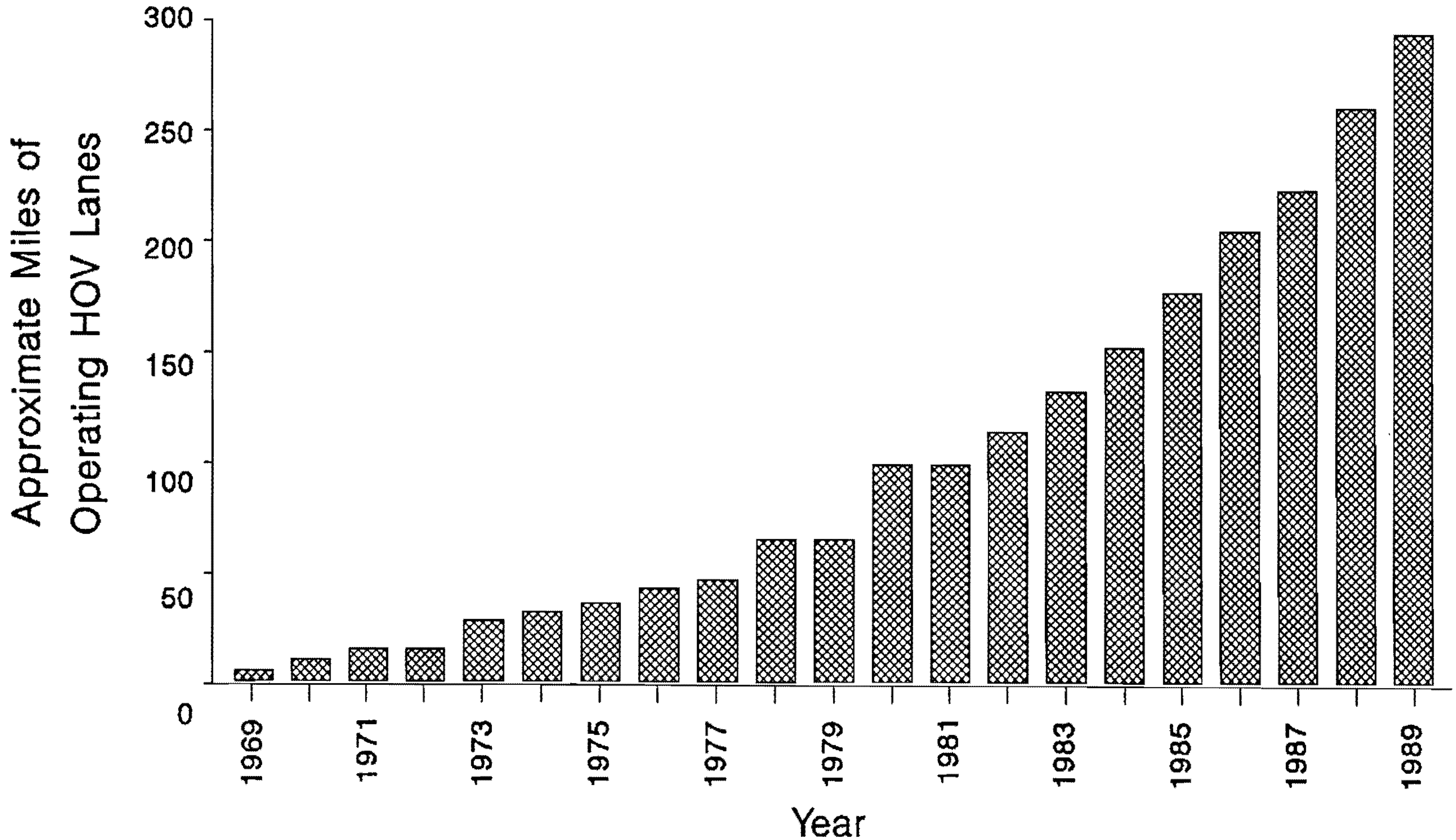
[1]Institute of Transportation Engineers, "The Effectiveness of High-Occupancy Vehicle Facilities," 1988.

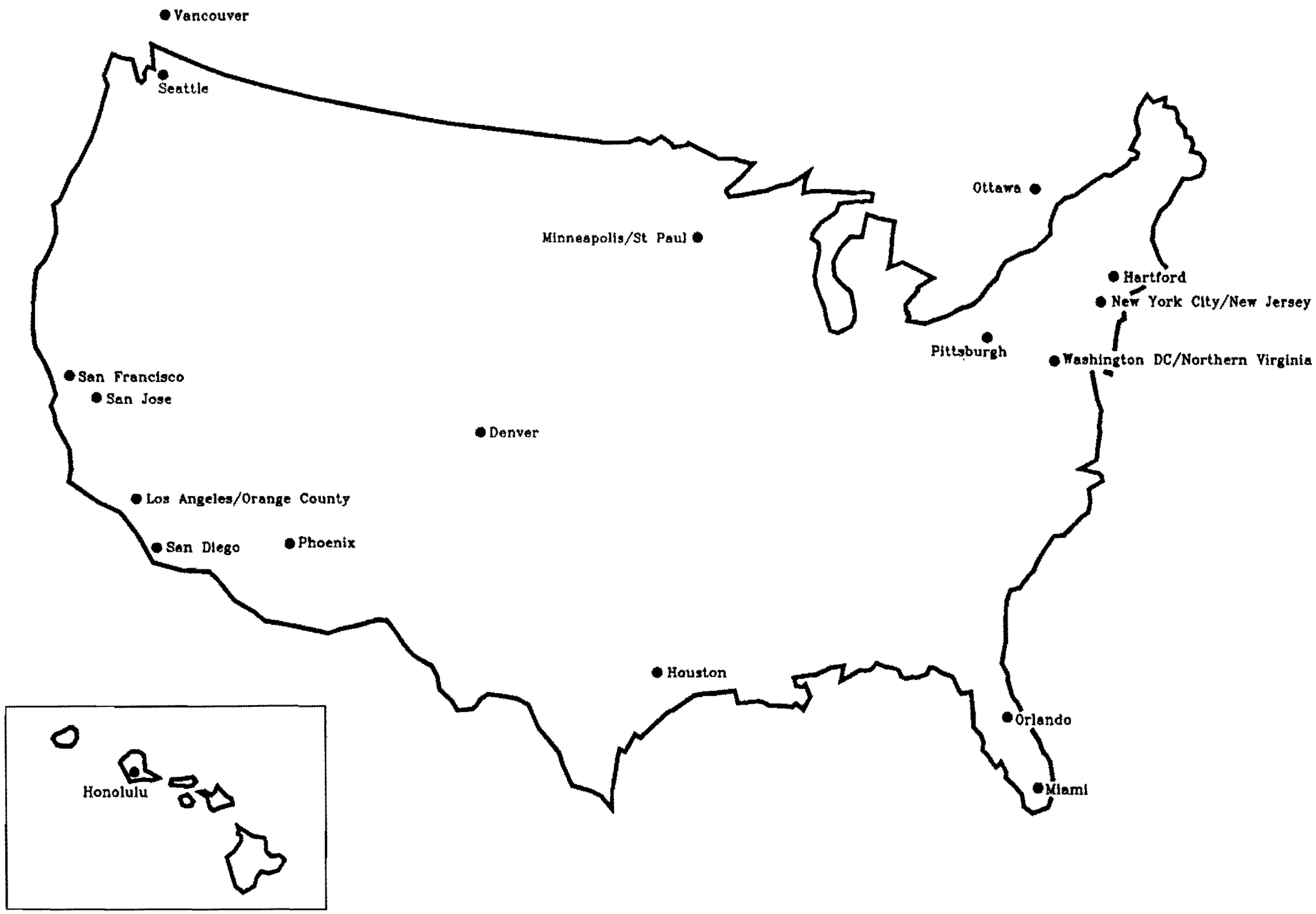
Figure 2
Miles of Operating HOV Lanes [1]



[1] Data shown are for continuously operating HOV Lanes located either on freeways or in separate rights-of-way in North America. Mileage is not shown for HOV Lanes that have been discontinued.

Figure 1

HOV Facilities in North America



the use of priority treatments for HOVs. Thus, HOV facilities are becoming more accepted as both a viable transit and a viable highway alternative.

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

Costs. While actual implementation costs depend on the type of facility and the site, when compared to other fixed-guideway transit alternatives or the addition of multiple general purpose lanes, HOV priority treatments often represent the low end of the cost scale. This is especially true when the HOV treatment is developed within existing freeway rights-of-way.

Implementation Time. HOV facilities can be planned and implemented within reasonably short time periods. While the exact timing depends on the type of facility and site, major HOV lanes have been planned, designed, and constructed within a 3- to 8-year time period.

Staged Implementation. HOV facilities allow for the staging of construction, and can be opened for use as the individual segments of the overall project are completed.

Lower Risk. Compared to other fixed transit improvements, HOV facilities often represent a lower risk option. Should the HOV lane not be sufficiently utilized, it may be converted to other uses, such as mixed-flow operation or emergency shoulders.

Multi-Agency Funding. HOV facilities are often eligible for funding from a variety of sources. Federal highway and transit funds can be used for HOV projects, and state and local transportation funds have often been used.

II. HIGH-OCCUPANCY VEHICLE FACILITIES

The HOV Facility Concept

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 are intended to 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 high-occupancy vehicles (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

Multiple User Groups. Most HOV facilities are used by not only transit vehicles but also by carpools and vanpools. Thus, multiple user groups have access to the facility, providing a wider base of support. Also, carpools are served at low marginal costs and can offer an effective means of serving suburban travel patterns that are sometimes difficult to serve with conventional transit.

Operating Speeds. Bus services operating on HOV lanes are usually express or limited-express. As a result, the line-haul travel speeds are usually fairly high, with many operating at or above 50 mph.

Flexibility. Buses, carpools, and vanpools can use the existing street system for the collection and distribution portion of the trip. This can provide a good deal of flexibility in service orientation, especially in matching service needs to changing demands. Park-and-ride lots and other support facilities need not always be located directly adjacent to the HOV lane, allowing for the ability to utilize less expensive land remote from the facility.

Time Adjustable Operation. Some priority facilities operate only in the peak periods and are used for other purposes at other times. In addition, the occupancy requirements on the facility may be different during different times of the day. This provides for the ability to increase the person carrying capacity of the facility in the future without needing to expand the vehicular capacity.

Even with these numerous potential advantages, it should be recognized that HOV facilities are not appropriate in all situations, and they represent only one of a number of potential transit and highway improvements. High-occupancy vehicle facilities, like other transit and highway alternatives, should be examined thoroughly during the planning stage to ensure that the planned improvements represent an effective and efficient alternative.

Types of HOV Facilities

This report focuses on HOV facilities operated in either freeways or in separate rights-of-way. It does not include HOV lanes on arterial streets or the use of HOV by-pass lanes at metered freeway entrance ramps. HOV facilities on freeways or in separate rights-of-way can be generally classified into 4 categories. These are described below and illustrated in Figure 3.

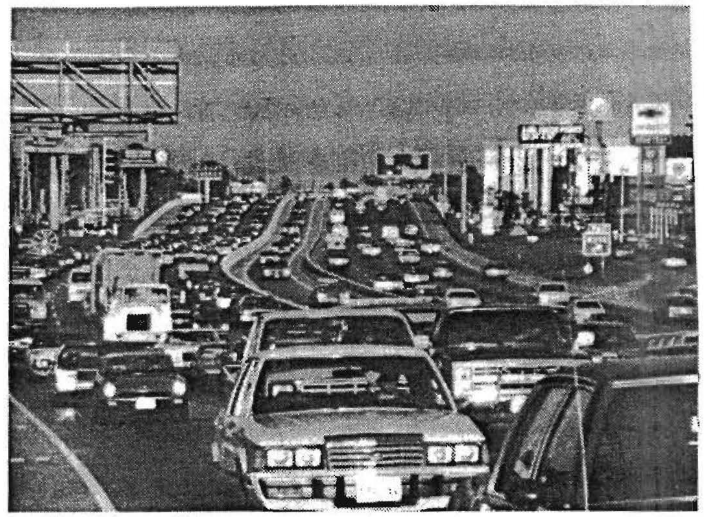
Exclusive HOV Facility, Separate Right-of-Way. A roadway or lane(s) developed in a separate right-of-way and designated for the exclusive use by high-occupancy vehicles. Most facilities of this type are designed and utilized by buses only. Most are two-lane, two-direction facilities. Examples of this type of HOV treatment are the South and East Busways in Pittsburgh and the Ottawa transitway system in Canada.

Exclusive HOV Facility, Freeway Right-of-Way. A 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. Most exclusive HOV facilities are physically separated from the general purpose freeway lanes through the use of a concrete barrier. However, a few exclusive facilities are separated from the general purpose lanes by a wide painted buffer. An example of this type of treatment is the I-84 HOV lanes in Hartford that utilize a 15-foot painted buffer to separate the HOV and mixed-traffic lanes. Facilities of this type are usually open to all types of HOVs -- buses, vanpools, and carpools. Examples of this type of HOV treatment include the Houston transitways and the Shirley Highway HOV lanes in the northern Virginia/Washington, D.C. area.

Concurrent Flow Lane. A freeway lane in the peak direction of travel, not physically separated from the general-purpose traffic lanes, designated for the exclusive use by HOVs for all or a portion of the day. Concurrent flow lanes are usually, although not always, located on the inside lane or shoulder. Paint striping is a common means used to delineate these lanes. HOV facilities of this type are usually open to buses, vanpools, and carpools.

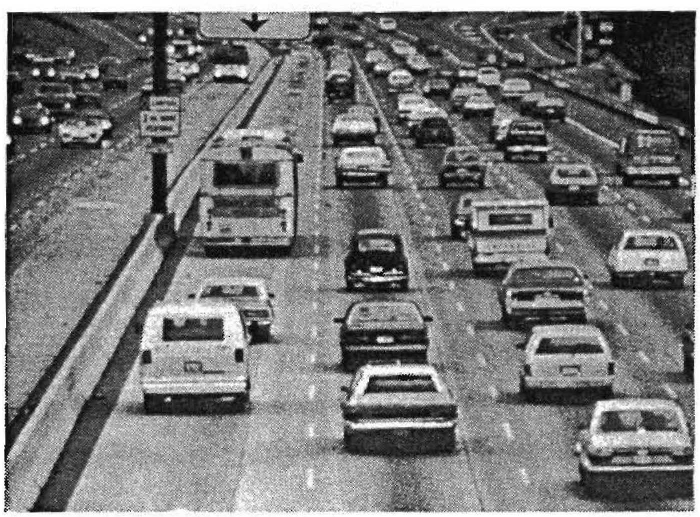
Examples of concurrent flow lanes are SR 520, I-5 and I-405 in Seattle, Route 55 in Orange County, and Route 101 in San Jose, California.

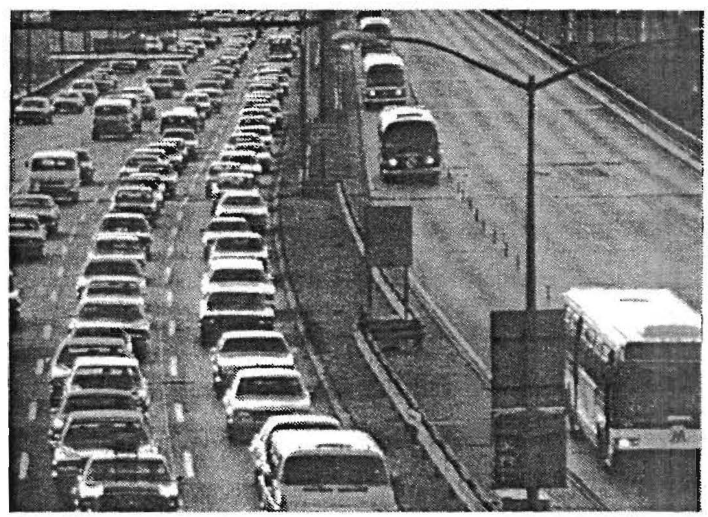
Contraflow Lane. A freeway lane in the off-peak direction of travel, commonly the inside lane, designated for exclusive use by HOVs traveling in the peak direction. The lane is typically separated from the off-peak direction general-purpose travel lanes by some type of changeable treatment, such as plastic posts or pylons that can be inserted into holes drilled in the pavement. Contraflow lanes are usually operated during the peak-periods only; many operate only during the a.m. peak-period and then revert back to normal use in non-peak periods. Examples of this type of facility include the approach to the Lincoln Tunnel on Route 495, the Long Island Expressway, and the Gowanus Expressway; all of these are located in the New York/New Jersey area.



Exclusive HOV Facility on Separate Right-of-Way Ottawa, Canada

Exclusive HOV Facility in Freeway Right-of-Way, Houston, Texas, Katy Freeway





Concurrent Flow Lane, I-5, Seattle, Washington

Contraflow Lane, Gowanus Expressway, New York City

Figure 3. Examples of High-Occupancy Vehicle (HOV) Facilities

III. SURVEY PROCESS AND HOV PROJECTS

The 1985 survey instrument utilized by the Institute of Transportation Engineers technical committee served as the basis for the 1989 survey. However, the number of questions was expanded to cover a wider variety of topics. In an attempt to match the types of questions and the information desired with the appropriate agencies, three separate questionnaires were used. One survey focused on HOV lane design and operating characteristics. This survey was usually completed by personnel from the state department of transportation or state highway department. The second survey -- which included specific questions relating to bus service, ridesharing programs and marketing efforts, in addition to general HOV lane operating characteristics -- was usually completed by representatives from the local transit agency. The third survey focused on enforcement and safety issues and was usually completed by the state patrol or other enforcement agency. Surveys were sent to the appropriate agencies, and follow-up calls for clarification of data and missing information were made as needed to provide as complete a listing of data as possible.

Information on the following HOV projects was obtained through the surveys. For each project, a brief description of the characteristics of the facility is provided along with a listing of the agencies responding to the surveys. More detailed information on each project is provided in summary tables in the next chapter.

Exclusive HOV Facilities, Separate Right-of-Way

Ottawa, Canada. Currently, approximately 15 miles of a 2-lane, 2-direction transitway system is in operation in Ottawa (Figure 4). This is part of a 19-mile, 26-station, Phase 1 system. A second phase, including an additional 19 miles, is planned for the future. The transitway system, which is restricted to bus use only, represents the fixed-guideway component of the transit system in Ottawa. The operating concept for the transitway system includes buses that operate exclusively on the transitway, and buses that provide local service and then access the transitway for a major portion of the trip. The 15-mile system includes approximately 1.5 miles of reserved bus lanes in the downtown area and 2.4 miles where buses operate in mixed-traffic lanes on the Ottawa River Parkway.

Responding Agency: Ottawa-Carleton Regional Transit Commission.

Pittsburgh, Pennsylvania. Two, 2-lane, bus-only facilities are in operation in Pittsburgh (Figure 5). The East Busway is approximately 7 miles long, and the South Busway is 4 miles in length. Service on the South Busway, which shares right-of-way with light rail transit vehicles for a portion of its length, is oriented primarily to buses operating in express fashion, after collection in the local neighborhoods. Service is focused mainly on downtown Pittsburgh. Service on the East Busway functions similar to traditional rapid transit lines, with buses operating exclusively on the facility, although there are also local and express routes which access the facility.

Responding Agency. Port Authority of Allegheny County.

Exclusive HOV Facilities, Freeway Right-of-Way

Hartford, Connecticut. A 10-mile, 2-way HOV lane opened on I-84 in Hartford in the fall of 1989 (Figure 6). The facility, which includes one lane operating in each direction, is separated from the mixed-traffic lanes by a painted 15-foot buffer. A 3+ vehicle occupancy requirement exists on the facility. The facility is reserved for HOV use on a 24-hour basis.

Responding Agency: Connecticut Department of Transportation.

Houston, Texas. Four transitways are in operation on freeways in Houston: I-45 North (North Transitway); I-45 South (Gulf Transitway); I-10 (Katy Transitway); and U.S. 290 (Northwest Transitway) (Figure 7). These facilities are primarily one-lane, reversible facilities located in the median of the freeway. A short 2-lane, two-directional segment is in operation on the southern portion of the Northwest Transitway. The lanes are separated from the general traffic lanes by concrete median barriers. As of April 1990, 46.5 miles out of a total 96 miles of planned transitway are in operation. Transitways are also under construction and in design on the Southwest and Eastex Freeways, respectively. The North Transitway is currently restricted to buses and vanpools only, although it is scheduled to be opened to 2+ carpools in June 1990. The other transitways are open to buses, vanpools, and carpools. A 2+ carpool occupancy requirement is used on these facilities, except on the Katy Transitway, which has a 3+ carpool requirement from 6:45 a.m. to 8:15 a.m.

Responding Agencies: Metropolitan Transit Authority of Harris County, Texas State Department of Highways and Public Transportation, and the Texas Transportation Institute.

Los Angeles, California. The San Bernardino Freeway (I-10) Busway operates from downtown Los Angeles to El Monte (Figure 8). A one-mile extension into the downtown area was completed in 1989. The two-way facility includes both a 5-mile barrier-separated segment and a 7-mile segment with a 13-foot paint striped buffer. Buses, vanpools, and carpools with 3 or more occupants are allowed to use the facility.

Responding Agencies: California Department of Transportation (Caltrans) and the California Highway Patrol.

Minneapolis, Minnesota. Currently, an interim HOV lane is in operation in the Highway 12/I-394 corridor (Figure 9). The interim facility includes 3 miles of a reversible, barrier-separated HOV lane located in the median of the highway. Additional concurrent flow diamond lanes are also in operation in different segments of the corridor to help manage traffic during construction. The final design of I-394, which is scheduled to open in 1993, includes 3 miles of two-lane, reversible, barrier-separated HOV lanes and eight miles of diamond lanes. The 3-mile, reversible, interim HOV lane is the facility included in this report. The facility is open to buses, vanpools, and carpools with two or more occupants.

Responding Agencies: Minnesota Department of Transportation (MN/DOT) and Minnesota State Patrol.

Pittsburgh, Pennsylvania. A 4-mile, two-lane, reversible, barrier-separated HOV facility was opened on the I-279 Freeway in August of 1989 (Figure 5). The facility includes two short, one-lane segments on the southern end, providing access to Three Rivers Stadium via I-579 and the downtown area via I-279. The facility is open to buses, vanpools, and carpools with 3 or more persons during the morning and afternoon. From 8:00 p.m. to 3:00 a.m. the lanes are open to general traffic.

Responding Agency: Pennsylvania Department of Transportation.

San Diego, California. An eight-mile, two-lane, reversible HOV facility has been open on the I-15 Freeway since October 1988 (Figure 10). The HOV lanes are located in the median of the freeway and are separated from the mixed-traffic lanes by concrete barriers. The facility is open to buses, vanpools and carpools with 2 or more persons during the morning and afternoon peak periods.

Responding Agencies: California Department of Transportation (Caltrans) and California Highway Patrol (CHP).

Washington, D.C./Northern Virginia. Two exclusive HOV facilities are in operation in the Washington, D.C. metropolitan area (Figure 11). These are located on the Shirley Highway (I-395) and on I-66. The HOV lanes on the Shirley Highway are located in the median of the freeway and are separated from the general-traffic lanes by concrete barriers. The facility includes two reversible lanes that operate inbound in the morning and outbound in the afternoon. HOV usage is restricted to the peak periods. General traffic is allowed to use the lanes outside of the peak period. In addition, concurrent flow diamond lanes, utilizing the inside traffic lane, are located on I-95 leading up to the Shirley Highway. I-66 is a four-lane freeway. During the peak periods, the two lanes in the peak direction are reserved for HOVs only. A 3+ occupancy requirement is currently used on all three facilities.

Responding Agencies: Virginia Department of Transportation and Virginia State Police.

Concurrent Flow Lanes

Denver, Colorado. A four-mile, bus-only concurrent flow lane is in operation in the peak direction during the a.m. peak period on a portion of U.S. 36 (Boulder Turnpike) in the Denver area (Figure 12). The lane is separated from the general-purpose lanes by a solid white paint stripe.

Responding Agency: Denver Regional Transit District (RTD).

Fort Lee, New Jersey/ New York City. A 1-mile HOV lane is operated in the morning peak period on the approach to the George Washington Bridge in Fort Lee, New Jersey, in the New York metropolitan area (Figure 13). The lane allows high-occupancy vehicles to by-pass the traffic queue and access the toll facility. The width of the lane varies from 12 feet to 20 feet and the exact configuration varies over the one-mile segment. The lane is separated from the general-purpose lanes by paint striping. The lane is open to buses, vanpools, and carpools with 3 or more occupants.

Responding Agencies: New Jersey Department of Transportation and Port Authority of New York and New Jersey.

Honolulu, Hawaii. Two HOV facilities are in operation in Honolulu (Figure 14). The inside lane on a 2.5 mile segment of the Moanalua Freeway is reserved for HOVs in the eastbound direction during the morning peak period. During other times of the day, the lane reverts to use by mixed-flow traffic. Seven miles of concurrent flow HOV lanes are in operation on H-1. The lanes are reserved for HOVs during the morning and afternoon peak periods, and are used by general traffic at other times. A 2+ carpool occupancy requirement is used on both facilities.

Responding Agencies: Honolulu Police Department and Federal Highway Administration.

Los Angeles, and Orange County, California. Concurrent flow HOV lanes have been in operation on Route 55 and Route 91 for a number of years, and on I-405 since 1988 (Figure 8). Called Commuter Lanes, these facilities are located on the inside lane and/or shoulder. The facilities are open to buses, vanpools, and carpools with 2+ occupants, and are separated from the general traffic lanes by a 4-foot or less painted buffer.

Responding Agencies: California Department of Transportation (Caltrans) and California Highway Patrol (CHP).

Miami, Florida. The inside freeway lanes on a 14-mile segment of I-95 in Miami operate as concurrent flow HOV lanes during the morning and evening peak periods (Figure 15). The lanes are separated from the general purpose lanes by white paint striping. A 2+ carpool occupancy requirement is used. At other times the lanes are used as mixed-traffic lanes.

Responding Agencies: Florida Department of Transportation and Metro-Dade Transit Agency.

Orlando, Florida. The inside lane in each direction on a 30-mile segment of I-4 in the Orlando area is reserved for HOVs during the morning and evening peak periods (Figure 16). At other times, the lanes are used as mixed-traffic lanes. The lanes are marked with the diamond symbol, and are separated from the mixed-traffic lanes by paint striping. A 2+ carpool occupancy requirement is used.

Responding Agency: East Central Florida Regional Planning Council.

Phoenix, Arizona. Concurrent flow HOV lanes are in operation on a 7-mile segment of I-10 in Phoenix, Arizona (Figure 17). The lanes are separated from the general-purpose lanes by a 4-foot painted median. The lanes are operated 24 hours a day and are open to buses, vanpools, and carpools with 2 or more persons and motorcycles. An additional 10 miles of HOV lanes opened on I-10 in January, 1990, and further extensions are under construction.

Responding Agency: Arizona Department of Transportation.

San Francisco, California. Three concurrent flow HOV facilities are in operation in the San Francisco area (Figure 18). These facilities are the Oakland Bay Bridge approach, US 101 in Marin County, and I-280. Four westbound lanes on the approach to the toll plaza on the Oakland Bay Bridge are reserved for HOVs during the morning and afternoon peak periods. The facility is open to buses, vanpools, and carpools with 3 or more occupants. On US 101, the inside freeway lane on two segments, totaling 7 miles, is designated as a concurrent flow HOV lane in the morning and afternoon peak periods. The lane is separated from the mixed-traffic lanes by paint striping. The facility is open to buses, vanpools, and carpools. A 3+ occupancy requirement was used on the facility until September 1989, when an 18 monthly demonstration was initiated lowering the occupancy requirement to 2+. One and six-tenths miles of concurrent flow lanes are operated on I-280. The lanes are separated from the mixed-traffic lanes by an 8-foot painted buffer and are operated as HOV lanes on a 24-hour basis. The I-280 facility has been closed since the earthquake in the fall of 1989. It is anticipated that it will reopen in September of 1990.

Responding Agencies: California Department of Transportation (Caltrans) and the California Highway Patrol (CHP).

San Jose, California. HOV lanes are in operation on 3 expressways and 1 freeway in the San Jose area (Figure 19). The outside shoulders are used on a 4-mile section of Route 237, a signalized expressway, to provide a peak-direction only HOV lane. The outside lane on a 5-mile segment of the Montague Expressway, a signalized expressway, is operated as an HOV lane during peak periods. On both of these facilities, in the morning the inbound lane is reserved for HOVs, and in the afternoon the outbound lane is used. At other times the lane is open to general traffic. The lanes are separated from the mixed-traffic lanes by a four-inch paint stripe. On Route 101, approximately 11 miles of the inside freeway lane in each direction are reserved for HOVs during the peak periods. These lanes, which are separated by normal paint striping, revert back to general purpose lanes during the off-peak periods. The San Tomas Expressway, a signalized expressway, includes 11 miles of concurrent flow HOV lanes utilizing the outside lane and shoulder. The lanes are operated in the peak direction only during the peak periods. Normal paint striping is used to delineate the lanes. During non-peak periods, the lanes revert to general-purpose lanes and shoulders. The occupancy requirement on all these facilities is 2+.

Responding Agencies: California Department of Transportation (Caltrans), California Highway Patrol (CHP) and Santa Clara County Transportation Agency.

Seattle, Washington. Four concurrent flow HOV lanes are in operation in the Seattle area on I-5, I-90, I-405 and SR 520 (Figure 20).

- I-5. To the north of the downtown area, a 2.8-mile HOV lane operates in the express lanes in the southbound direction. This facility is in operation only when the express lanes are open in the southbound direction. A 2+ occupancy requirement is used in this facility. Forther to the north, HOV lanes are located in both the express lanes and the mainlanes on a 6-mile segment of I-5. On the mainlanes, the inside lane in each direction operates as an HOV lane with a 3+ occupancy requirement on a 24-hour basis.

- I-90. A five-mile, concurrent flow, interim HOV lane operates westbound on I-90. A 3+ occupancy requirement is used on this facility, which is open on a 24-hour basis. The final design for I-90, which is scheduled to open in 1991, includes approximately 10 miles of a 2-lane, reversible HOV facility located in the freeway median.

- SR-520. A 3-mile HOV lane operates only in the westbound direction on SR-520 on a 24-hour basis. The facility is separated by paint striping. A vehicle occupancy requirement of 3+ is used on SR-520

- I-405. Six miles of HOV lanes are operated on a 24-hour basis on I-405. These are located on the outside lanes and operate in both directions. The occupancy requirement on I-405 is 2 or more persons.

Responding Agencies: Washington State Department of Transportation and Seattle Metro.

Vancouver, Canada. Bus only, concurrent flow lanes are in operation on H-99 in Vancouver, Canada (Figure 21). A 4-mile, bus-only lane is provided on H-99 in the southbound direction before the Massey Tunnel, and a 1-mile bus-only lane is provided in the northbound direction before the tunnel. Both lanes are located on the outside shoulder and are separated from the general-purpose lanes by paint striping. The lanes operate on a 24-hour basis, allowing buses to by-pass the queue that often forms in the general purpose lanes on the approach to the tunnel.

Responding Agencies: British-Columbia Transit and British Columbia Provincial Ministry of Highways.

Washington, D.C./Northern Virginia. Concurrent flow HOV lanes are located on a 7-mile segment of I-95 leading to the Shirley Highway (Figure 11). The HOV lanes utilize the inside general-purpose lane during the peak period and are separated from the mixed-traffic lanes by paint striping. The lanes revert to general-purpose lanes outside the restricted periods. When the HOV lane is in opreation the outside shoulder lane is used as a general purpose lane, providing 3 mixed-traffic lanes and the HOV lane for use during the peak period in the peak direction. Outside of this period the outside shoulder reverts back to use as an emergency shoulder. A 3+ occupancy requirement is used.

Responding Agencies: Virginia Department of Transportation and Virginia State Patrol.

Contraflow Lanes

New York City. Three contraflow lanes are in operation in the New Jersey/New York City area (Figure 13). During the morning peak period, a 2.5-mile contraflow lane operates on New Jersey Route 495 (formerly I-495) on the approach to the Lincoln Tunnel. The bus-only lane is separated from the mixed-traffic lanes by drop-in cones. A 2.2-mile contraflow lane operates westbound on the Long Island Expressway, from the Brooklyn-Queens Expressway into the Queens-Midtown Tunnel. The lane operates only in the morning peak period and is open to buses, vanpools and taxis. The lane is separated from the general-purpose lanes by drop-in cones. A 0.9-mile contraflow lane operates on the Gowanus Expressway, northbound from the Prospect Expressway into the Brooklyn-Battery Tunnel. The facility is also operated only in the morning peak period and is open to buses, vanpools and taxis. The lane is separated from the general-purpose lanes by drop-in cones.

Responding Agencies: Port Authority of New York and New Jersey, New Jersey Transit, New York City Department of Transportation, and New Jersey Turnpike Authority.

Figure 4

Ottawa Transitway System

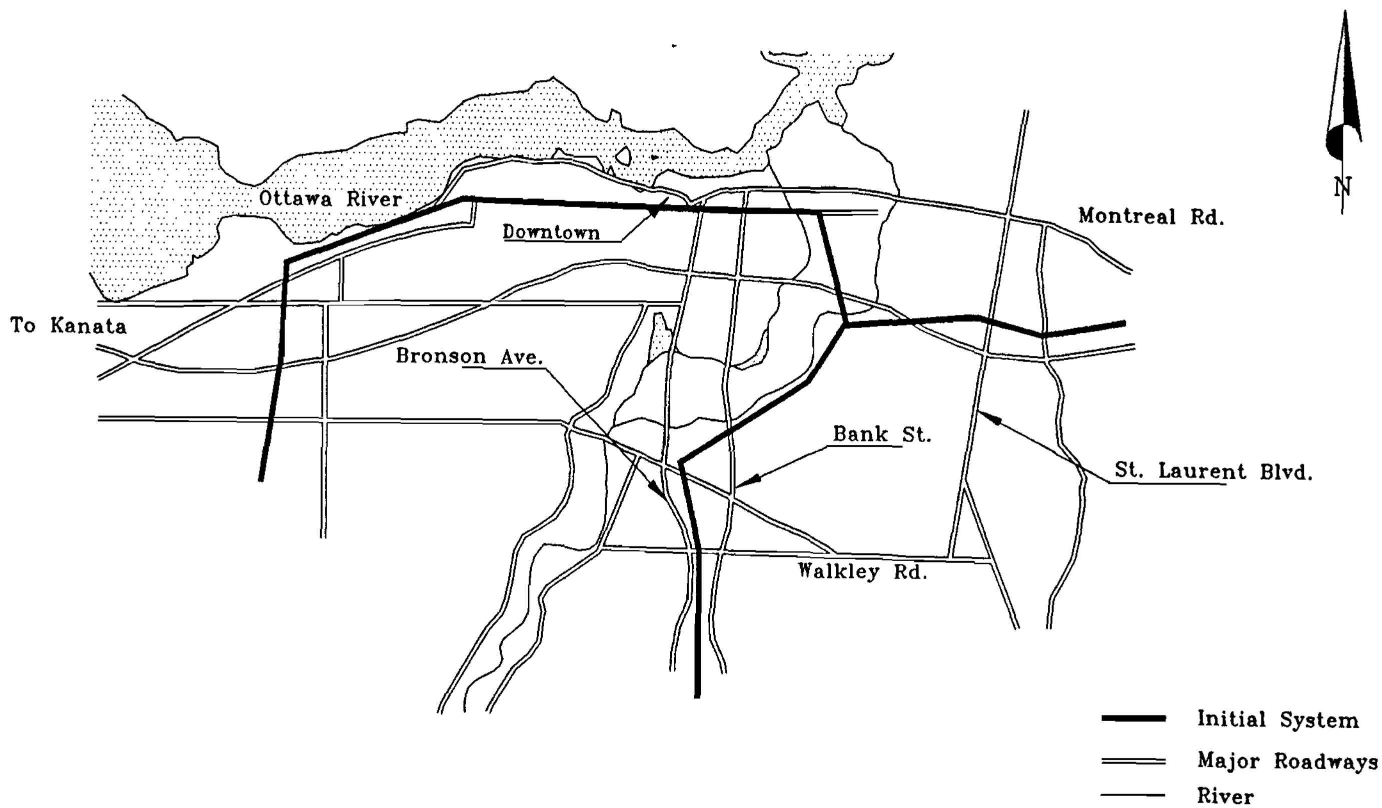


Figure 5

Pittsburgh
Busways and HOV Lanes

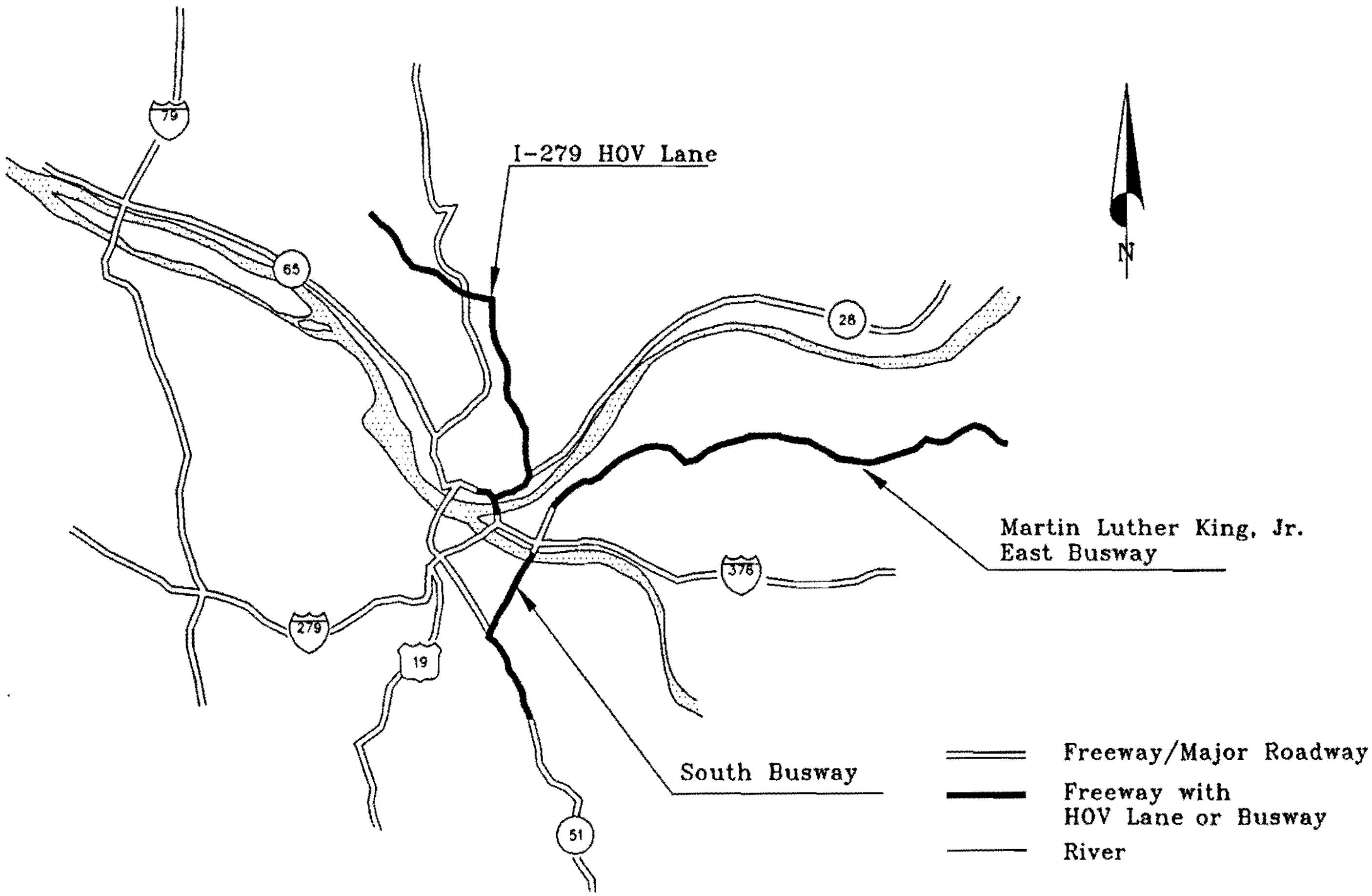
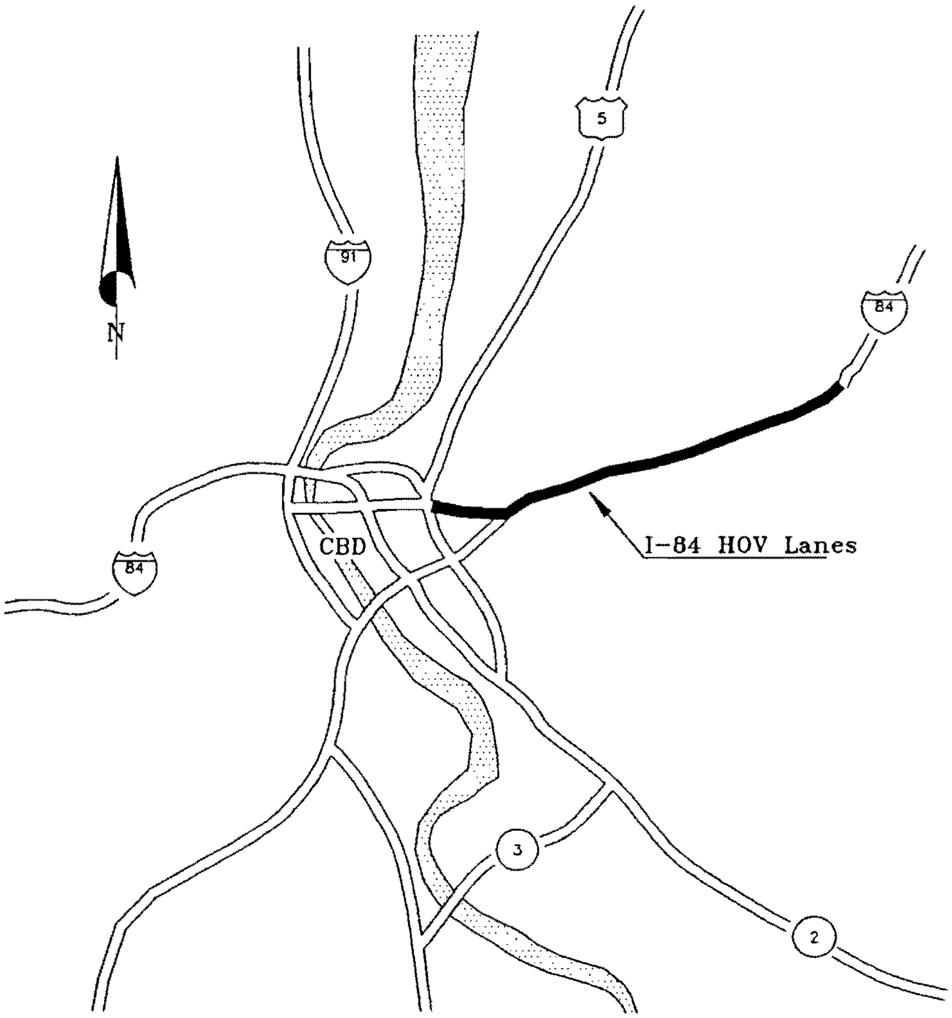


Figure 6

Hartford
I-84 HOV Lanes



Freeway/Major Roadway

Freeway with
HOV Lane

River

Figure 7

Houston Transitways

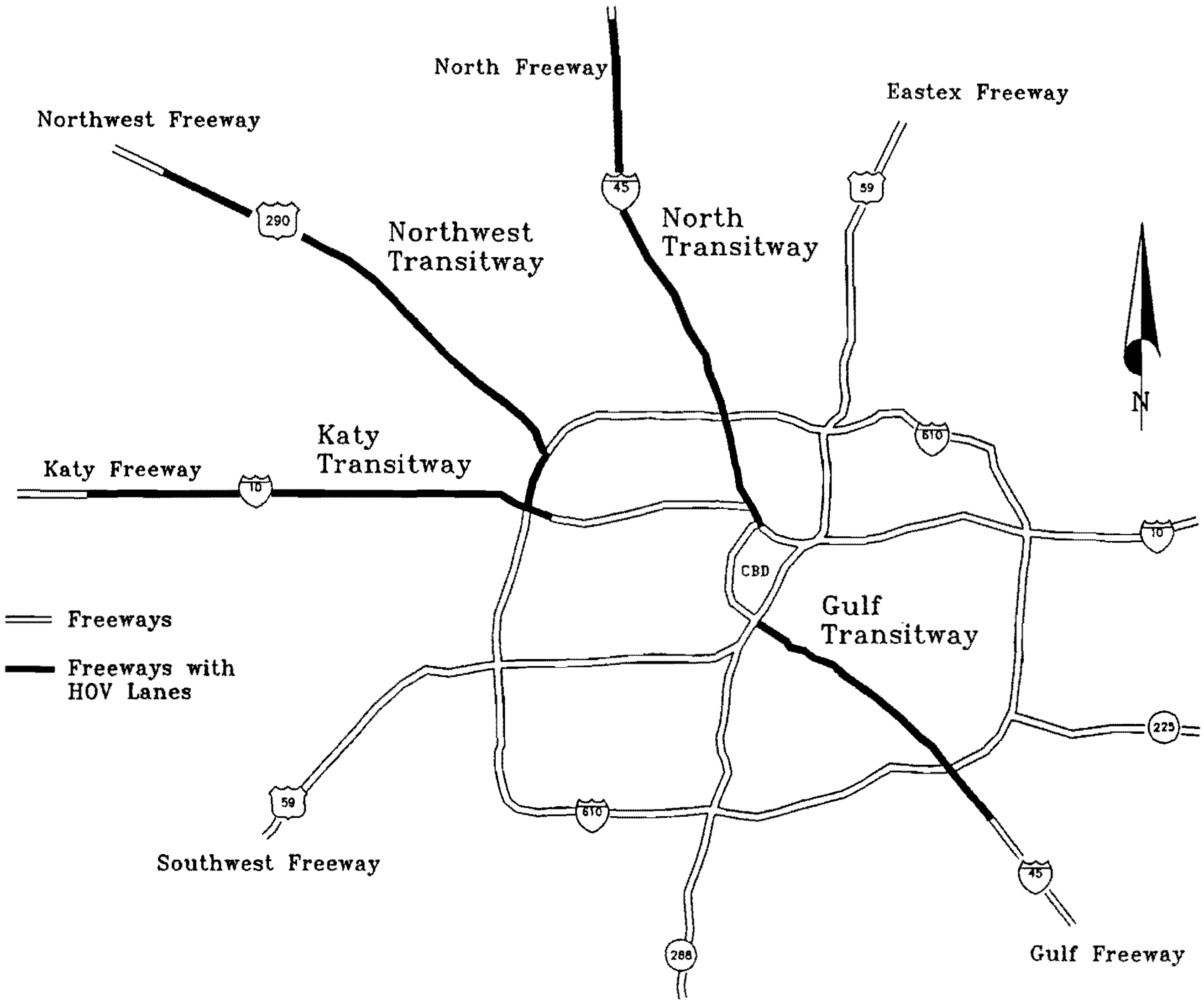


Figure 8

Los Angeles/Orange County
HOV Lanes

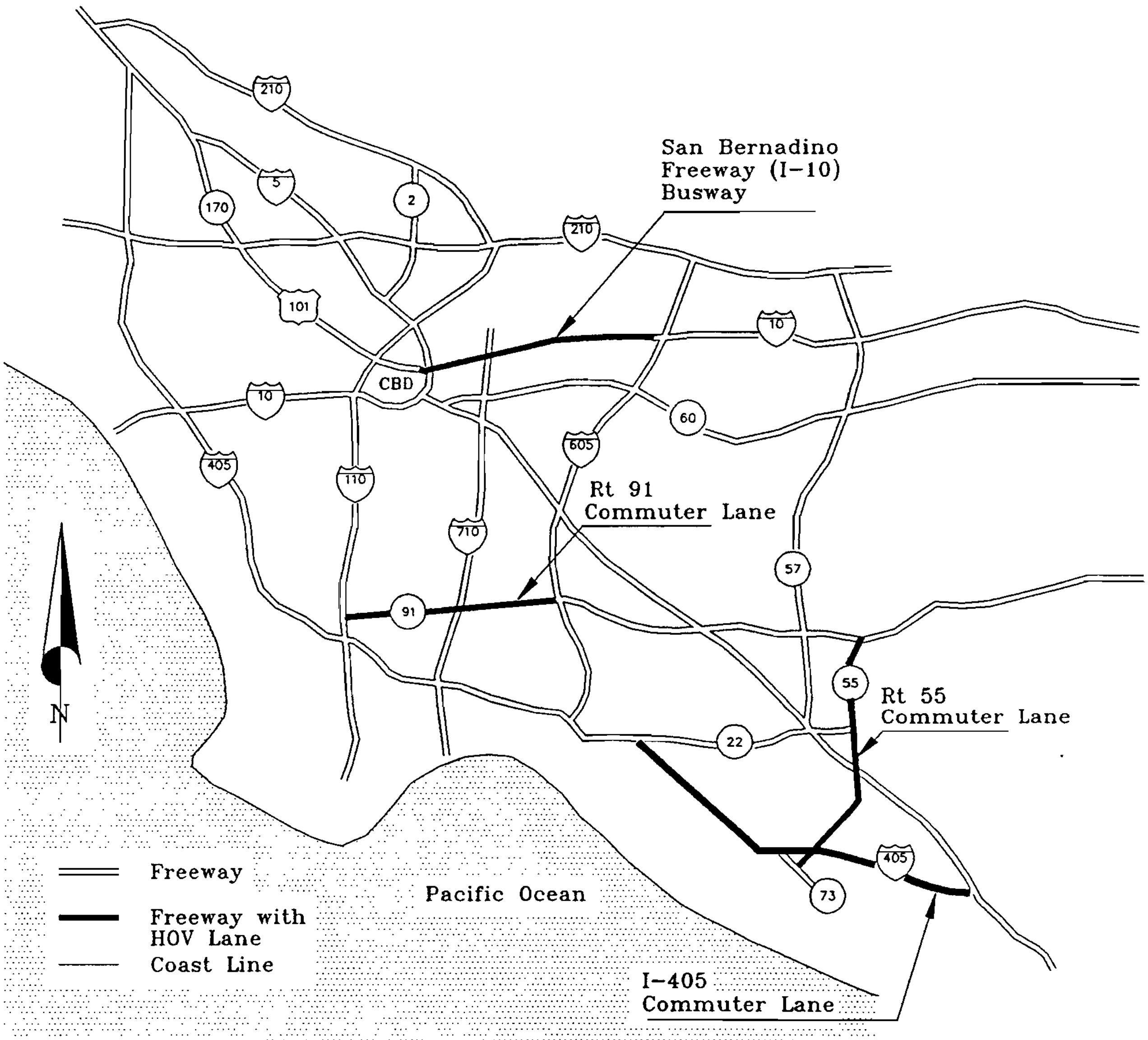


Figure 9

Minneapolis/St Paul
Metropolitan Area
I-394 HOV Lanes

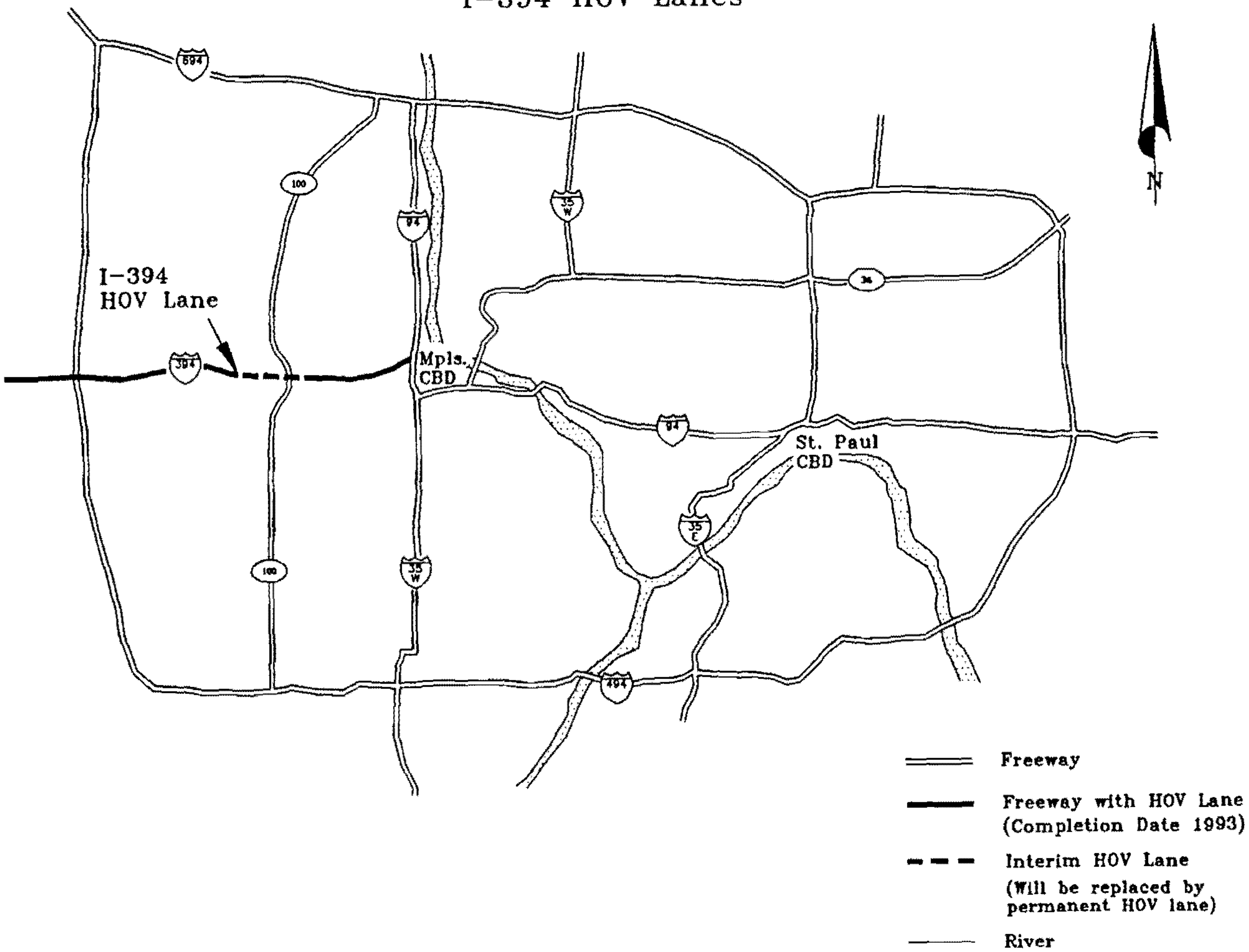


Figure 10

San Diego
I-15 HOV Lanes

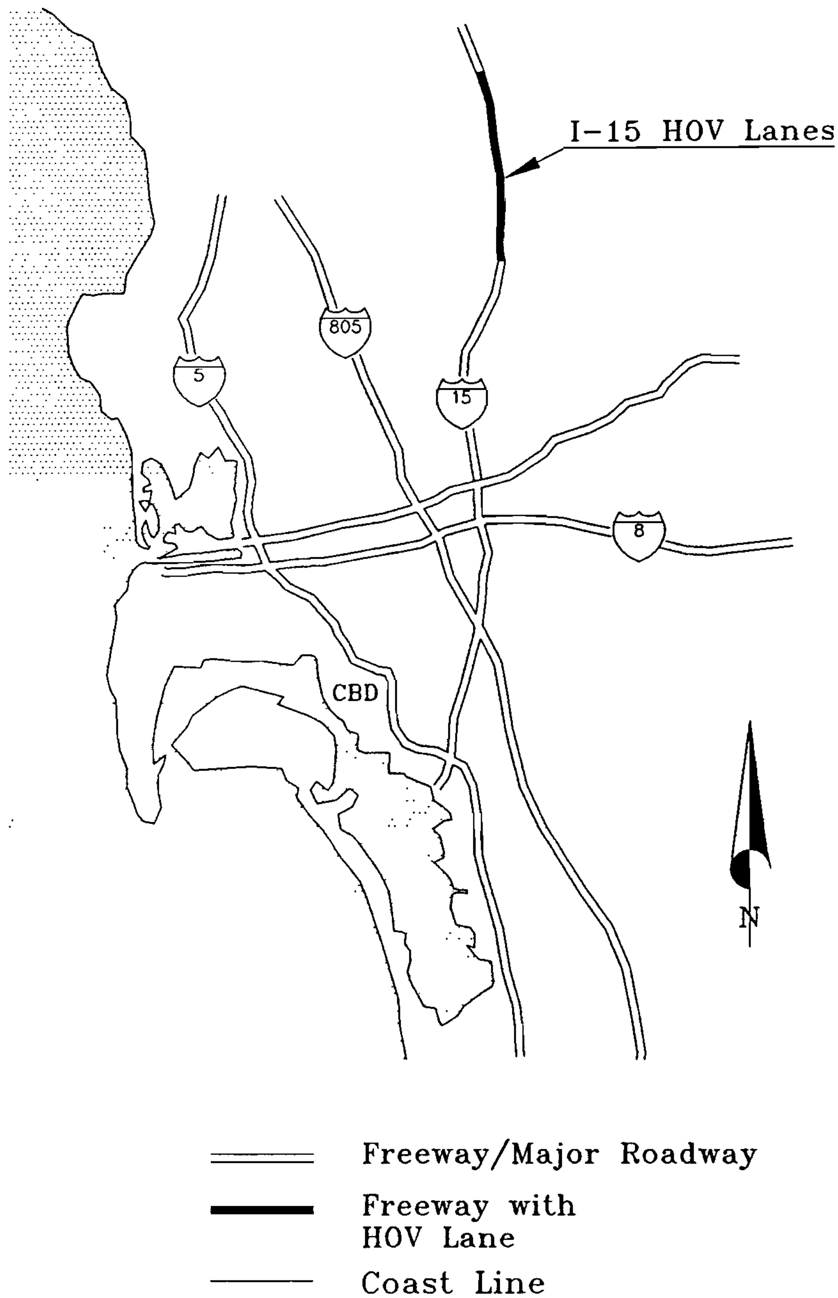


Figure 11

Washington D.C./Northern Virginia
HOV Lanes

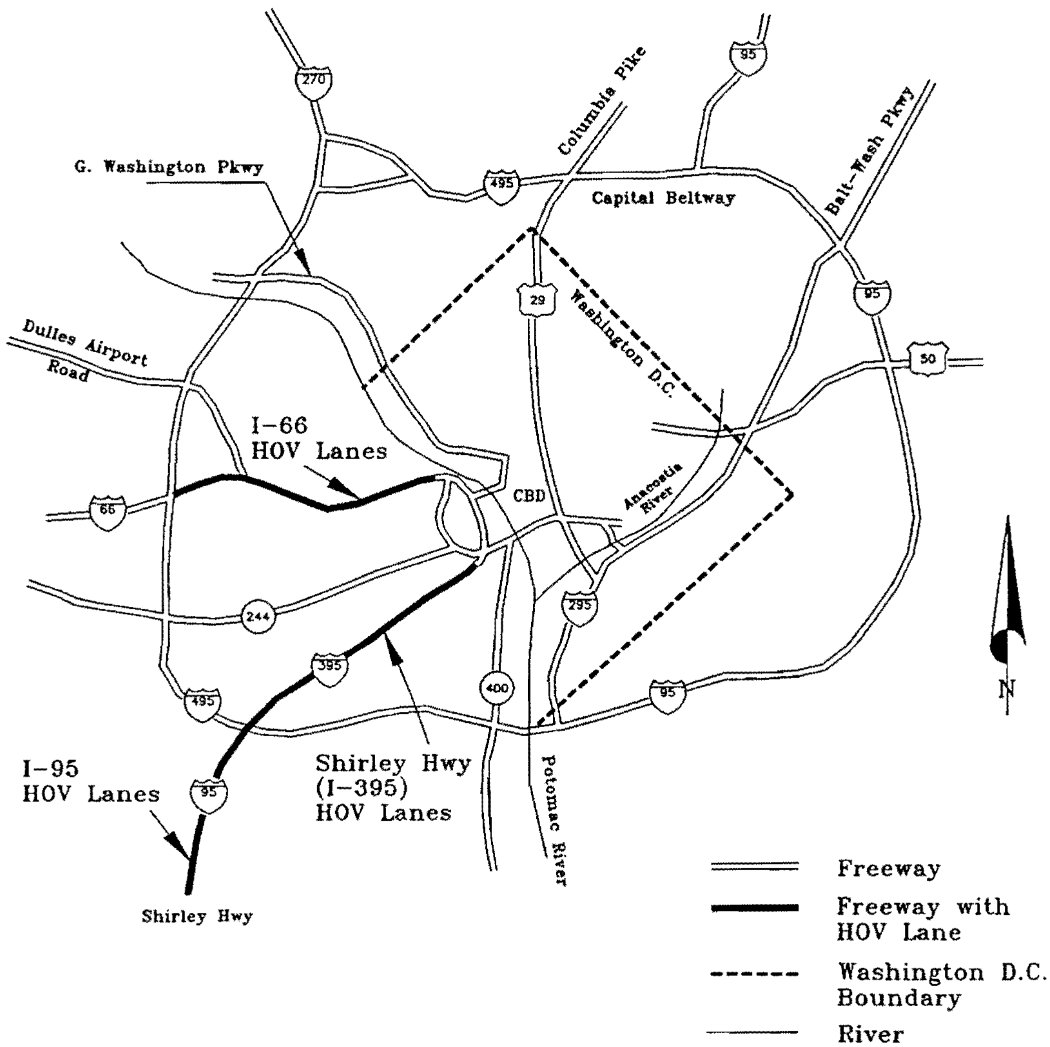


Figure 12

Denver
US 36 (Boulder Turnpike)
Bus Lane

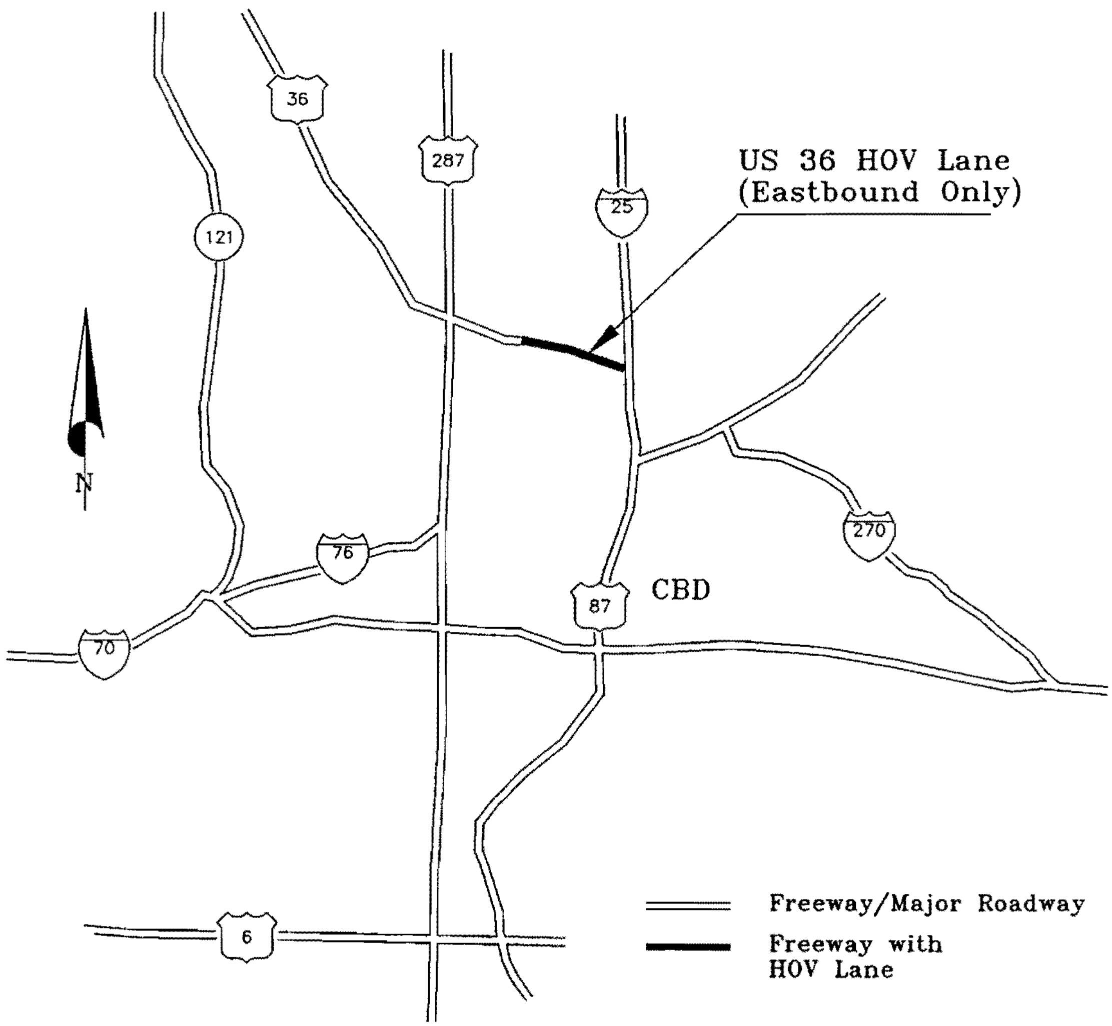


Figure 13

New York City/New Jersey HOV Facilities

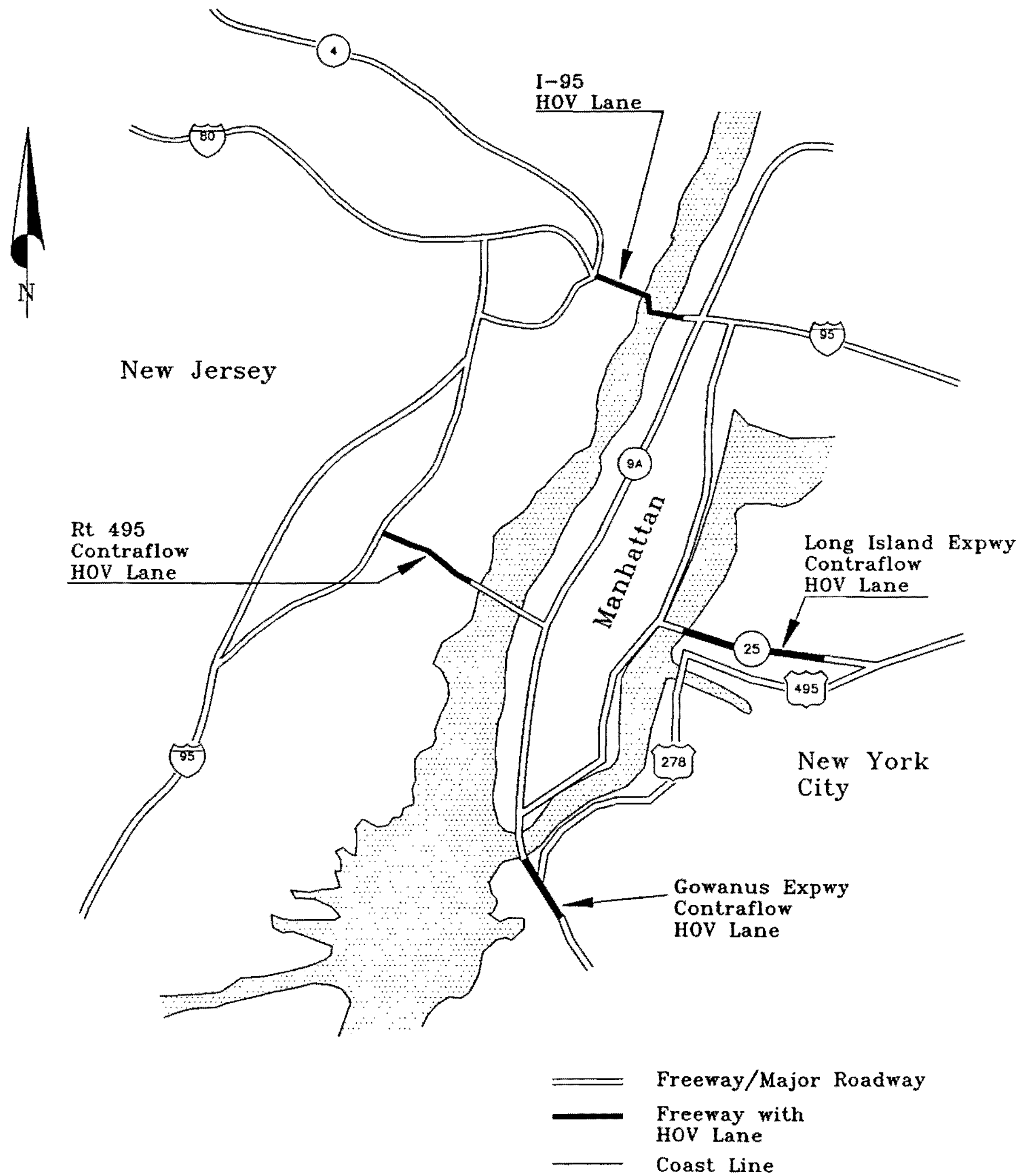


Figure 14

Honolulu
HOV Facilities

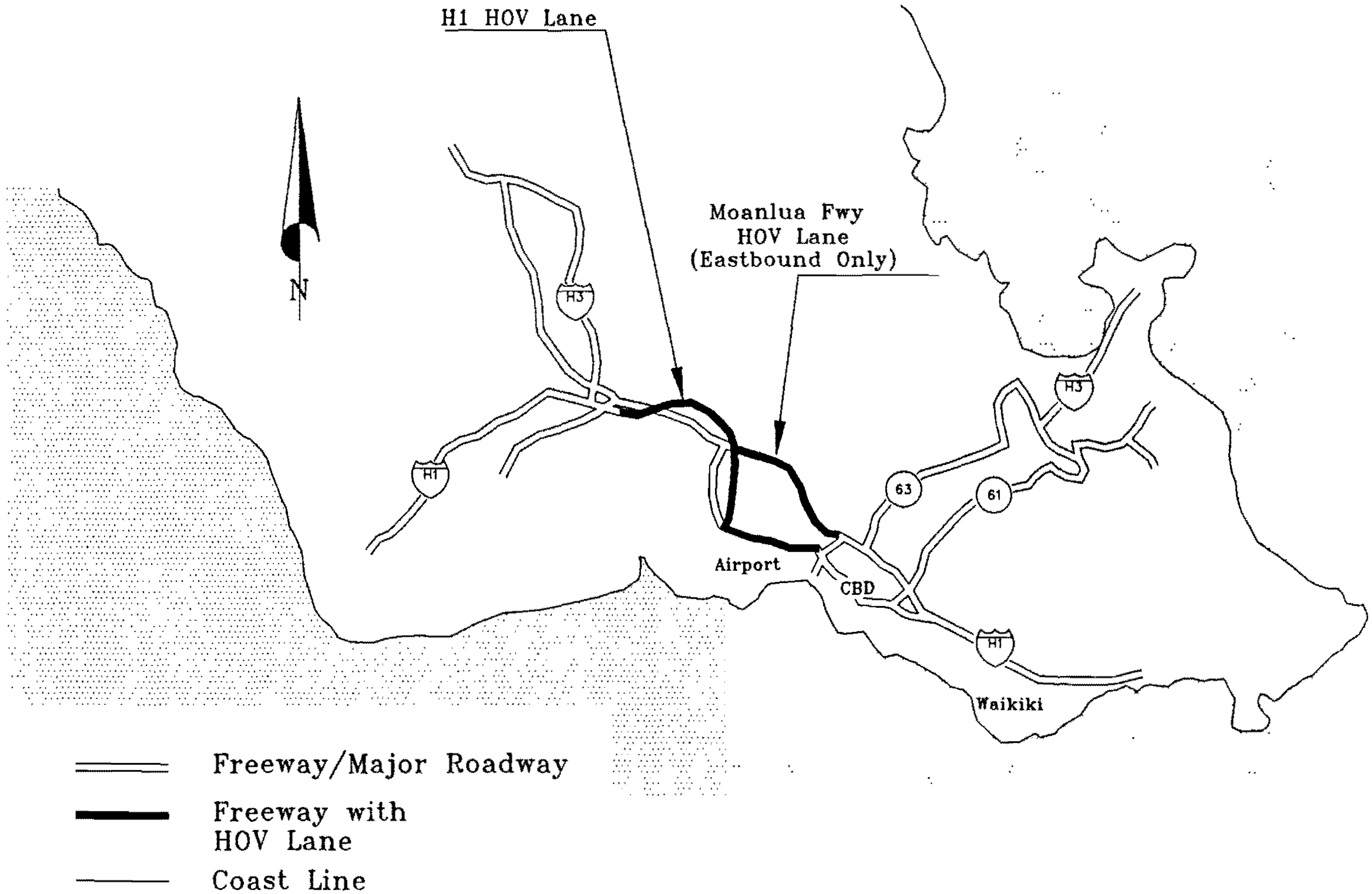


Figure 15

Miami
I-95 HOV Lanes

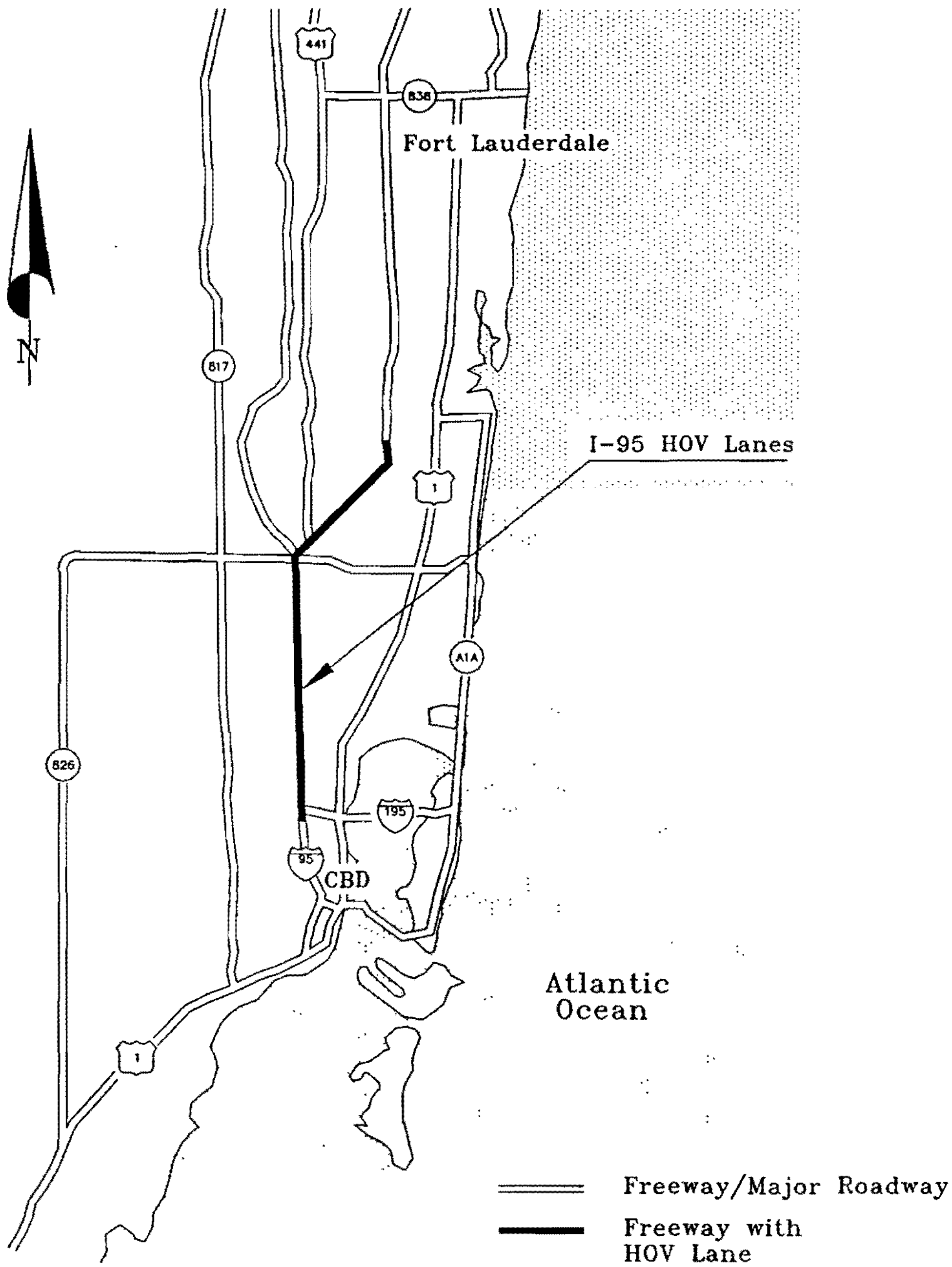


Figure 16

Orlando
I-4 HOV Lanes

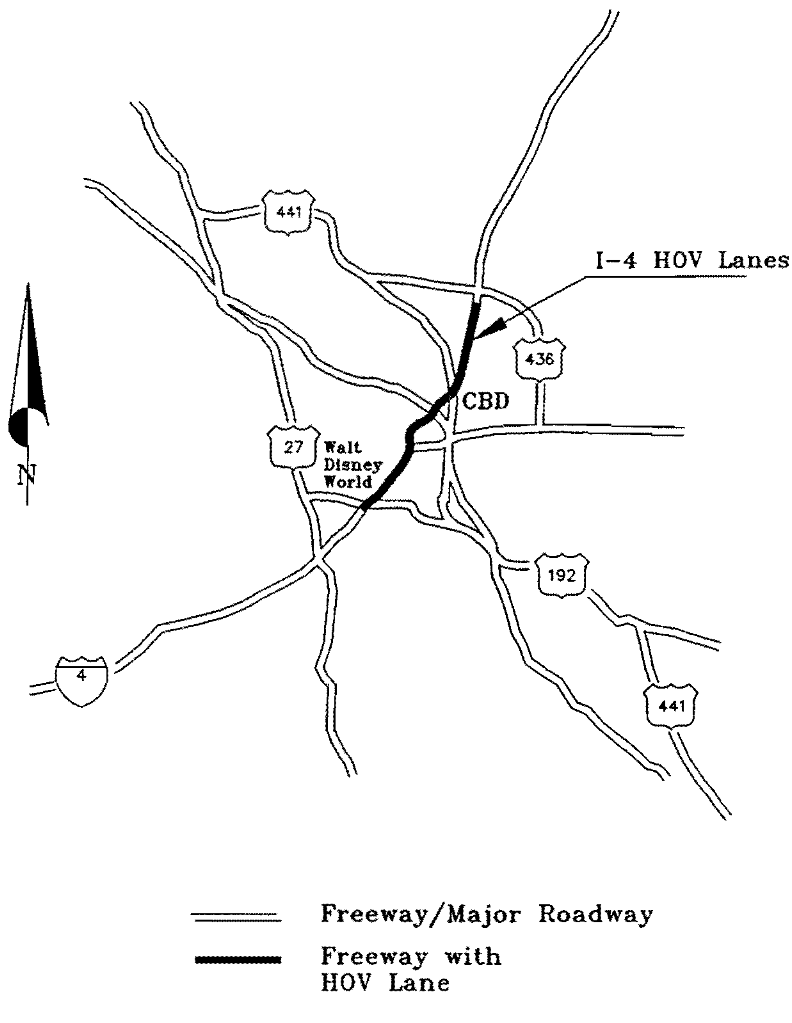


Figure 17

Phoenix
I-10 HOV Lanes

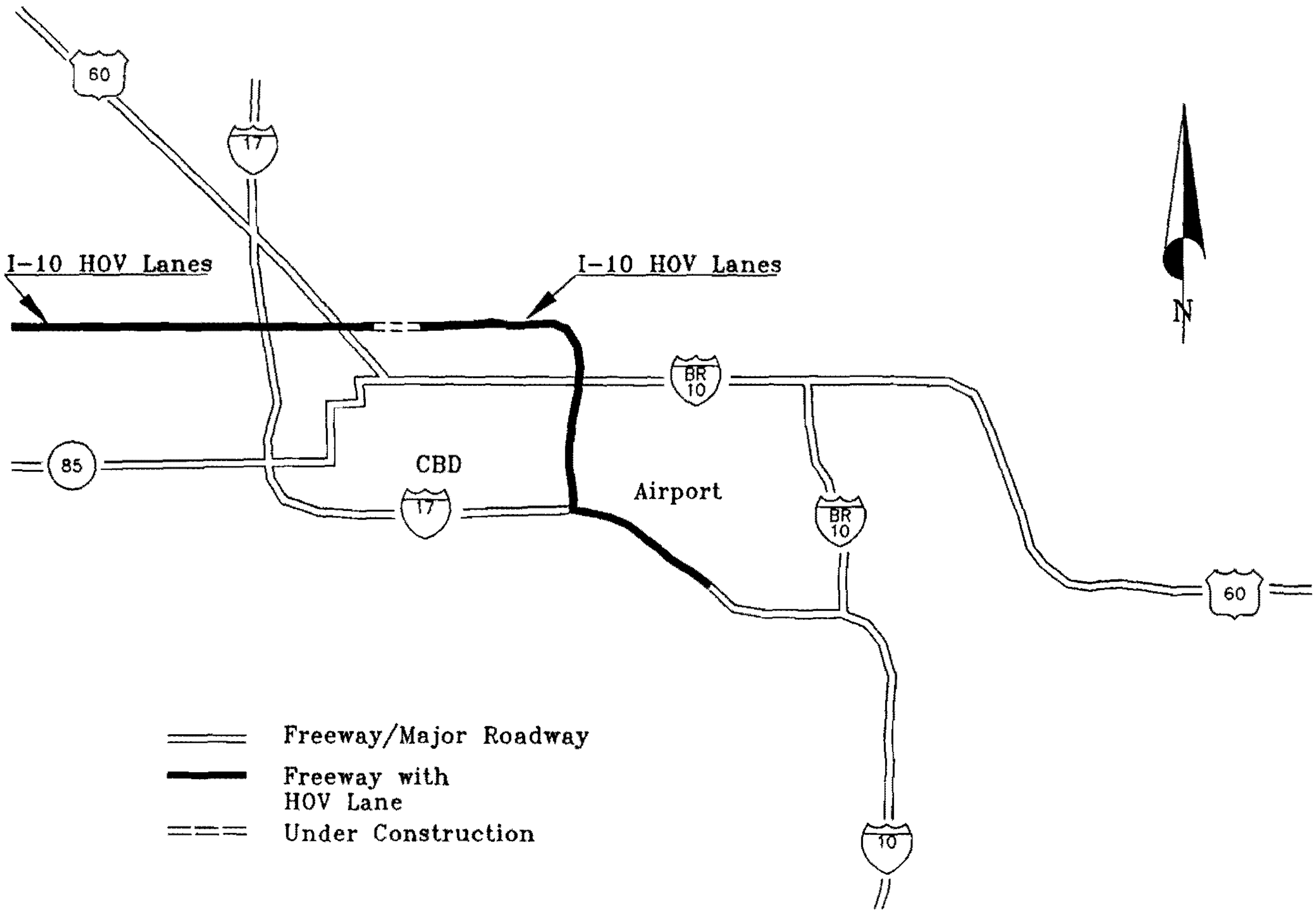


Figure 18

San Francisco/Oakland
HOV Lanes

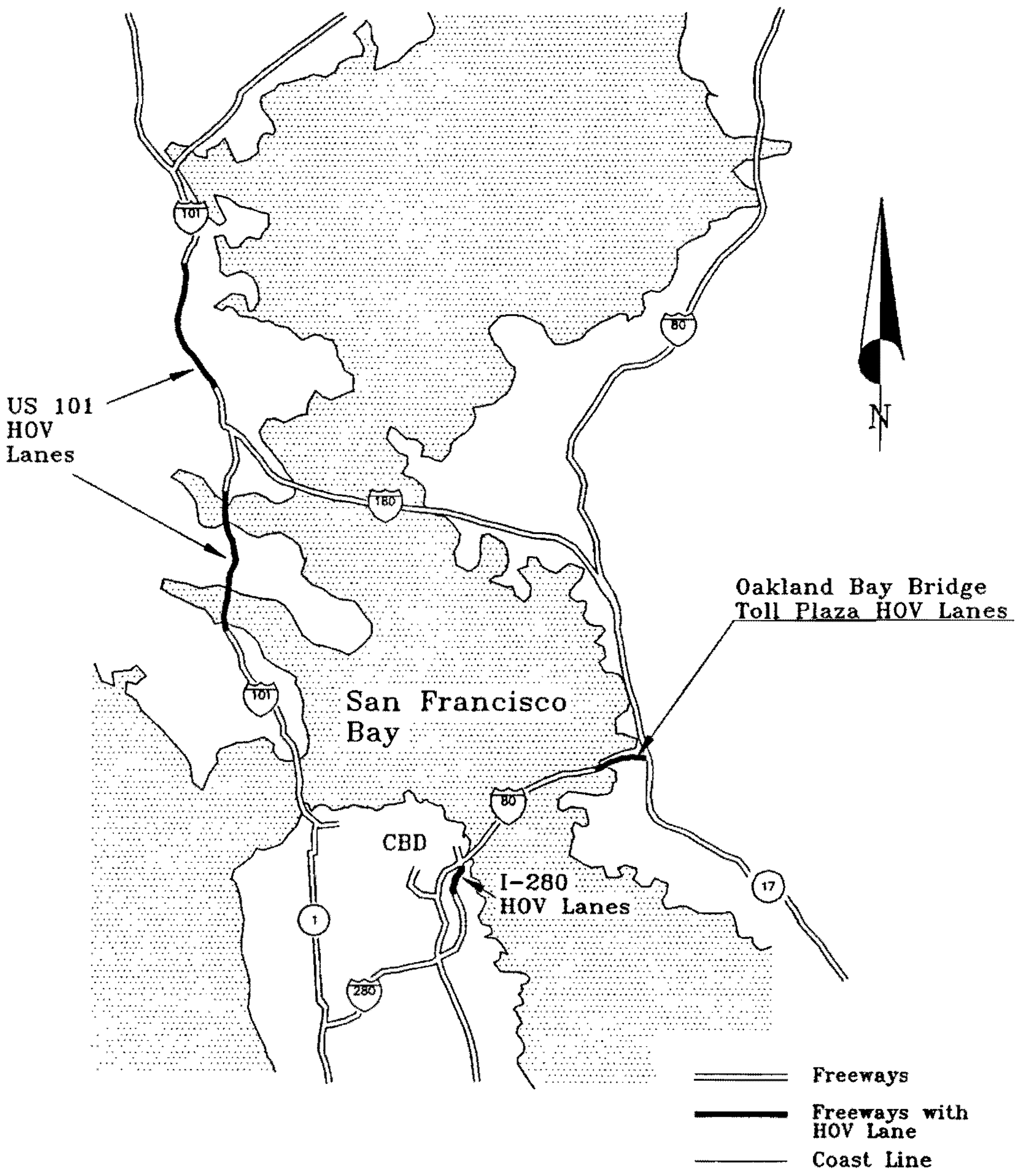


Figure 19

San Jose/Santa Clara County
HOV Lanes

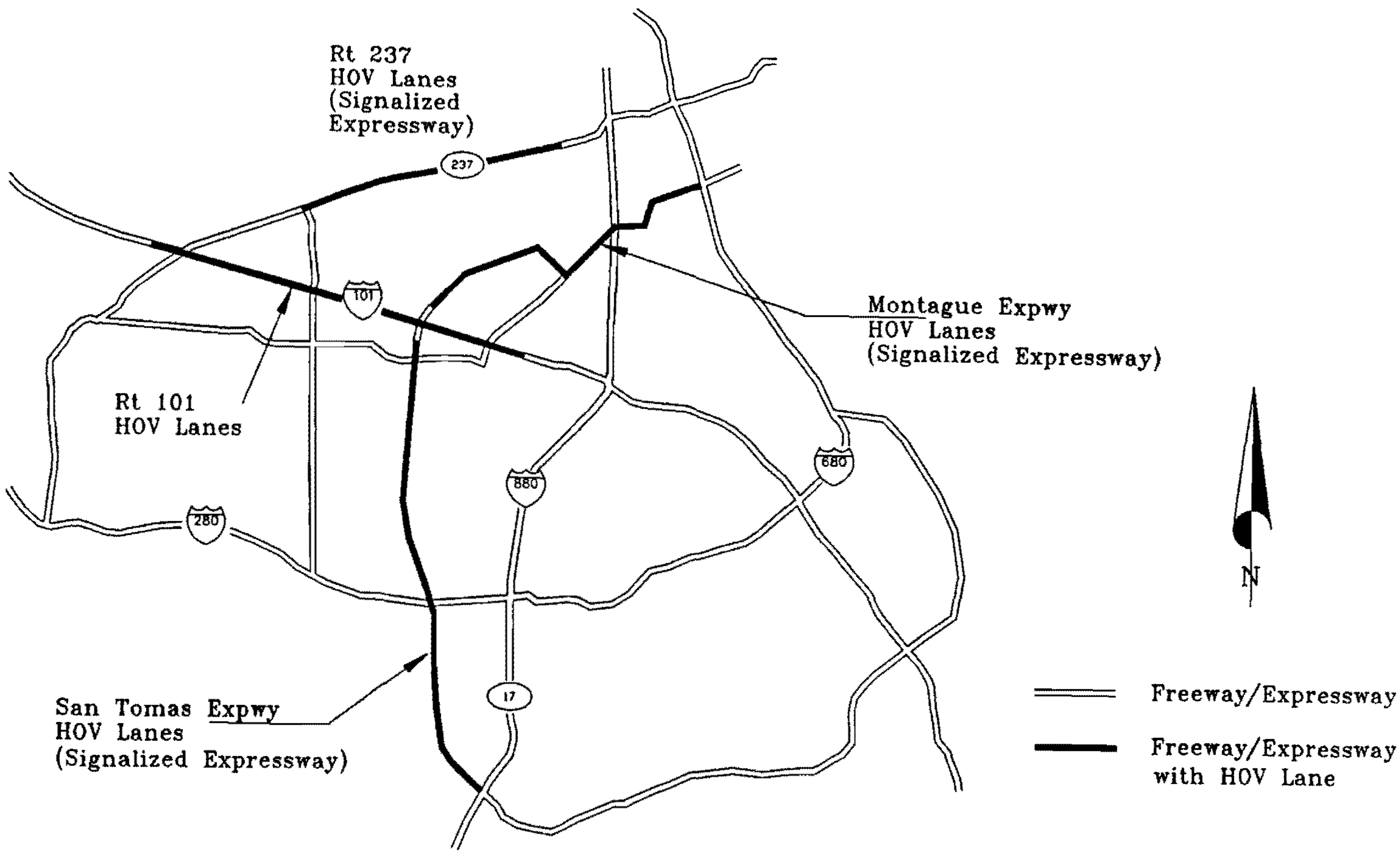


Figure 20

Seattle HOV Lanes

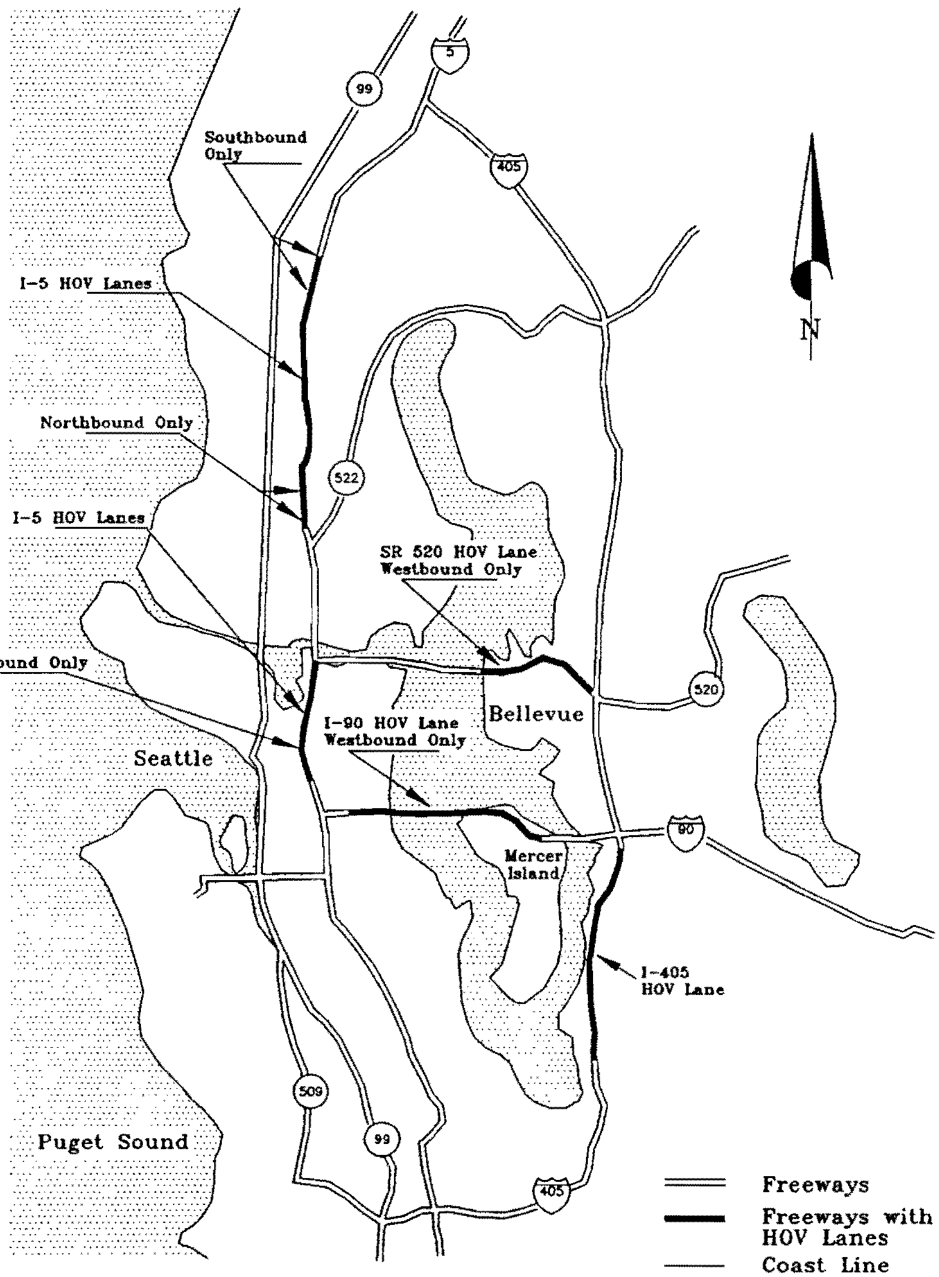
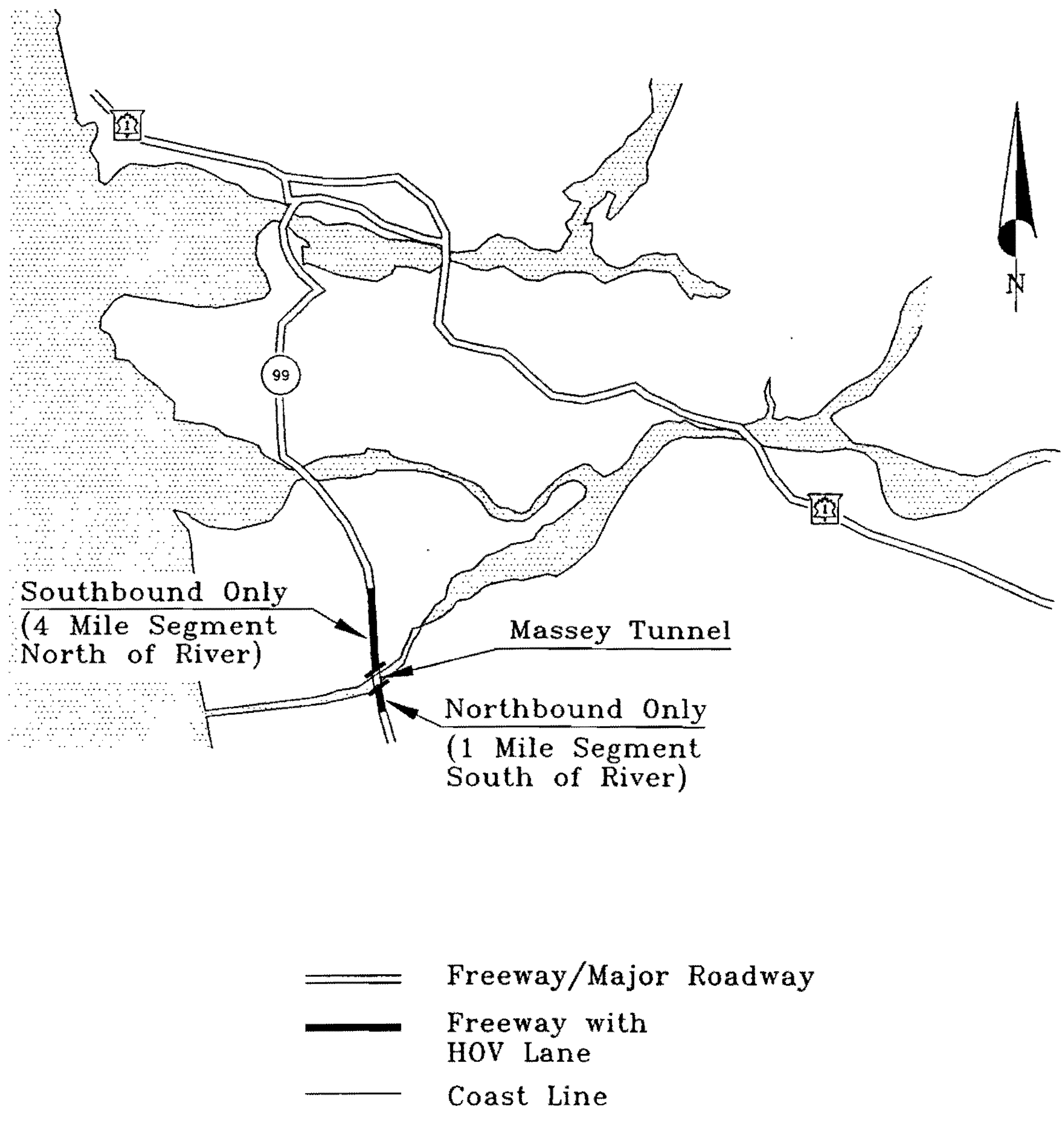


Figure 21

Vancouver
H 99 HOV Lanes



IV. HIGH-OCCUPANCY VEHICLE PROJECT CHARACTERISTICS

This section presents a summary of the design and operating characteristics of the HOV facilities covered in the survey. Information is presented in 3 general categories: 1) project descriptions and operating characteristics; 2) utilization levels and public reactions; and 3) enforcement data and violation rates. A series of tables provide information on each project. HOV facilities are listed in the tables by type of project and by city.

Project Descriptions and Operating Characteristics

Design

The four general types of HOV facilities operated on freeways and in separate rights-of-way were described previously. As shown in Table 1, the majority of HOV projects are either exclusive facilities or concurrent flow lanes located within freeway rights-of-way. Exclusive facilities on separate rights-of-way are in operation in only two cities. These are the two busways in Pittsburgh and the transitway system in Ottawa. Similarly, only three contraflow lanes are in operation; all of these are in the New Jersey/New York City area.

Although the exclusive and concurrent flow lanes represent the largest number of HOV facilities, differences exist between projects, especially the concurrent flow lane projects. Most of the exclusive facilities are reversible lanes, operating inbound toward the central business district (CBD) in the morning and outbound in the evening. Only the San Bernardino Freeway Busway in Los Angeles and I-84 in Hartford are two-direction facilities. Most exclusive HOV facilities are separated from the general-traffic lanes by concrete barriers. Some type of daily set up is usually required with the reversible facilities. This involves opening and closing the lanes, as well as reversing the direction of operation. These tasks usually require at least some manual operation, except on I-5 in San Diego, where the gates are opened and closed electronically. With the exception of two early projects, the Shirley Highway in 1969 and the San Bernardino Freeway in 1973, all of the exclusive HOV facilities were implemented during the 1980's.

The concurrent flow HOV facilities include a variety of designs and treatments. Concurrent flow lanes are operated on both the inside and outside lanes and/or shoulders. Some of these operate only during the peak periods, and some only in the peak direction. Concurrent flow lanes are separated from the mixed-traffic lanes by paint striping or, in a few cases, by special striping or an extra buffer zone. No daily set-up is needed with these types of facilities. A few concurrent flow lanes were implemented in the 1970's, with most opening during the 1980's.

Representative Cross Sections

A wide range of design treatments have been used in the development of HOV facilities. Figures 22 through 30 identify some of the general design standards and cross sections that have been used with different types of HOV facilities. Given the fact that many HOV lanes have been added to existing freeways where available right-of-way is often limited, reduction or modifications in the widths of existing lanes or shoulders sometimes occurs.

Figure 22 shows the typical cross section used for the two-direction, bus-only facilities in Ottawa and Pittsburgh. The lanes are separated by normal paint striping. A variety of on-line and off-line station treatments are used in the two cities.

Figure 23 illustrates a common design for two-lane reversible HOV lanes. The typical cross section includes two, 12-foot traffic lanes, shoulders on both sides, and concrete barriers separating the lanes from the general-traffic lanes. The width of the shoulders varies between projects, and some, like I-279 in Pittsburgh, use one wide shoulder and one narrow shoulder.

A typical design for one-lane reversible HOV facilities, such as those used with the Houston transitways, is shown in Figure 24. The cross section typically includes one 12-foot lane and 4-foot shoulders on each side of the lane. The facility is separated from the

Figure 25 identifies a design commonly used with two-lane, two-direction HOV lanes, such as I-84 in Hartford and the San Bernardino Freeway Busway in Los Angeles. The HOV lanes are separated from the mixed-flow lanes by 10- to 16-foot painted buffers. Figure 26 shows the design used on the two-lane, two-direction section of the Northwest transitway (US 290) in Houston. This elevated 2-mile section includes 3 feet of lateral clearance on both sides, and two 12-foot HOV lanes separated by an 8-foot buffer.

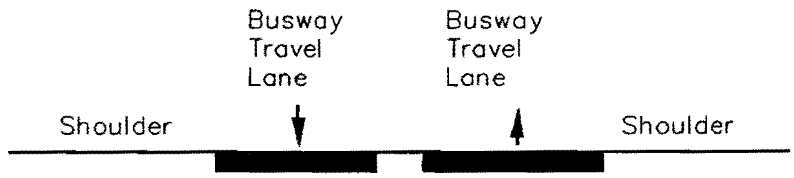
Figures 27 and 28 show typical cross sections for two different types of concurrent flow HOV lanes; these are HOV facilities separated from the mixed-traffic lanes by a buffer and HOV facilities with no separation. In both cases, an inside shoulder is usually provided, although in some instances it may be narrow. The HOV lane is either separated from the general-purpose traffic lane by a narrow buffer, usually 1- to 4-feet in width, or by normal paint striping.

A common design used with concurrent HOV lanes located on the outside freeway lane is shown in Figure 29. This is the design used with some of the HOV facilities in Santa Clara County and Seattle. A paint stripe is the normal method of separation from the mixed-traffic lanes, and, since many use the outside shoulder, there may be either no shoulder or a very narrow one.

The last cross section, shown in Figure 30, is used with the contraflow facilities in the New Jersey/New York City area. In these cases, one of the off-peak direction lanes, separated from the off-peak direction traffic by drop-in traffic cones, is used as an HOV lane for vehicles traveling in the peak direction.

Hours of Operation

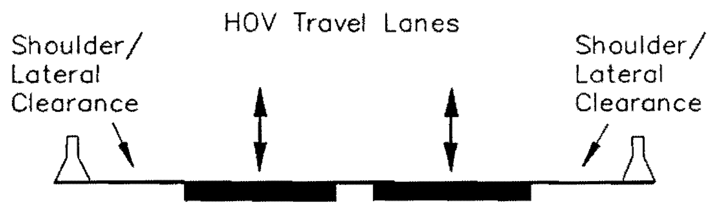
The operating hours of HOV facilities can be characterized by three different scenarios: 1) 24-hour operation; 2) morning and afternoon/evening operation; and 3) peak-period only operation. No one specific operating scenario necessarily equates to a certain type of facility. However, the exclusive facilities on separate rights-of-way in



Busway System	Shoulder	Busway Travel Lane	Busway Travel Lane	Shoulder
Ottawa	10'	12'	12'	10'
Pittsburgh	10'	11' to 12'	11' to 12'	10'

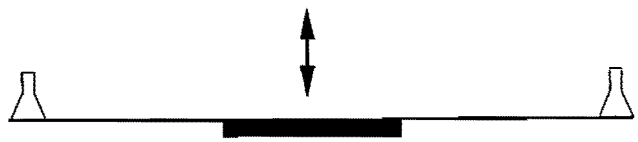
Note: Both systems use a double paint stripe to separate the two directions of traffic flow

Figure 22. Typical Cross Section for Two-Way Busway



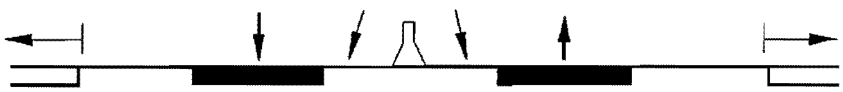
HOV Project and Location	Shoulder/ Lateral Clearance	HOV Travel Lane	HOV Travel Lane	Shoulder/ Lateral Clearance
Minneapolis, I-394	5'	12'	12'	10'
Pittsburgh, I-279	2'	12'	12'	10'
San Diego, I-15	10.5'	12'	12'	10.5'
Seattle, I-90	10'	12'	12'	10'
Washington, D.C., I-395 (Shirley)	10'	12'	12'	10'

Figure 23. Typical Cross Section for Two-Lane, Reversible HOV Facilities



HOV Project and Location	Lateral Clearance	HOV Travel Lane	Lateral Clearance
Houston			
Gulf Transitway, I-45	4'	12'	4'
Katy Transitway, I-10	3.75'	12'	3.75'
North Transitway, I-45	3.75'	12'	3.75'
Northwest Transitway, US 290	4'	12'	4'

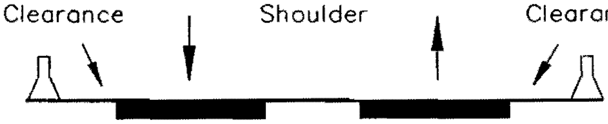
Figure 24. Typical Cross Section for One-Lane, Reversible HOV Facilities



HOV Project and Location	Fwy	Shld	HOV Travel Lane	Lateral Clearance		HOV Travel Lane	Shld	Fwy
Hartford I-84		16'[1]	12'	2'-4'	2'-4'	12'	16'[1]	
Los Angeles San Bernardino, I-10		13'[1]	12'	2'	2'	12'	13'[1]	

[1] These shoulders are not separated from the general purpose lanes by a barrier. They are striped as full shoulder for HOV traffic and as lateral clearances for general purpose traffic.

Figure 25. Typical Cross Section for Exclusive Two-Lane, Two-Way HOV Facilities



HOV Project and Location	Lateral Clearance	HOV Travel Lane	Buffer/ Shoulder	HOV Travel Lane	Lateral Clearance
Houston Northwest Transitway, US 290, 2-mile, 2-lane, 2-direction section	3'	12'	8'	12'	3'

Figure 26. Typical Cross Section for Two-Lane, Two-Way HOV Facilities with Buffer Separating HOV Flow

HOV Project and Location	Shoulder/ Lateral Clearance	HOV Travel Lane	Buffer	General Purpose Travel Lane
Los Angeles, Rt 91	3'	11'	2' [1]	11.75'
Miami, I-95	10' to 12'	12'	2' [1]	12'
Orange County, CA				
SR 55	2'	11'	1' [1]	12'
I-405	4'	12'	4' [1]	12'
Phoenix, I-10	12'	12'	4' [1]	12'

[1] The buffers on these types of facilities are narrower than those on the exclusive two-lane, two-way HOV facilities. Thus, even though both types of facilities do not use barriers to separate the HOV and general purpose lanes, facilities with 13-16 foot buffers are considered exclusive facilities, while those with 1-4 foot buffers are not.

Figure 27. Typical Cross Section for Concurrent Flow HOV Facilities with a Buffer Separating HOV and General Purpose Traffic Lanes

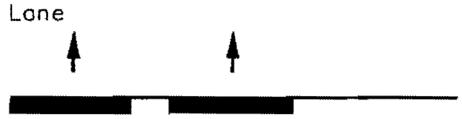
HOV Project and Location	Shoulder/ Lateral Clearance	HOV Travel Lane	General Purpose Travel Lanes

HOV Project and Location	Shoulder/ Lateral Clearance	HOV Travel Lane	General Purpose Travel Lanes
Honolulu, Moanalua	7'	12'	12'
Minneapolis, I-394	10'	12'	12'
Orlando, I-4	10'	12'	12'
San Francisco, US 101	3' to 6'	11' to 12'	11' to 12'
Santa Clara, CA			
US 101	10'	12'	12'
I-280	10'	12'	12'
Seattle, I-5	1' to 6'	12'	11' to 12'

Note: Paint stripes used to separate the HOV and general-purpose travel lanes

Figure 28. Typical Cross Section for Concurrent Flow HOV Facilities without a Buffer Separating the HOV and General Purpose Lanes

HOV Project and Location	General Purpose Travel Lane	HOV Travel Lane	Outside Shoulder



HOV Project and Location	General Purpose Travel Lane	HOV Travel Lane	Outside Shoulder
Santa Clara, CA			
San Tomas	11' & 12'	11' to 13'	0' to 10'
Montague	11' & 12'	11' & 12'	5' to 10'
Rte 237	11' & 13'	13'	0'
Seattle			
I-90 (Interim)	11'	12'	6'
I-405	11'	12'	6'
SR 520	11'	12'	4'

Note: Paint stripes used to separate the HOV and general-purpose travel lanes

Figure 29. Typical Cross Section for Concurrent Flow HOV Facilities Located on the Right Side (Outside) of Freeway Mainlanes

HOV Project and Location	Off-Peak Direction Travel Lane	Buffer Temp Traffic Cone	Contraflow HOV Lane	Shoulder/ Lateral Clearance	Peak-Dir Travel Lane
New York/New Jersey					
Rt 495	10.7'	0'	10.7'	0'	
Gowanus Expy	12'	0'	12'	0' to 6'	
Long Island Expy	12'	0'	12'	0' to 6'	

Figure 30. Typical Cross Section for Contraflow HOV Facilities

Pittsburgh and Ottawa operate on a 24-hour basis, and all three contraflow lanes operate only in the inbound direction in the morning peak period.

Operating hours for the exclusive and concurrent flow lanes vary. In two urban areas, Seattle and Los Angeles/Orange County, the HOV lanes are operated on a 24-hour basis. In other areas, the HOV lanes open in the morning and operate inbound until midday. After a period for reversing the operation, during which the lanes are usually closed for an hour, the facility is open in the outbound direction until the evening. Operation during only the peak periods is characteristic of most of the concurrent flow lanes, except those in Seattle and Los Angeles/Orange County. The exact time these facilities operate with the HOV restriction varies. Most operate from approximately 6 a.m. to 9 a.m. in the morning and 3 p.m. to 6 or 7 p.m. in the evening.

Vehicles Allowed to Use HOV Facilities and Occupancy Requirements

As shown in Table 2, the types of vehicles allowed to use the different HOV facilities are fairly similar. The Ottawa Transitway system, the two Pittsburgh Busways, the U.S. 36 bus lane in Denver, the HOV lanes on H-99 in Vancouver, British Columbia, and the contraflow lane on Route 495 on the approach to the Lincoln Tunnel in New Jersey/New York City are open only to buses. The remainder of the facilities, except the North Transitway in Houston, allow use by buses, vanpools and carpools. Most facilities also allow use by taxis meeting the occupancy requirements, and allow police and emergency vehicles to use the lanes without meeting the occupancy requirements. Motorcycle use of HOV lanes is less common. Only 3 of the exclusive facilities allow motorcycles, while ten of the concurrent flow lanes allow use by motorcycles.

The carpool vehicle occupancy requirements for existing HOV facilities vary between 2+ and 3+ persons per vehicle. No facilities currently use a 4+ requirement, although for many years the Shirley Highway HOV lanes operated with a 4+ carpool occupancy requirement. Sixteen HOV lanes utilize a 3+ occupancy requirement, while sixteen also utilize a 2+ requirement. Some areas with multiple HOV facilities, such as San Jose, utilize the same occupancy requirements on all HOV lanes. Other areas, such as Seattle and Los Angeles, have different requirements on different HOV facilities.

The Katy Transitway in Houston is the only HOV facility that changes occupancy requirements over the course of the day. A 2+ occupancy requirement is utilized during all operating periods except between 6:45 a.m. and 8:00 a.m., when a 3+ requirement is in effect. This change was implemented in October 1988 in response to declining travel speeds on the transitway resulting from increased use of the facility. At the time, vehicle volumes on the transitway were exceeding 1,500 vehicles per hour (vph) during the a.m. peak-hour. This caused considerable delay, diminishing the travel time savings users of the facility were accustomed to. The change represented the first time vehicle occupancy requirements had been increased on an HOV facility and the first use of variable occupancy requirements. The change was implemented with very little public controversy and has worked acceptably in the field.

Analysis conducted by TTI indicates that initially peak-hour vehicle volumes dropped by approximately 64%, immediately eliminating the travel time delays. While the initial vehicle volumes declined, the use of 3+ carpools and bus ridership increased. Thus, it is apparent that some individuals changed to a higher occupancy mode of travel to continue to use the transitway. The vehicle volumes have been steadily increasing, and are currently averaging between 1,000 to 1,200 vehicles in the morning peak-hour. Thus, the increase in occupancy requirements utilized on the Katy Transitway appears to be one viable approach to managing demand in an HOV facility.

Bus Operating Characteristics

The orientation of bus service and the number of buses utilizing the different HOV facilities varies. The number of peak-hour and peak-period buses utilizing each HOV facility is provided in Table 7. Obviously, the exclusive bus-only facilities in Pittsburgh and Ottawa are oriented specifically toward bus operations and provide high levels of bus service. In both areas, service is provided by buses operating exclusively on the facility, similar to traditional rapid transit lines, and buses that access the facility after collection in the local neighborhoods. In this regard, the exclusive HOV facilities on separate rights-of-way allow for great flexibility in the orientation and level of bus service provided.

Bus service on most of the exclusive HOV facilities within freeway rights-of-way is oriented primarily to express service. In most cases, the express service originates at park-and-ride lots, although some may provide limited local collection in neighborhood areas. In some cases, direct access is provided from the park-and-ride lot to the HOV facility. In other cases, buses access the HOV lane from the local streets and freeway. The actual level of service differs greatly between facilities. The highest levels of bus service are found on the Shirley Highway HOV lanes in Washington, D.C./northern Virginia, the San Bernardino Freeway Busway in Los Angeles, and the North Transitway in Houston.

Bus service on the concurrent flow HOV facilities is also oriented primarily to express service, although local service is provided in some areas. In most instances, buses access the facility from park-and-ride lots or limited local collection. In a few cases, such as some of the Seattle facilities, bus stops may be provided along the HOV lane. Some of the concurrent flow HOV lanes, such as those on US 36-Boulder Turnpike in Denver and H-99 in Vancouver, British Columbia, are open to buses only, allowing buses to by-pass traffic queues that form due to congestion. Other concurrent flow HOV lanes, such as those in Los Angeles, Orange County, San Jose, Orlando, Miami, and Phoenix are oriented primarily to carpools, with little bus service provided.

The three contraflow HOV facilities located in the New York City area are oriented primarily to buses. Only buses are allowed on the Route 495 facility, while buses and vanpools are allowed on the Long Island and Gowanus Expressway facilities. In all three cases, the HOV lanes allow buses to by-pass the traffic queues formed at major congestion points.

Use During Non-Restricted Periods

As noted previously, HOV facilities are usually characterized by one of 3 operating scenarios: 1) 24-hour operation; 2) morning and afternoon/evening operation; and 3) peak-period only operation. Obviously, HOV facilities in the first category are open for use by eligible vehicles on a 24-hour basis. HOV lanes in the last two categories are utilized for different functions during the non-restricted periods. Some are closed, while others revert to general purpose lanes or shoulders.

Of the 11 exclusive facilities, two, I-84 in Hartford, Connecticut and the San Bernardino Freeway Busway in Los Angeles, operate as HOV lanes on a 24-hour basis. Three of the four Houston transitways are open as HOV lanes over an extended portion of the day (4 a.m. to 10 p.m.) and closed at other times. The I-394 and I-15 HOV lanes are open during the peak periods and closed during the remainder of the day. I-279 in Pittsburgh and I-395, I-95 and I-66 in the Washington, D.C./northern Virginia area are open to general traffic during the non-restricted periods.

Of the 23 concurrent flow lanes, 10 are used as HOV facilities on a 24-hour basis. These include the Seattle and Los Angeles/Orange County facilities, I-280 in San Francisco, H-99 in Vancouver, British Columbia, and I-10 in Phoenix. The concurrent flow HOV lanes in other areas revert to either general-purpose lanes or shoulders during the non-restricted periods. The 3 contraflow HOV lanes also revert back to general-purpose lanes during non-restricted times.

Agency Responsibilities

Table 3 identifies the agencies responsible for the different activities associated with planning, implementing, and operating HOV lanes. In almost all cases, the state department of transportation has been the lead agency in planning, designing, and constructing the facilities. Exceptions to this include the bus-only facilities in Ottawa and Pittsburgh, the HOV lanes on county facilities in Santa Clara County, and the Long Island Expressway and Gowanus Expressway in New York City. The agencies with the lead responsibilities for these projects are the Ottawa-Carlton Regional Transit Authority and the Municipality of Ottawa-Carlton, the Port Authority of Allegany County, Santa Clara County, and the New York City Department of Transportation. Operation and maintenance are usually the responsibility of either the transit agency or the state department of transportation. The state police or state patrol are most often responsible for enforcement activities, although enforcement on the Houston transitways, the Pittsburgh busways, and the Ottawa transitway system is the responsibility of the transit agency.

Primary Reason for Project Implementation

As identified in Table 4, increasing the capacity of the roadway was the primary reason cited for implementing most HOV facilities. Reducing vehicle-miles of travel (VMT), energy and air quality concerns, and increasing the efficiency of bus operations were also noted as important considerations. In a few cases, funding or legislative requirements were mentioned as significant reasons.

Capital Costs and Funding Sources

Table 5 provides a listing of the estimated capital costs and the funding sources for the HOV facilities. In many cases, it is difficult to identify the costs associated with only the HOV lane, as construction of the HOV lane(s) is often part of a major freeway project. The following capital costs serve as general "rules-of-thumb" for the different types of HOV lanes.

- o Exclusive HOV facility in separate right-of-way; greater than $8 million per mile.
- o Exclusive HOV facility in freeway right-of-way; greater than $4 million per mile.
- o Concurrent flow freeway HOV lane; between $30,000 and $2 million per mile.
- o Contraflow freeway HOV lane; between $30,000 and $500,000 per mile.

A few examples of the capital costs associated with operating HOV facilities indicate that these estimates provide realistic ranges. Examples of the average capital costs per mile of the different types of HOV facilities include the following: Ottawa Transitway System, $17 million per mile; Pittsburgh South Busway, $7 million per mile; Pittsburgh East Busway, $16 million per mile; initial Katy Transitway in Houston, $3 million per mile; initial Route 91 concurrent flow lane in Orange County, $340,000 per mile; SR 520 concurrent flow lane in Seattle, $670,000 per mile; and the Gowanus Expressway contraflow lane in New York City, $400,000 per mile.

Most HOV facilities have been constructed using a mixture of funding sources. Federal funding, through either the Federal Highway Administration (FHWA) or the Urban Mass Transportation Administration (UMTA), usually comprises the largest share. Local funding, from either a state highway department, transit authority, or other local agency, is commonly used to match the federal funds.

Signing

The types of signing used varies between the different HOV facilities. As shown in Table 6, most projects utilize ground-mounted or overhead static signing. The use of overhead lane assignment arrows and overhead variable message signs is more common with reversible facilities than with concurrent flow lanes. Concurrent flow lanes are more likely to use a combination of overhead static signs and diamond pavement markings.

Four areas responded that signing has been a problem from either a user or enforcement perspective. Concerns raised included standardizing signing among HOV facilities within the same metropolitan area, the reliability of changeable message signs, and initial confusion by users over signing.

HOV Facility Utilization and Public Reaction

HOV Facilities and Freeway Utilization

Tables 7 through 9 provide information on the peak-direction utilization rates associated with the different HOV projects. Table 7 identifies the morning peak-hour and peak-period volumes for the HOV lane(s) and the mixed-traffic freeway lanes. Tables 8 and 9 provide total vehicle and passenger volumes for the HOV facility, and the volumes per lane for the HOV and freeway facilities. The exact times for the peak hour and peak period were defined by each locality. The length of time associated with the peak period is shown in Table 7.

Desirable HOV Lane Volumes

Respondents were asked to identify the preferred maximum volume of traffic to provide the desirable speed and level-of-service on the HOV facility. Individuals indicated a range between 200 to 1,600 vehicles per hour per lane as the maximum volume. The lower volumes were generally identified with the interim facilities, concurrent flow lanes utilizing shoulders, and the contraflow lanes. A range of 1,200 to 1,600 vehicles per hour per lane were identified as a desirable maximum volume for exclusive facilities and concurrent flow lanes utilizing regular traffic lanes.

Public Reaction to HOV Facilities

Representatives from agencies surveyed were asked two questions relating to the general perception among the public toward the HOV facility. First, respondents were asked if the public reaction to the HOV lane had been positive, negative, or neutral. A majority of respondents indicated that the general reaction had been positive. Three areas identified that there had been some negative public reaction, while four indicated it had been neutral. Objections from drivers in the general-traffic lanes who are unable to use the HOV lane were the most commonly reported negative reaction. Even in those areas where the public perception was positive, many respondents indicated that non-users had raised objections about not being able to use the facility.

Second, respondents were asked if the current volumes resulted in the facility appearing to be underutilized or if it was so well utilized that the level-of-service on the lane had deteriorated. Most individuals responded that the current volumes were not causing a problem in either of these extremes. Only four facilities were noted as being underutilized. Three facilities, I-95 in the Washington, D.C./northern Virginia area, Route 495 in New York, and I-4 in Orlando, Florida, were identified as being at or near capacity.

Marketing and Public Information

The survey respondents were asked to identify the types of marketing and public information activities conducted to promote the use of the HOV facility. All areas reported that some type of marketing or public information program had been used to introduce the HOV lane, and most indicated that some type of ongoing marketing programs were in use. The nature of these programs, and the associated costs, varies greatly. The types of activities used included press releases, opening ceremonies, initial marketing activities, special advertisements and incentives, and ongoing promotional campaigns. Not enough information was provided to identify the most effective marketing strategies or to determine any relationships between utilization rates and marketing expenditures.

Enforcement Levels and Violation Rates

Enforcement Levels and Responsibilities

Table 10 presents the level of enforcement associated with the different HOV projects. The number of personnel and vehicles assigned to each facility during the HOV operating period is identified, as is the responsible agency. The level and nature of enforcement activities varies between projects. Almost all HOV facilities utilize some enforcement. However, this varies from full-time, dedicated personnel to monitoring by patrols that simply cover the geographical area in which the lane is located.

Approximately half of the projects utilize enforcement personnel whose primary responsibility is to monitor the lane. In other areas, monitoring the HOV facility is only one of many responsibilities of the patrol, and is usually not the top priority. Respondents from most areas indicated that they felt the current levels of enforcement were adequate.

The state patrol or state police is the most common agency responsible for enforcement of HOV facilities. Exceptions to this are the bus-only facilities in Ottawa and Pittsburgh, the transitways in Houston, and the HOV lanes in New York and New Jersey. In these cases, the transit police or other local agency has the lead responsibility for enforcement activities.

Table 11 identifies the enforcement methods used with the different HOV projects. Specially designed vehicle pullover areas and diverting violators from the HOV lane are the most commonly used enforcement mechanisms. Both the Seattle area and the Washington, D.C./Northern Virginia area utilize "HERO" programs. These programs encourage individuals to report violators. Follow-up letters are then sent to the violators indicating that the vehicle was observed violating the lane requirements. No fine is levied, but information on the proper use of the facility and on rideshare programs and bus service is usually provided. Only the

Washington, D.C./Northern Virginia area reported using a ticket by mail program based on the state police recording the license plates of violators in the lane. This program, which was authorized by the Virginia Legislature in 1989, has been in operation for almost a year. Currently, the Virginia State Patrol is stopping vehicles that violate the HOV lane occupancy requirements to record information on the driver. The citation is then sent through the mail. A number of areas reported that the use of cameras and other innovative approaches to HOV lane enforcement are under consideration.

Fines

The fines for violation of the HOV occupancy requirements or other misuse of the facilities are also shown in Table 11. The fines for first time violators are usually in the $50-$80 range. However, some are as high as $100 to $250. Fines for repeat offenses often increase significantly. In addition to the fine, some areas also assess points leading toward revocation of the violator's drivers license.

Violation Rates

The violation rate for an HOV facility refers to the percentage of vehicles using the HOV lane that do not meet the minimum occupancy requirement and therefore are in violation of the usage regulations. Most areas estimate violation rates based on periodic surveys and by ongoing enforcement activities. As identified in Table 11, the estimated peak-hour violation rates range from a low of 1% to a high of 75%. The violation rates appear to correspond to the type of facility and enforcement level. Those with the higher violation rates tend to be the concurrent flow facilities with low enforcement levels. The Katy Transitway also experiences higher violation rates during the morning peak period when the 3+ occupancy requirement is in effect. Barrier-separated facilities, and those with full time dedicated enforcement personnel, usually have lower violation rates.

Safety

Little safety or accident data are available relating to the different HOV facilities. The limited information made available seems to indicate that accident rates for the HOV lanes are generally either lower, or the same, as those reported on the general-traffic lanes. For example, the evaluations done on the four Houston transitways and one freeway without a transitway, indicate that compared to pre-transitway conditions, freeway mainlane accident rates have generally changed very little; the transitway accident rates are lower than the freeway mainlane accident rates.

A variety of incident management techniques are used on the different HOV facilities. Tow trucks are used on seven facilities to help deal with accidents or breakdowns. Other areas reported using other methods for monitoring the facilities. These included the use of bus radios, roving transit monitors or police, and, in a few cases, camera surveillance and monitoring equipment. In most cases, the agency responsible for enforcement was also identified as the agency responsible for handling emergencies.

Table 1. General Characteristics of Operating High-Occupancy Vehicle Projects

City	Number of Lanes[1]	Length (miles)	Year Implemented	Hours of Operation	Separation from General Purpose Lanes[2]	Daily Set up Required?[3]
Exclusive Facilities, Separate Right-of-Way						
Ottawa, Ontario, Canada Ottawa-Carleton Transitway	1 (Each direction)	14.5[4]	1982-1989	24 hours	Separate R.O.W.	No
Pittsburgh, PA South Busway	1 (Each direction)	4.0	1977	24 hours	Separate R.O.W.[5]	No
East Busway	1 (Each direction)	6.8	1983	24 hours	Separate R.O.W.	No
Exclusive Facilities, Freeway Right-of-Way						
Hartford, CT I-84[6]	1 (Each direction)	10.0	1989	24 hours	15'-17' painted buffer	No
Houston, TX I-45N (North)[7]	1 (Reversible)	9.1[8]	1979-1984[9]	5:45 am - 8:45 am 3:30 pm - 7 pm	Concrete Barriers	Yes
I-45S (Gulf)[10]	1 (Reversible)	6.5	1988	4 am - 1 pm 2 pm - 10 pm	Concrete Barriers	Yes
I-10 (Katy)[11]	1 (Reversible)	11.5	1984-1987	4 am - 1 pm 2 pm - 10 pm	Concrete Barriers	Yes
US 290 (Northwest)[12]	1[13] (Reversible)	9.5	1988	4 am - 1 pm 2 pm - 10 pm	Concrete Barriers	Yes
Los Angeles, CA San Bernardino Fwy. Busway (I-10)	1 (Each direction)	12	1973 & 1989	24 hours	Concrete Barriers and paint striping[14]	No
Minneapolis, MN I-394[15]	1 (Reversible)	3.4	1985	6 am - 9 am 2 pm - 7 pm	Concrete Barriers	Yes
Pittsburgh, PA I-279	2[16] (Reversible)	4.1	1989	5 am - noon 2 pm - 8 pm	Concrete Barriers	Yes
San Diego, CA I-15	2 (Reversible)	8.0	1988	6 am - 9 am 3 pm - 6:30 pm	Concrete Barriers	Yes

Table 1. General Characteristics of Operating High-Occupancy Vehicle Projects (continued)

City	Number of Lanes[1]	Length (miles)	Year Implemented	Hours of Operation	Separation from General Purpose Lanes[2]	Daily Set up Required?[3]
Washington, D.C./ Northern Virginia						
I-395 (Shirley)[17]	2 (Reversible)	11	1969-1975	6 am - 9 am 3:30 pm - 6 pm	Concrete Barriers	Yes
I-66	2 (Peak direction)	10.0	1982	6:30 am - 9 am 4 pm - 6:30 pm	Both Freeway lanes used[18]	No
Concurrent Flow Facilities						
Denver, CO						
US 36-Boulder Turnpike	1 (Eastbound only)	4.1	1986-1988	6 am - 9 am	Striping	No
Fort Lee, NJ/New York City						
I-95	1 (Eastbound only)	1.0	1986	7 am - 9 am	Striping	No
Honolulu, Hawaii						
Moanalua Freeway	1 (Eastbound only)	2.5	1978	6 am - 8 am	Striping	No
H-1	1 (Each direction)	7	1987	6 am - 8 am 3:30 pm - 6 pm	Striping	No No
Los Angeles/Orange Co., CA						
Rt. 55 Commuter Lane[19]	1 (Each direction)	11	1985	24 hours	Striping	No
I-405 Commuter Lane	1 (Each direction)	14	1989	24 hours	Striping	No
Rt. 91 Commuter Lane	1 (Eastbound only)	8	1985	24 hours	Striping	No
Miami, FL						
I-95	1 (Each direction)	14	1976-1978	7 am - 9 am 4 pm - 6 pm	Striping	No
Orlando, FL						
I-4	1 (Each direction)	30.0	1980	7 am - 9 am 4 pm - 6 pm	Striping	No
Phoenix, AZ						
I-10[20]	1 (Each direction)	7.0	1987	24 hours	4' painted buffer	No
San Francisco, CA						
I-280 (Reopening 9/90)	1 (Each direction)	1.6	1975	24 hours	Striping	No
Oakland Bay Bridge	4 (Peak direction)	2.3	1970	5 am - 10 am 3 pm - 6 pm	Pylons	No
US 101[21]	1 (Each direction)	7.0	1974 1986-1987	6:30 am - 8:30 am 4:30 pm - 7:00 pm	Striping	No

Table 1. General Characteristics of Operating High-Occupancy Vehicle Projects (continued)

City	Number of Lanes[1]	Length (miles)	Year Implemented	Hours of Operation	Separation from General Purpose Lanes[2]	Daily Set up Required?[3]
Concurrent Flow Facilities						
San Jose, CA						
Montague Expressway[22]	1 (Each direction)	5.0	1982, 1984 1988	6 am - 9 am 3 pm - 7 pm	Striping	No
Rt. 101	1 (Each direction)	12 SB; 11 NB	1986 & 1988	5 am - 9 am 3 pm - 7 pm	Striping	No
San Tomas Expressway[23]	1 (Each direction)	11	1982 & 1984	6 am - 9 am 3 pm - 7 pm	Striping	No
Rt. 237[24]	1 (Each direction)	4	1984	5 am - 9 am 3 pm - 7 pm	Striping	Yes
Seattle, WA						
I-90[25]	1 (Westbound Only)	5.8	1988	24 hours	Striping	No
SR 520[26]	1 (Westbound Only)	2.8	1973	24 hours	Striping	No
I-5[27]	1 (Each direction)	6.2 NB; 5.9 SB	1983	24 hours	Striping	No
I-405	1 (Each direction)	6	1986	24 hours	Striping	No
Vancouver, Canada						
H-99	1 (Each direction)	4 SB; 1 NB	1980	24 hours	Striping	No
Washington, D.C./ Northern Virginia						
I-95[28]	1 (Each direction)	6.8	1985-1986	6 am - 9 am 3:30 pm - 6 pm	Striping	No
Contraflow Facilities						
New York City, NY						
Rt. 495	1 (Inbound Only)	2.5	1970	6:30 am - 10 am[29]	Drop-in cones	Yes
Long Island Expressway	1 (Inbound Only)	2.2	1971	7 am - 10 am	Drop-in cones	Yes
Gowanus Expressway	1 (Inbound Only)	0.9	1980	7 am - 9:30 am	Drop-in cones	Yes

Notes:
1. Number of lanes reported by direction; if reversible facility, represents total number of lanes.
2. Figures 20-27 show the representative cross sections for the different facilities.
3. Daily set up refers to any manual or electronic operation needed to open or close the facility.
4. The total 15 mile Ottawa Transitway system includes 1.4 miles of downtown bus-only lanes and 2.3 miles operated in mixed-traffic lanes. In downtown Ottawa, buses operate in bus-only lanes on parallel one-way streets. The bus lane is the second lane from the curb lane. The curb lane is reserved for bus stops, taxis, and delivery vehicles. A bus tunnel through the downtown area is in the planning stage for future implementation. To the west of the downtown area, buses operate in mixed-traffic lanes on the Ottawa River Parkway for approximately 2.4 miles. The parkway is a limited access facility, allowing buses to travel at high speeds. Eventually, a separate transitway is planned for this segment, but due to the high current travel speeds, it is not a priority.

Table 1. General Characteristics of Operating High-Occupancy Vehicle Projects (continued)

5. A portion of the South busway includes a shared right-of-way with a light rail transit line.
6. The Hartford I-84 HOV lane is listed as an exclusive HOV facility. It is separated from the mixed traffic lanes by a 15-17 foot painted buffer.
7. An additional 5 miles of the North Transitway are scheduled to open in mid-1990. The final 5.6 mile segment is scheduled to open in two phases; 2.9 miles in 1994 and 2.7 miles in 1997.
8. An additional 4.4 mile segment of the North Transitway opened in two stages in late 1989 and April, 1990. This brings the total length of the facility to 13.5 miles.
9. Between 1979 and 1984 a contraflow lane was operated on I-45N. The current exclusive facility was opened in 1985.
10. An additional 9 miles of the Gulf Transitway are scheduled to open in three phases by 1993.
11. The 1.5 mile eastern extension of the Katy Transitway was opened in January, 1990. This brings the total length of the facility to 13 miles.
12. The final 4 miles of the Northwest Transitway were opened in February, 1990. This brings the total length of the facility to 13.5 miles.
13. Approximately 2-miles of 2-lane, 2-direction HOV lanes are in operation on the Northwest Transitway at the connection to the Northwest Transit Center.
14. The San Bernardino Freeway Busway includes 5 miles of barrier separated lanes and 7 miles with a 13 foot painted buffer.
15. The I-394 HOV lane is currently an interim facility operating on a signalized arterial street. The final facility includes a combination of reversible barrier separated HOV lanes and concurrent flow diamond lanes.
16. The two lane reversible I-279 HOV facility splits into two short, one lane segments at the southern end. One segment connects to Three Rivers Stadium and one provides access into the downtown.
17. The I-95 concurrent flow lanes in Northern Virginia connect to the exclusive HOV lanes on I-395 (Shirley Highway).
18. I-66 is a 4-lane freeway, with 2 lanes in each direction. The 2 lanes operating in the peak direction are restricted to HOVs during the morning and afternoon peak periods.
19. An additional 10 miles of the I-405 HOV lanes are scheduled to open in April, 1990, bringing the total length of the HOV lanes to 24 miles.
20. An additional 10 mile segment of the I-10 HOV lanes in Phoenix opened in January, 1990. This segment is to the west of the HOV lane reported in this survey. The two facilities are separated by a short segment currently under construction.
21. The HOV lanes on US 101 in Marin County include two segments, 3 miles and 4 miles in length, separated by approximately 1 mile of mixed traffic lanes.
22. The HOV lanes on the Montague Expressway operate only in the peak direction. The outside lane is used as the HOV lane during the restricted period and is open to general traffic at other times. The Montague Expressway is a signalized expressway.
23. The San Tomas Expressway HOV lanes operate only in the peak direction. The outside lane and shoulder are used for the HOV lane during the restricted period and revert to general purpose lanes and shoulders during other times. The San Tomas Expressway is a signalized expressway.
24. The Rt. 237 HOV lanes operate only in the peak direction. The outside shoulder is used for the HOV lane. The section of Rt. 237 where the HOV lanes are located is a signalized expressway.
25. The I-90 HOV lane included in this survey is an interim facility. It is a contiguous concurrent flow facility on the outside lane. Currently only 5.8 miles are open in the westbound direction. The completed I-90 facility will include a 10 mile 2-lane reversible HOV facility located in the freeway median.
26. The SR 520 HOV lane is located on the outside shoulder and operates only in the westbound direction.
27. Different segments of HOV lanes are operated along I-5. The segment included in this survey is the 6-mile segment north of downtown with HOV lanes operating in both directions on the inside lane.
28. The I-95 concurrent flow lanes connect to the exclusive HOV lanes on I-395 (Shirley Highway). The lanes are located on the inside lane and revert back to general-purpose lanes when not in use as HOV lanes.
29. The exact closing time for the Route 495 contraflow lane depends on the volume of traffic. While 10:00 a.m. is usually the time the lane is closed, it may be kept open later or closed earlier depending upon the daily demand.

Table 2. Vehicles Allowed to Use High-Occupancy Vehicle Facilities[1]

City	Public Transit Buses	School Buses	Private Buses	Van-pools	Car-pools	Taxis	Police	Emergency	Motorcycles	Other Vehicles	Carpool Occupancy Requirements
Exclusive Facilities, Separate Right-of-Way											
Ottawa, Ontario Canada											
Ottawa-Carleton Transitway	X		X				X	X			
Pittsburgh, PA											
South Busway	X						X	X		Light Rail Vehicles[2]	
East Busway	X						X	X			
Exclusive Facilities, Freeway Right-of-Way											
Hartford, CT											
I-84	X	X	X	X	X	X			X		3+
Houston, TX											
I-45N (North)	X		X	X			X	X			-[3]
I-45S (Gulf)	X	X	X	X	X	X	X	X			2+
I-10 (Katy)	X	X	X	X	X	X	X	X			2+/3+[4]
US 290 (Northwest)	X	X	X	X	X	X	X	X			2+
Los Angeles, CA											
San Bernardino Fwy. Busway	X	X	X	X	X	X	X	X			3+
Minneapolis, MN											
I-394	X	X	X	X	X	X	X	X	X		2+
Pittsburgh, PA											
I-279	X	X	X	X	X	X	X	X		State Highway automobiles; open to all traffic outbound 8:00 pm to 3:00 am	3+
San Diego, CA											
I-15	X	X	X	X	X	X	X	X	X		2+

Table 2. Vehicles Allowed to Use High-Occupancy Vehicle Facilities (Continued)

City	Public Transit Buses	School Buses	Private Buses	Van-pools	Car-pools	Taxis	Police	Emergency	Motorcycles	Other Vehicles	Carpool Occupancy Requirements
Concurrent Flow Facilities											
Washington, D.C./ Northern Virginia											
I-395 (Shirley)	X	X	X	X	X	X	X	X		Lanes open to all traffic at other than restricted times[5]	3+
I-66	X	X	X	X	X	X	X	X		Lanes open to all traffic at other than restricted times[6]	3+
Denver, CO											
US 36-Boulder Turnpike	X										
Fort Lee, NJ/New York City											
I-95	X	X	X	X	X	X	X	X	X	Any vehicle with at least 3 occupants	3+
Honolulu, Hawaii											
Moanalua Freeway	X	X	X	X	X	X	X	X	X		2+
H-1	X	X	X	X	X	X	X	X	X		2+
Los Angeles/Orange Co., CA											
Rt. 55 Commuter Lane	X		X	X	X	X	X	X	X		2+
I-405 Commuter Lane	X		X	X	X	X	X	X	X		2+
Rt. 91 Commuter Lane	X		X	X	X	X	X	X			2+
Miami, FL											
I-95	X	X	X	X	X	X	X	X			2+
Orlando, FL											
I-4	X	X	X	X	X	X	X	X			2+
Phoenix, AZ											
I-10	X	X	X	X	X				X		2+
San Francisco, CA											
I-280	X	X	X	X	X						3+
Oakland Bay Bridge	X	X	X	X	X	X	X	X	X[7]		3+
US 101	X	X	X	X	X	X	X	X			2+[8]

Table 2. Vehicles Allowed to Use High-Occupancy Vehicle Facilities (Continued)[1]

City	Public Transit Buses	School Buses	Private Buses	Van-pools	Car-pools	Taxis	Police	Emergency	Motorcycles	Other Vehicles	Carpool Occupancy Requirements
Concurrent Flow Facilities											
San Jose, CA											
Montague Expressway	X	X	X	X	X	X	X	X	X		2+
Rt. 101	X	X	X	X	X	X	X	X	X		2+
San Tomas Expressway	X	X	X	X	X	X	X	X	X		2+
Rt. 237	X	X	X	X	X	X	X	X	X		2+
Seattle, WA											
I-90	X	X	X	X	X	X	X	X	X		3+
SR 520	X	X	X	X	X	X	X	X	X		3+
I-5	X	X	X	X	X	X	X	X	X		2+/3+[9]
I-405	X	X	X	X	X	X	X	X	X		2+
Vancouver, Canada											
H-99	X	X	X				X	X			
Washington, D.C./ Northern Virginia											
I-95	X	X	X	X	X	X	X	X			3+
Contraflow Facilities											
New York City, NY											
Rt. 495	X		X								
Long Island Expressway	X	X	X	X		X		X			
Gowanus Expressway	X	X	X	X		X		X			

Notes:
1. Unless noted, taxis must meet the occupancy requirements to use the HOV facility, while police, emergency vehicles and motorcycles do not.
2. A portion of the South busway includes a shared right-of-way with a light rail transit line.
3. The North Transitway is currently not open to carpools. Once construction is completed in mid-1990 carpools will be allowed. It is anticipated that a 2+ occupancy requirement will be used. Also vanpools must currently be authorized by Metro to use the lane.
4. The occupancy requirement on the Katy Transitway is 3+ during the morning peak period from 6:45 am to 8:15 am. A 2+ occupancy requirement is used during other times.
5. The HOV lanes on the Shirley Highway are restricted to HOVs from 6 am - 9 am and 3:30 pm - 6 - pm. During other times the lanes are open to general- purpose traffic. The direction of traffic is inbound during the morning and outbound during the afternoon and evening. On weekends the lanes are open in the outbound direction.
6. I-66 is restricted to HOVs from 6:30 am - 9 am and 4 pm - 6:30 pm in the peak direction. During other times, I-66 operates as a normal four lane freeway, open to all traffic except trucks, which are prohibited inside the beltway at all times. Also, traffic to and from Dulles Airport is not subject to the HOV restrictions.
7. Motorcycles are required to obtain a permit for use of the HOV lanes on the Bay Bridge.
8. Prior to September, 1989, the vehicle occupancy requirement on I-101 in Marin County was 3+. In September 1989, an 18 month demonstration project was initiated lowering the occupancy requirement to 2+.
9. The different segments of HOV lanes on I-5 have different occupancy requirements. The HOV lanes located in the express lanes have 2+ occupancy requirements, while those located in the mainlanes have 3+ occupancy requirements.

Table 3. Agencies with Primary Responsibility for Developing and Operating HOV Facilities[1]

City	Planning & Design	Construction	Operation	Enforcement	Maintenance
Exclusive Facilities, Separate Right-of-Way					
Ottawa, Ontario Canada					
Ottawa-Carleton Transitway	Municipality of O-C	Municipality of O-C	O-C Transit	O-C Transit	O-C Transit
Pittsburgh, PA					
South Busway	Penn DOT & PAT	PAT	PAT	PAT	PAT
East Busway	PAT	PAT	PAT	PAT	PAT
Exclusive Facilities, Freeway Right-of-Way					
Hartford, CT					
I-84	Conn DOT	Conn DOT	Conn DOT	State police	Conn DOT
Houston, TX					
I-45N (North)	SDHPT & METRO	SDHPT & METRO	METRO	METRO	SDHPT
I-45S (Gulf)	SDHPT & METRO	SDHPT & METRO	METRO	METRO	SDHPT
I-10 (Katy)	SDHPT & METRO	SDHPT & METRO	METRO	METRO	SDHPT
US 290 (Northwest)	SDHPT & METRO	SDHPT & METRO	METRO	METRO	SDHPT
Los Angeles, CA					
San Bernardino Fwy. Busway	Caltrans & SCRTD	Caltrans	Caltrans	CHP	Caltrans
Minneapolis, MN					
I-394	MN/DOT	MN/DOT	MN/DOT	State Patrol	MN/DOT
Pittsburgh, PA					
I-279	Penn DOT	Penn DOT	Penn DOT	State Police	Penn DOT
San Diego, CA					
I-15	Caltrans	Caltrans	Caltrans	CHP	Caltrans
Washington, D.C./ Northern Virginia					
I-395	VDOT	VDOT	VDOT	State Police	VDOT
I-66	VDOT	VDOT	VDOT	State Police	VDOT

Table 3. Agencies with Primary Responsibility for Developing and Operating HOV Facilities (Continued)[1]

City	Planning & Design	Construction	Operation	Enforcement	Maintenance
Concurrent Flow Facilities					
Denver, CO					
US 36-Boulder Turnpike	RTD, CO Hwy. Dept.	RTD, CO Hwy. Dept.	RTD	State Patrol	CO Hwy. Dept.
Fort Lee, NJ/New York City					
I-95	NJ DOT	NJ DOT	PA NY & NJ	PA NY & NJ, NJ DOT	PA NY & NJ, NJ DOT
Honolulu, Hawaii					
Moanalua Freeway	Hawaii DOT	Hawaii DOT	Hawaii DOT	Honolulu Police	Hawaii DOT
H-1	Hawaii DOT	Hawaii DOT	Hawaii DOT	Honolulu Police	Hawaii DOT
Los Angeles/Orange Co., CA					
Rt. 55 Commuter Lane	Caltrans	Caltrans	Caltrans	CHP	Caltrans
I-405 Commuter Lane	Caltrans	Caltrans	Caltrans	CHP	Caltrans
Rt. 91 Commuter Lane	Caltrans	Caltrans	Caltrans	CHP	Caltrans
Miami, FL					
I-95	FDOT	FDOT	FDOT	State Police	FDOT
Orlando, FL					
I-4	FDOT	FDOT	FDOT	State Police	FDOT
Phoenix, AZ					
I-10	ADOT	ADOT	ADOT	State Police	ADOT
San Francisco, CA					
I-280	Caltrans	Caltrans	Caltrans	CHP	Caltrans
Oakland Bay Bridge	Caltrans	Caltrans	Caltrans	CHP	Caltrans
US 101	Caltrans	Caltrans	Caltrans	CHP	Caltrans
San Jose,CA					
Montague Expressway	SCCTA	SCCTA	SCCTA	CHP	SCCTA
Rt. 101	Caltrans	Caltrans	Caltrans	CHP	Caltrans
San Tomas Expressway	SCCTA	SCCTA	SCCTA	CHP	SCCTA
Rt. 237	Caltrans	Caltrans	Caltrans	CHP	Caltrans
Seattle, WA					
I-90	WASH DOT	WASH DOT	WASH DOT	State Patrol	WASH DOT
SR 520	WASH DOT	WASH DOT	WASH DOT	State Patrol	WASH DOT
I-5	WASH DOT	WASH DOT	WASH DOT	State Patrol	WASH DOT
I-405	WASH DOT	WASH DOT	WASH DOT	State Patrol	WASH DOT

Table 3. Agencies with Primary Responsibility for Developing and Operating HOV Facilities (Continued)[1]

City	Planning & Design	Construction	Operation	Enforcement	Maintenance
Concurrent Flow Facilities					
Vancouver, Canada H-99	BC Provincial Hwy & BC Transit	BC Provincial Hwy	BC Provincial Hwy	RCMP	BC Provincial Hwy
Washington, D.C./ Northern Virginia I-95	VDOT	VDOT	VDOT	State Police	VDOT
Contraflow Facilities					
New York City, NY Rt. 495	NJ DOT, PA NY&NJ, NJTPKA	NJ DOT, PA NY & NJ NJTPKA	PA NY & NJ	PA NY & NJ	PA NY & NJ, NJTPKA
Long Island Expressway	NYC DOT	NYC DOT	NYC DOT	NYC DOT	NYC DOT
Gowanus Expressway	NYC DOT, Triboro Bridge & Tunnel Authority (TBTA)	NYC DOT, TBTA	NYC DOT, TBTA	NYC DOT	NYC DOT, TBTA

[1]The following abbreviations are used in Table 3.

ADOT - Arizona Department of Transportation
BC Provincial Hwy - British Columbia Provincial Highway Department
BC Transit - British Columbia Transit Authority
Caltrans - California Department of Transportation
CHP - California Highway Patrol
CO Hwy. Depart - Colorado Highway Department
Conn DOT - Connecticut Department of Transportation
FDOT - Florida Department of Transportation
Hawaii DOT - Hawaii Department of Transportation
METRO - Metrpolitan Transit Authority of Harris County - Houston, Texas
MN/DOT - Minnesota Department of Transportation
Municipality of O-C - Municipality of Ottawa-Carlton, Canada
NJ DOT - New Jersey Department of Transportation
NJTPKA - New Jersey Turnpike Authority
NYC DOT - New York City Department of Transportation
O-C Transit - Ottawa-Carlton Regional Transit Authority, Canada
PA NY & NJ - Port Authority of New York and New Jersey
PAT - Port Authority of Allegany County - Pittsburgh, Pennsylvania
Penn DOT - Pennsylvania Department of Transportation
RTD - Regional Transit District - Denver, Colorado
RCMP - Royal Canadian Mounted Police
SCCTA - Santa Clara County Transportation Agency
SCRTCD - Southern California Rapid Transit District
SDHPT - Texas State Department of Highways and Public Transportation
TBTA - Triboro Bridge and Tunnel Authority, New York City
VDOT - Virginia Department of Transportation
WASH DOT - Washington State Department of Transportation

Table 4. Primary Reasons for High-Occupancy Vehicle Project Implementation

City	Air Quality	Energy	Reduce VMT	Increase Capacity	Other
Exclusive Facilities Separate Right-of-Way					
Ottawa, Ontario Canada					
Ottawa-Carleton					Rapid transit component of region's official plan
Pittsburgh, PA					
South Busway		X	X	X	
East Busway			X		
Exclusive Facilities Freeway Right-of-Way					
Hartford, CT					
I-84	X	X		X	
Houston, TX					
I-45N (North)			X	X	
I-45S (Gulf)				X	
I-10 (Katy)				X	
US 290 (Northwest)			X	X	
Los Angeles, CA					
San Bernardino Fwy. Busway	X	X		X	Improve bus service
Minneapolis, MN					
I-394				X	Interim lane--introduction of HOV lane concept
Pittsburgh, PA					
I-279				X	
San Diego, CA					
I-15				X	
Washington, D.C./ Northern Virginia					
I-395			X	X	
I-66	X			X	Legislative requirements[1]
Concurrent Flow Facilities					
Denver, CO					
US 36-Boulder Turnpike	X	X	X	X	Decrease travel time for for commuter express buses
Fort Lee, NJ/New York City					
I-95	X	X	X	X	Extension of existing bus-only lane and reduce bus travel times to the PA NY & NJ Station.
Honolulu, Hawaii					
Moanalua Freeway			X	X	
H-1			X	X	
Los Angeles/Orange Co., CA					
Rt. 55 Commuter Lane	X				
I-405 Commuter Lane				X	
Rt. 91 Commuter Lane	X			X	
Miami, FL					
I-95		X	X	X	Funding requirements[2]

Table 4. Primary Reasons for High-Occupancy Vehicle Project Implementation (Continued)

City	Air Quality	Energy	Reduce VMT	Increase Capacity	Other
Concurrent Flow Facilities					
Orlando, FL					
I-4				X	Funding requirements[3]
Phoenix, AZ					
I-10				X	
San Francisco, CA					
I-280				X	
Oakland Bay Bridge				X	
US 101				X	Increase bus efficiency
San Jose, CA					
Montague Expressway	X	X	X	X	Ridesharing incentive
Rt. 101				X	
San Tomas Expressway	X	X	X	X	Ridesharing incentive
Rt. 237				X	
Seattle, WA					
I-90	X	X		X	Compromise agreement[4]
SR 520				X	
I-5	X			X	
I-405	X			X	
Vancouver, Canada					
H-99				X	Provide priority queue jumping for buses[5]
Washington, D.C./ Northern Virginia					
I-95			X	X	
Contraflow Facilities					
New York City, NY					
Rt. 495	X	X	X	X	Reduce bus travel time
Long Island Expressway	X	X		X	Reduce bus travel time
Gowanus Expressway	X	X		X	Reduce bus travel time

1. One of the provisions for approval of federal funding for the construction of I-66 by the U.S. Secretary of Transportation in 1976 was that the peak direction lanes would be reserved for HOVs during the peak periods.
2. One of the provisions for approval of federal funding for the construction of additional lanes on I-95 in Miami by the Federal Highway Administration was that one lane be reserved for HOVs during the peak periods.
3. One of the provisions for approval of federal funding for the construction of additional lanes on I-4 in Orlando by the Federal Highway Administration was that one lane be reserved for HOVs during the peak periods.
4. The inclusion of the HOV lanes on I-90 was part of the Memorandum Agreement for I-90 agreed upon by the cities of Seattle, Mercer Island and Bellevue, King County, Seattle Metro and the Washington State Department of Transportation in 1976. This Agreement resolved the issues surrounding the design of the facility by stipulating that it should include 3 general-purpose lanes in each direction and 2 HOV lanes, designed to accommodate operation in either a reversible or a 2-directional mode.
5. The bus-only HOV lanes on H-99 in Vancouver, British Columbia allow buses to bypass the congestion on the approaches to the Massey Tunnel.

Table 5. Estimated Capital Costs for High-Occupancy Vehicle Projects[1]

City	Estimated Capital Costs in Millions (Construction Year Costs Shown)[1]	Funding Sources
Exclusive Facilities Separate Right-of-Way		
Ottawa, Ontario Canada		
Ottawa-Carleton	$450.0[2]	Province-75%; Local-25%
Pittsburgh, PA		
South Busway	$ 27.0[3]	UMTA, Penn DOT, Allegheny Co.
East Busway	$ 93.0[4]	UMTA, Penn DOT, Allegheny Co.
Exclusive Facilities Freeway Right-of-Way		
Hartford, CT		
I-84	Part of freeway construction	FHWA-90%; Conn DOT
Houston, TX		
I-45N (North)	$ 29.0[5]	UMTA-55%; METRO-45%
I-45S (Gulf)	$ 27.3[5]	FHWA/State Highway-80%; METRO-20%
I-10 (Katy)	$ 32.0[6]	UMTA-13%; METRO-82%; FHWA/State Highway-5%
US 290 (Northwest)	$ 44.0[5]	FHWA/State Highway-6%; UMTA-57%; METRO-37%
Los Angeles, CA		
San Bernardino Fwy. Busway	$ 56. for 11 miles[7] $ 35. for .7 miles[6]	UMTA, FHWA, Caltrans
Minneapolis, MN		
I-394	Part of freeway construction	FHWA-90%; State-10%
Pittsburgh, PA		
I-279	Part of freeway construction	FHWA-90%; MN/DOT-10%
San Diego, CA		
I-15	$ 31.4[5]	FHWA-90%; Caltrans-10%
Washington, D.C./ Northern Virginia		
I-395	-	FHWA-90%; State-10%
I-66	Part of freeway construction	FHWA-90%; State-10%
Concurrent Flow Facilities		
Denver, CO		
US 36-Boulder Turnpike	$ 6.9[8]	State; Local
Fort Lee, NJ		
I-95	$ 1.5[6]	FHWA-84%; State-9%; Port Authority NY & NJ-7%
Honolulu, Hawaii		
Moanalua Freeway	$ 10.0[9]	FHWA; State
H-1	--	FHWA; State

Table 5. Estimated Capital Costs for High-Occupancy Vehicle Projects (Continued)

City	Estimated Capital Costs in Millions (Construction Year) Costs Shown)[1]	Funding Sources
Concurrent Flow Facilities		
Los Angeles/Orange Co., CA		
Rt. 55 Commuter Lane	$.410[9]	FHWA; Caltrans
I-405 Commuter Lane	$ 54 -	FHWA; Caltrans
Rt. 91 Commuter Lane	$.275[9]	FHWA; Caltrans
Miami, FL		
I-95	-	FHWA; State
Orlando, FL		
I-4	$ 14.0[10]	FHWA-90%; State-10%
Phoenix, AZ		
I-10	-	FHWA; State
San Francisco, CA		
I-280	-	FHWA; State
Oakland Bay Bridge	-	FHWA; State
US 101	-	FHWA; State
San Jose, CA		
Montague Expressway	$ 1.45	Santa Clara County & FHWA
Rt. 101	-	Sales tax
San Tomas Expressway	$ 3.5	Santa Clara County & FHWA
Rt. 237	-	-
Seattle, WA		
I-90	-	FHWA; State
SR 520	$ .1[7]	FHWA; State
I-5	$ 6.98[11]	FHWA; State
I-405	$ 10.2[8]	FHWA; State
Vancouver, Canada		
H-99	-	Provincial Government
Washington, D.C./ Northern Virginia		
I-95	$ 6.5[12]	FHWA-90%; State-10%
Contraflow Facilities		
New York City, NY		
Rt. 495	$ .53[13]	NJ Turnpike Authority; NJDOT, Port Authority NY/NJ
Long Island Expressway	$ .41[14]	-
Gowanus Expressway	$ .401[10]	Triboro Bridge and Tunnel Authority and state

Notes:
1. Unless otherwise noted, capital costs include only the construction costs. Design costs are not included, unless noted. Costs are shown for year of construction. The footnotes identify the year for each project. If no date is listed, the information was not provided in the survey.
2. 1993 cost estimate. Represents total design and construction cost for 31 Km system to 1993 including inflation; in Canadian dollars.
3. Costs presented in 1977 dollars. Cost estimate from 1985 ITE Survey.
4. Costs presented in 1983 dollars. Cost estimate from 1985 ITE Survey.
5. Costs presented in 1988 dollars.
6. Costs presented in 1989 dollars.
7. Cost presented in 1973 dollars.
8. Costs presented in 1986 dollars.
9. Cost estimate from 1985 ITE Survey.
10. Cost presented in 1980 dollars.
11. Cost presented in 1983 dollars.
12. Costs presented in 1985 dollars.
13. Costs presented in 1970 dollars.
14. Costs presented in 1971 dollars.

Table 6. High-Occupancy Vehicle Facility Signing[1]

City	Overhead Static Signs	Overhead Lane Assignment Arrows	Bus or HOV Only Pavement Markings	Overhead Variable Message Signs	Diamond Pavement Markings
Exclusive Facilities Separate Right-of-Way					
Ottawa, Ontario Canada					
Ottawa-Carleton Transitway	X		X		
Pittsburgh, PA					
South Busway	X		X		
East Busway	X		X		
Exclusive Facilities Freeway Right-of-Way					
Hartford, CT					
I-84	X				X
Houston, TX					
I-45N (North)	X	X		X	X
I-45S (Gulf)	X	X		X	X
I-10 (Katy)	X	X		X	X
US 290 (Northwest)	X	X		X	X
Los Angeles, CA					
San Bernardino Fwy. Busway	X		X		X
Minneapolis, MN					
I-394	X	X			X
Pittsburgh, PA					
I-279	X			X	
San Diego, CA					
I-15				X	
Washington, D.C./ Northern Virginia					
I-395	X			X	
I-66	X				
Concurrent Flow Facilities					
Denver, CO					
US 36-Boulder Turnpike	X				X
Fort Lee, NJ					
I-95	X	X		X[2]	X
Honolulu, Hawaii					
Moanalua Freeway	X				X
H-1	X				X
Los Angeles/Orange Co., CA					
Rt. 55 Commuter Lane	X		X		X
I-405 Commuter Lane	X		X		X
Rt. 91 Commuter Lane			X		
Miami, FL					
I-95	X				X

Table 6. High-Occupancy Vehicle Facility Signing[1]

City	Overhead Static Signs	Overhead Lane Assignment Arrows	Bus or HOV Only Pavement Markings	Overhead Variable Message Signs	Diamond Pavement Markings
Concurrent Flow Facilities					
Orlando, FL					
I-4					X
Phoenix, AZ					
I-10	X	X			X
San Francisco, CA					
I-280					X
San Francisco, CA					
Oakland Bay Bridge			X	X	X
US 101	X				X
San Jose, CA					
Montague Expressway			X	X	
Rt. 101					X
San Tomas Expressway				X	
Rt. 237		X		X	
Seattle, WA					
I-90	X				X
SR 520					X
I-5	X				X
I-405	X				X
Vancouver, Canada					
H-99	X		X		X
Washington, D.C.					
I-95	X				X
Contraflow Facilities					
New York City, NY					
Rt. 495	X	X		X	
Long Island Expressway		X		X	
Gowanus Expressway		X		X	

Notes: 1. Some type of ground mounted sign used with all facilities.
2. Overhead variable message signs being installed on I-95 in Fort Lee, NJ.

Table 7. Morning Peak Direction Bus, Vanpool, and Carpool Ridership and Vehicle Volume

City	Number of Directional Lanes		Peak-Hour HOV Facility				Peak-Hour Non HOV Freeway		Peak-Period HOV Facility				Peak-Period Non HOV Freeway		Length of Peak-Period
			Bus		Van & Carpool				Bus		Van & Carpool				
	HOV	Freeway	Veh	Pass	Veh	Pass	Veh	Pass	Veh	Pass	Veh	Pass	Veh	Pass	(Hours)
Exclusive Facilities, Separate Right-of-Way															
Ottawa, Ontario Canada															
Ottawa-Carleton Transitway	1	0	180	11,000	-	-	-	-	495	29,000	-	-	-	-	3
Pittsburgh, PA[1]															
South Busway	1	0	51	2,098	-	-	-	-	83	3,682	-	-	-	-	2
East Busway	1	0	103	5,892	-	-	-	-	145	9,065	-	-	-	-	2
Exclusive Facilities, Freeway Right-of-Way															
Hartford, CT															
I-84	1	3	20	600	119	604	-	-	35	1,050	259	1,367	-	-	3
Houston, TX[2]															
I-45N (North)	1	4	75	2,810	52[3]	416[3]	7,897	8,566	128	4,700	86[3]	682[3]	22,750	25,441	3.5
I-45S (Gulf)	1	4	26	840	706	1,598	4,631	5,795	54	1,600	1,130	2,548	14,061	17,345	3.5
I-10 (Katy)	1	3	46	1,820	962	2,595	5,252	5,687	92	2,875	2,604	6,239	16,473	18,205	3.5
US 290 (Northwest)	1	3	17	600	1,558	3,248	6,140	6,630	33	940	2,598	5,450	16,360	17,363	3.5
Los Angeles, CA															
San Bernardino Fwy. Busway	1	4	71	2,750	1,374	4,352	8,375	9,548	132	5,110	2,516	8,075	16,515	19,295	2
Minneapolis, MN															
I-394	1	2	13	455	430	942	1,956	2,328	17	595	737	1,595	5,250	6,194	3
Pittsburgh, PA															
I-279	1	2	13	485	147	498	-	-	22	720	200	664	-	-	2
San Diego, CA															
I-15	2	4	14	350	1,259	2,686	2,818	-	23	575	2,782	5,961	28,690	-	3
Washington, D.C.															
I-395	2	4	161	5,621	2,314	9,483	8,696	10,435	441	15,316	4,767	18,917	23,467	28,160	3
I-66	2	0	13	398	618	2,278	-	-	30	1,018	1,085	3,963	-	-	2.5

Table 7. Morning Peak Direction Bus, Vanpool, and Carpool Ridership and Vehicle Volume (Continued)

City	Number of Directional Lanes		Peak-Hour HOV Facility				Peak-Hour Non HOV Freeway		Peak-Period HOV Facility				Peak-Period Non HOV Freeway		Length of Peak-Period
			Bus		Van & Carpool				Bus		Van & Carpool				
	HOV	Freeway	Veh	Pass	Veh	Pass	Veh	Pass	Veh	Pass	Veh	Pass	Veh	Pass	(Hours)
Concurrent Flow Facilities															
Denver, CO															
US 36-Boulder Turnpike	1	2	28	1,000	-	-	-	-	55	1,900	-	-	-	-	3
Fort Lee, NJ															
I-95	1	5	36	1,800	253	919	7,100[4]	9,798[4]	70	3,500	429	1,499	12,700[4]	17,018[4]	2
Honolulu, Hawaii															
Moanalua Freeway	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
H-1	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-
Los Angeles/Orange Co., CA															
Rt. 55 Commuter Lane	1	3	3	50	1,295	2,687	5,284	5,656	5	70	2,371	4,977	10,009	10,691	2
I-405 Commuter Lane	1	4	4	120	1,625	3,705	8,322	9,154	7	160	3,173	7,171	16,384	18,002	2
Rt. 91 Commuter Lane	1	4	0	0	1,294	3,112	10,478	11,212	3	120	2,153	5,186	20,360	21,785	2
Miami, FL															
I-95[5]	1	3	9[5]	350[5]	1,300[5]	2,460[5]	6,100[5]	7,260[5]	-	-	-	-	-	-	-
Orlando, FL															
I-4	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Phoenix, AZ															
I-10	1	3	-	-	-	-	1,332	-	-	-	-	-	-	-	-
San Francisco, CA															
I-280 (Reopening 9/90)	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Oakland Bay Bridge	4	5	101	3,535	2,325	8,273	-	-	252	8,820	5,553	20,012	-	-	5
US 101[1]	1	3	57	1,995	678	1,490	4,952	6,274	96	3,360	1,284	2,840	11,888	14,645	2.5
San Jose, CA															
Montague Expressway	1	2	-	-	-	-	-	-	-	-	-	-	-	-	3
Rt. 101	1	3	3	105	376	803	4,921	5,433	4	140	831	3,108	13,280	-	3
San Tomas Expressway	1	2	-	-	-	-	-	-	-	-	-	-	-	-	3
Rt. 237	1	2	18	630	754	1,720	3,204	3,222	36	1,260	2,010	4,605	8,920	8,963	3

Table 7. Morning Peak Direction Bus, Vanpool, and Carpool Ridership and Vehicle Volume (Continued)

City	Number of Directional Lanes		Peak-Hour HOV Facility				Peak-Hour Non HOV Freeway		Peak-Period HOV Facility				Peak-Period Non HOV Freeway		Length of Peak-Period
			Bus		Van & Carpool				Bus		Van & Carpool				
	HOV	Freeway	Veh	Pass	Veh	Pass	Veh	Pass	Veh	Pass	Veh	Pass	Veh	Pass	(Hours)
Concurrent Flow Facilities															
Seattle, WA															
I-90	1	3	34	1,250	127	229	5,133	5,749	89	2,890	270	607	13,547	15,037	3
SR 520	1	2	56	3,140	210	498	2,766	3,043	92	3,690	393	1,191	6,252	6,877	2
I-5	1	4	64	2,605	466	1,105	7,691	9,476	146	5,810	841	2,062	20,721	25,350	3
I-405	1	2	1	20	193	435	1,960	1,999	-	-	-	-	-	-	-
Vancouver, Canada															
H-99	1	2	27	1,080	-	-	-	-	45	1,800	-	-	-	-	2
Washington, D.C./ Northern Virginia															
I-95	1	3	36	1,226	1,242	5,336	3,879	4,500	101	3,356	2,303	9,544	9,697	11,248	3
Contraflow Facilities															
New York City, NY															
Rt. 495	1	3	725[7]	34,685[7]	-	-	4,475	7,380	1,640[7]	65,600[7]	-	-	17,435	29,120	4
Long Island Expressway	1	3	165	7,838	214	394	-	-	366	17,385	428	761	-	-	3
Gowanus Expressway	1	4	202	8,686	173	899	3,794	7,569	409	14,724	399	1,907	10,720	20,818	2.5

1. The utilization rates provided in the 1988 ITE report on the Pittsburgh busways were slightly higher than those reported here due additional bus service provided on the South Busway during the reconstruction of the adjacent light rail transit line. In addition, the peak-period volumes shown in the 1988 report were two direction, rather than peak direction volumes.
2. Data for the Houston Transitways are from March, 1990.
3. Represents vanpools only as carpools were not allowed to use the North Transitway at the time of this survey.
4. The non HOV lane vehicle counts for I-95 in Fort Lee, N.J. are recorded at the toll plazas an approach to the George Washington Bridge. The 5 general traffic lanes turn into 30 toll lanes.
5. No 1989 information provided. Data shown are from the 1985 survey conducted by a technical committee of the Institute of Transportation Engineers and contained in the report, "The Effectiveness of High-Occupancy Vehicle Facilities," 1988, Table 6, page 16.
6. On the Oakland Bay Bridge there are 18 lanes at the toll plaza for general purpose traffic and 4 lanes for HOVs. These later merge into 5 lanes.
7. The volumes for the Route 495 contraflow lane are representative of the higher volumes recorded when the lane is open the full 4 hours or slightly longer. The average daily volumes may be slightly lower.

Table 8. Peak Direction, Peak-Hour Freeway and High-Occupancy Vehicle Facility Volume Per Lane

City	Number of Directional Lanes		Total HOV Facility Peak-Hour Volumes				Volume Per Lane							
							Morning Peak-Hour				Afternoon Peak-Hour			
			Morning		Afternoon		HOV		Freeway		HOV		Freeway	
	HOV	Freeway	Veh	Pass	Veh	Pass	Veh/ Lane	Pass/ Lane	Veh/ Lane	Pass/ Lane	Veh/ Lane	Pass/ Lane	Veh/ Lane	Pass/ Lane
Exclusive Facilities, Separate Right-of-Way														
Ottawa, Ontario Canada														
Ottawa-Carleton Transitway	1	0	180	11,000	170	9,500	180	11,000	-	-	170	9,500	-	-
Pittsburgh, PA														
South Busway	1	0	51	2,098	51	1,946	51	2,098	-	-	51	2,098	-	-
East Busway	1	0	103	5,892	103	4,272	103	4,272	-	-	103	4,272	-	-
Exclusive Facilities, Freeway Right-of-Way														
Hartford, CT														
I-84	1	3	139	1,204	-	-	139	1,204	-	-	-	-	-	-
Houston, TX[1]														
I-45N (North)	1	4	127[2]	3,226[2]	114[2]	2,944[2]	127[2]	3,226[2]	1,974	2,141	114[2]	2,944[2]	1,848	2,140
I-45S (Gulf)	1	4	732	2,438	470	1,748	732	2,438	1,158	1,448	470	1,748	1,227	1,545
I-10 (Katy)	1	3	1,008	4,415	1,713	4,929	1,008	4,415	1,750	1,895	1,713	4,929	1,720	1,943
US 290 (Northwest)	1	3	1,575	3,848	684	1,944	1,575	3,848	2,046	2,210	684	1,944	2,563	2,802
Los Angeles, CA														
San Bernardino Fwy. Busway	1	4	1,445	7,106	1,267	5,889	1,445	7,106	2,094	2,387	1,267	5,889	1,905	2,324
Minneapolis, MN														
I-394	1	2	443	1,397	764	2,190	443	1,397	978	1,164	327	1,024	1,002	1,222
Pittsburgh, PA														
I-279	1	2	160	983	53	430	160	983	-	-	81	651	-	-
San Diego, CA														
I-15	2	4	1,375	3,138	1,567	3,755	686	1,569	-	-	783	1,877	-	-
Washington, D.C./ Northern Virginia														
I-395	2	4	2,590	15,308	1,420[3]	11,650[3]	1,295	7,654	2,174	2,608	710[3]	5,830[3]	1,805[3]	2,360[3]
I-66	2	0	761	2,850	835	2,530	380	1,425	-	-	417	1,269	-	-

Table 8. Peak Direction, Peak-Hour Freeway and High-Occupancy Vehicle Facility Volume Per Lane (Continued)

City	Number of Directional Lanes		Total HOV Facility Peak-Hour Volumes				Volume Per Lane							
							Morning Peak-Hour				Afternoon Peak-Hour			
			Morning		Afternoon		HOV		Freeway		HOV		Freeway	
	HOV	Freeway	Veh	Pass	Veh	Pass	Veh/ Lane	Pass/ Lane	Veh/ Lane	Pass/ Lane	Veh/ Lane	Pass/ Lane	Veh/ Lane	Pass/ Lane
Concurrent Flow Facilities														
Denver, CO														
US 36-Boulder Turnpike	1	2	28	1,000	-	-	28	1,000	-	-	-	-	-	-
Fort Lee, NJ/New York City														
I-95	1	5	290	2,720	-	-	290	2,720	1,420	1,956	-	-	-	-
Honolulu, Hawaii														
Moanalua Freeway[3]	1	3	1,730[3]	4,750[3]	1,750[3]	4,800[3]	1,730[3]	4,750[3]	1,400[3]	1,680[3]	1,750[3]	4,800[3]	1,400[3]	1,680[3]
H-1	1	4	-	-	-	-	-	-	-	-	-	-	-	-
Los Angeles/Orange Co., CA														
Rt. 55 Commuter Lane	1	3	1,298	2,798	1,578	3,606	1,298	2,737	1,761	1,884	1,578	3,606	1,661	1,827
I-405 Commuter Lane	1	4	1,294	3,112	1,082	2,546	1,294	3,112	1,746	1,869	1,082	2,546	1,877	2,008
Rt. 91 Commuter Lane	1	4	-	-	1,629	3,825	-	-	-	-	1,629	3,825	2,081	2,289
Miami, FL														
I-95[3]	1	3	1,310[3]	2,810[3]	1,380[3]	2,690[3]	1,310[3]	2,810[3]	2,035[3]	2,420[3]	1,380[3]	2,690[3]	1,865[3]	2,410[3]
Orlando, FL														
I-4[4]	1	2	815[4]	990[4]	725[4]	920[4]	815[4]	990[4]	950[4]	1,107[4]	725[4]	920[4]	885[4]	1,040[4]
Phoenix, AZ														
I-10	1	3	-	-	-	-	-	-	-	-	-	-	-	-
San Francisco, CA														
I-280 (Reopening 9/90)	1	3	-	-	-	-	-	-	-	-	-	-	-	-
Oakland Bay Bridge	4	5	2,544	11,859	518	2,542	636	2,965			130	635		
US 101	1	3	624	2,739	560	2,893	624	2,739	1,650	2,091	560	2,893	1,633	2,042
San Jose, CA														
Montague Expressway	1	2	-	-	-	-	-	-	-	-	-	-	-	-
Rt. 101	1	3	379	908	830	1,875	379	908	1,640	1,811	830	1,875	1,333	1,466

Table 8. Peak Direction, Peak-Hour Freeway and High-Occupancy Vehicle Facility Volume Per Lane (Continued)

City	Number of Directional Lanes		Total HOV Facility Peak-Hour Volumes				Volume Per Lane							
							Morning Peak-Hour				Afternoon Peak-Hour			
							HOV		Freeway		HOV		Freeway	
			Morning		Afternoon		Veh/ Lane	Pass/ Lane	Veh/ Lane	Pass/ Lane	Veh/ Lane	Pass/ Lane	Veh/ Lane	Pass/ Lane
	HOV	Freeway	Veh	Pass	Veh	Pass								
Concurrent Flow Facilities														
San Jose, CA (continued)														
San Tomas Expressway	1	2	-	-	-	-	-	-	-	-	-	-	-	-
Rt. 237	1	2	895	2,472	928	2,270	895	2,472	1,602	1,611	928	2,270	1,235	1,272
Seattle, WA														
I-90	1	3	170	1,488	-	-	170	1,488	1,711	1,916	-	-	-	-
SR 520	1	2	268	3,656	-	-	268	3,656	1,383	1,521	-	-	-	-
I-5	1	4	530	3,710	550	3,080	530	3,710	1,923	2,307	550	3,080	2,013	2,416
I-405	1	2	214	475	317	664	214	475	1,960	1,999	317	664	2,093	2,198
Vancouver, Canada														
H-99	1	2	45	1,650	40	1,500	45	1,650	-	-	40	1,500	-	-
Washington, D.C./ Northern Virginia														
I-95	1	3	1,612	7,012	-	-	1,612	7,012	1,293	1,500	-	-	-	-
Contraflow Facilities														
New York City, NY														
Rt. 495	1	3	725	34,685	-	-	725	34,685	1,490	2,460	-	-	-	-
Long Island Expressway	1	3	394	8,254	-	-	-	-	-	-	-	-	-	-
Gowanus Expressway	1	4	375	9,585	948	1,892	375	9,585	-	-	948	1,892	-	-

1. Data for the Houston Transitways are from March, 1990.
2. Represents buses and vanpools only as carpools were not allowed to use the North Transitway at the time of this survey.
3. No 1989 information provided. Data shown are from the 1985 survey conducted by a technical committee of the Institute of Transportation Engineers and contained in the report, "The Effectiveness of High-Occupancy Vehicle Facilities," 1988, Table 12, page 22.
4. No 1989 information provided on I-4 in Orlando. Data shown are from the above reference ITE Report for the north segment of the I-4 HOV lanes.

Table 9. Peak Direction, Peak-Period Freeway and High-Occupancy Vehicle Facility Volume Per Lane

City	Number of Directional Lanes		Total HOV Facility Peak-Period Volumes				Volume Per Lane							
							Morning Peak-Period				Afternoon Peak-Period			
			Morning		Afternoon		HOV		Freeway		HOV		Freeway	
	HOV	Freeway	Veh	Pass	Veh	Pass	Veh/ Lane	Pass/ Lane	Veh/ Lane	Pass/ Lane	Veh/ Lane	Pass/ Lane	Veh/ Lane	Pass/ Lane
Exclusive Facilities, Separate Right-of-Way														
Ottawa, Ontario Canada														
Ottawa-Carleton Transitway	1	0	495	29,000	450	31,000	495	29,000	-	-	450	31,500	-	-
Pittsburgh, PA														
South Busway	1	0	83	3,682	80	3,476	83	3,682	-	-	80	3,476	-	-
East Busway	1	0	145	9,065	139	7,911	145	9,065	-	-	139	7,911	-	-
Exclusive Facilities, Freeway Right-of-Way														
Hartford, CT														
I-84	1	3	294	2,417	-	-	294	2,417	-	-	-	-	-	-
Houston, TX														
I-45N (North)	1	4	212[2]	5,382[2]	223[2]	5,834[2]	212[2]	5,382[2]	5,687	6,360	223[2]	5,834[2]	6,151	7,032
I-45S (Gulf)	1	4	1,184	4,148	891	3,488	1,184	4,148	3,515	4,336	891	3,488	3,744	4,467
I-10 (Katy)	1	3	2,696	9,114	3,748	10,350	2,696	91143	5,491	6,068	3,748	10,350	5,472	6,051
US 290 (Northwest)	1	3	2,631	6,390	1,237	3,676	2,631	6,390	5,453	5,787	1,237	3,676	7,122	7,738
Los Angeles, CA														
San Bernardino Fwy. Busway	1	4	2,648	13,185	2,465	11,045	2,648	13,185	4,129	4,824	2,465	11,045	3,689	4,532
Minneapolis, MN														
I-394	1	2	746	2,190	930	2,698	746	2,190	2,603	3,098	930	2,698	3,643	4,444
Pittsburgh, PA														
I-279	1	2	222	1,384	81	651	222	1,384	-	-	81	651	-	-
San Diego, CA														
I-15	1	4	2,991	6,722	-	-	1,495	3,361	-	-	-	-	-	-
Washington, D.C./ Northern Virginia														
I-395	2	4	6,066	35,456	-	-	3,033	17,728	5,866	7,039	-	-	-	-
I-66	2	0	1,725	5,729	2,346	5,981	862	2,864	-	-	1,173	2,990	-	-

Table 9. Peak Direction, Peak-Period Freeway and High-Occupancy Vehicle Facility Volume Per Lane (Continued)

City	Number of Directional Lanes		Total HOV Facility Peak-Period Volumes				Volume Per Lane							
							Morning Peak-Period				Afternoon Peak-Period			
			Morning		Afternoon		HOV		Freeway		HOV		Freeway	
	HOV	Freeway	Veh	Pass	Veh	Pass	Veh/ Lane	Pass/ Lane	Veh/ Lane	Pass/ Lane	Veh/ Lane	Pass/ Lane	Veh/ Lane	Pass/ Lane
Concurrent Flow Facilities														
Denver, CO														
US 36-Boulder Turnpike	1	-	55	1,900	-	-	55	1,900	-	-	-	-	-	-
Fort Lee, NJ														
I-95	1	5	500	5,000	-	-	500	5,000	2,540	3,403	-	-	-	-
Honolulu, Hawaii														
Moanalua Freeway	1	3	-	-	-	-	-	-	-	-	-	-	-	-
H-1	1	4	-	-	-	-	-	-	-	-	-	-	-	-
Los Angeles/Orange Co., CA														
Rt. 55 Commuter Lane	1	3	2,376	5,047	2,983	6,720	2,376	5,047	3,336	3,570	2,983	6,720	3,274	3,600
I-405 Commuter Lane	1	4	2,156	5,306	2,025	4,890	2,156	5,306	3,393	3,631	2,025	4,890	3,752	4,015
Rt. 91 Commuter Lane	1	4	-	-	3,180	7,331	-	-	-	-	3,180	7,331	4,096	4,506
Miami, FL														
I-95	1	3	-	-	-	-	-	-	-	-	-	-	-	-
Orlando, FL														
I-4	1	2	-	-	-	-	-	-	-	-	-	-	-	-
Phoenix, AZ														
I-10	1	3	130	-	100	-	130	-	444	-	100	-	433	-
San Francisco, CA														
I-280 (Reopening 9/90)	1	3	-	-	-	-	-	-	-	-	-	-	-	-
Oakland Bay Bridge	4	5	6,366	29,366	-	-	1,591	7,342	-	-	-	-	-	-
US 101	1	3	1,935	6,746	2,663	8,159	1,935	6,746	3,962	4,881	2,663	8,159	6,298	8,598
San Jose, CA														
Montague Expressway	1	2	1,880	-	1,731	-	1,880	-	3,354	-	1,731	-	3,620	-
Rt. 101	1	3	1,084	2,261	1,721	4,118	1,084	2,261	4,484	4,698	1,721	4,118	5,863	6,961
San Tomas Expressway	1	2	1,323	-	2,055	-	1,323	-	3,718	-	2,055	-	4,466	-
Rt. 237	1	2	2,380	6,199	2,309	5,773	2,380	6,199	4,460	4,481	2,309	5,773	3,352	3,590

Table 9. Peak Direction, Peak-Period Freeway and High-Occupancy Vehicle Facility Volume Per Lane (Continued)

City	Number of Lanes		Total HOV Facility Peak-Period Volumes				Volume Per Lane							
							Morning Peak-Period				Afternoon Peak-Period			
			Morning		Afternoon		HOV		Freeway		HOV		Freeway	
	HOV	Freeway	Veh	Pass	Veh	Pass	Veh/ Lane	Pass/ Lane	Veh/ Lane	Pass/ Lane	Veh/ Lane	Pass/ Lane	Veh/ Lane	Pass/ Lane
Concurrent Flow Facilities														
Seattle, WA														
I-90	1	3	384	3,522	-	-	384	3,522	4,516	5,012	-	-	-	-
SR 520	1	2	526	4,921	-	-	526	4,921	3,126	3,439	-	-	-	-
I-5	1	4	1,104	6,388	868	6,240	1,104	6,388	5,180	6,337	868	6,240	4,864	5,910
I-405	1	3	-	-	-	-	-	-	-	-	-	-	-	-
Vancouver, Canada														
H-99	1	2	-	-	-	-	-	-	-	-	-	-	-	-
Washington, D.C./ Northern Virginia														
I-95	1	3	3,959	14,940	-	-	3,959	14,940	3,232	3,749	-	-	-	-
Contraflow Facilities														
New York City, NY														
Rt. 495	1	3	1,750	-	-	-	1,750	-	-	-	-	-	-	-
Long Island Expressway	1	3	855	18,237	-	-	855	18,237	-	-	-	-	-	-
Gowanus Expressway	1	4	808	16,631	-	-	808	16,631	2,680	5,204	-	-	-	-

1. Data for the Houston Transitways are from March, 1990.
2. Represents vanpools only as carpools were not allowed to use the North Transitway at the time of this survey.

Table 10. Enforcement of High-Occupancy Vehicle Facilities

City	Level of Enforcement During HOV Operating Period[1]			Is Enforcement Primary Responsibility of Personnel	Primary Agency Responsible
	Number of Persons	Number of Vehicles	Adequate?		
Exclusive Facilities, Separate Right-of-Way					
Ottawa, Ontario Canada					
Ottawa-Carleton	10	3	Yes	No	OC Transpo & Local Police
Pittsburgh, PA					
South Busway	4[2]	-	Yes[2]	-	Transit Police
East Busway	4[2]	-	Yes[2]	-	Transit Police
Exclusive Facilities, Freeway Right-of-Way					
Hartford, CT					
I-84	2	2	Yes	Yes	State Police
Houston, TX					
I-45N (North)	1	1	Yes	Yes	Transit Police
I-45S (Gulf)	1	1	Yes	Yes	Transit Police
I-10 (Katy)	1	1	Yes	Yes	Transit Police
US 290 (Northwest)	1	1	Yes	Yes	Transit Police
Los Angeles, CA					
San Bernardino Fwy. Busway	No full time	-	Yes	Yes[3]	CHP
Minneapolis, MN					
I-394	No full[4] time	-	Yes	No	State Patrol
Pittsburgh, PA					
I-279	No full time	-	Yes	No	State Police
San Diego, CA					
I-15	2	2	Yes	Yes	CHP
Washington, D.C.					
I-395	2	2	No	No	State Police
I-66	2	2	No	No	State Police
Concurrent Flow Facilities					
Denver, CO					
US 36-Boulder Turnpike	No full time	-	-	No	State Patrol
Fort Lee, NJ					
I-95	1	1	Yes	Yes	Port Auth. of NY&NJ, NJ DOT
Honolulu, Hawaii					
Moanalua Freeway	4	4	No	No	Honolulu Police
H-1	-	-	No	No	Honolulu Police
Los Angeles, CA					
Rt. 55 Commuter Lane	No full time[3]	-	Yes	Yes[3]	CHP
I-405 Commuter Lane	No full time[3]	-	Yes	Yes[3]	CHP
Rt. 91 Commuter Lane	No full time[3]	-	Yes	Yes[3]	CHP
Miami, FL					
I-95	No full time	-	No	No	State Patrol

Table 10. Enforcement of High-Occupancy Vehicle Facilities (Continued)

City	Level of Enforcement During HOV Operating Period[1]			Is Enforcement Primary Responsibility of Personnel	Primary Agency Responsible
	Number of Persons	Number of Vehicles	Adequate?		
Concurrent Flow Facilities					
Orlando, FL					
I-4	No full time	-	-	No	State Patrol
Phoenix, AZ					
I-10	No full time	-	-	No	State Police
San Francisco, CA					
I-280	1	-	Yes	Yes	CHP
Oakland Bay Bridge	4	4	Yes	No	CHP
US 101	Varies	Varies	Yes	Yes	CHP
San Jose, CA					
Montague Expressway	No full time	-	Yes	No	CHP
Rt. 101	2	2	Yes	No	CHP
San Tomas Expressway	3	3	Yes	No	CHP
Rt. 237	2	2	Yes	No	CHP
Seattle, WA					
I-90	5[5]	5[5]	No	No	State Patrol
SR 520	5[6]	5[6]	Yes	No	State Patrol
I-5	4[6]	4[6]	No	No	State Patrol
I-405	3[6]	3[6]	Yes	Yes	State Patrol
Vancouver, Canada					
H-99	No full time	-	Yes	No	BC Provincial Hwy
Washington, D.C.					
I-95	1	1	No	Yes	State Police
Contraflow Facilities					
New York City, NY					
Rt. 495	3[7]	1[7]	Yes	Yes	PA NY & NJ[7]
Long Island Expressway	1	1	Yes	No	NYC DOT
Gowanus Expressway	1	1	Yes	No	NYC DOT

Note:

1. Enforcement levels listed are for the HOV operating period. However, the exact level of enforcement may vary over the course of the operating period. Usually, more enforcement personnel are assigned during the peak-periods than during other times of the day.
2. No 1989 information provided. Data shown are from the 1985 survey conducted by a technical committee of the Institute of Transportation Engineers and contained in the report, "The Effectiveness of High-Occupancy Vehicle Facilities", 1988, Table 15, page 25. The number of enforcement personnel listed is the total for both the South and East Busways.
3. No full time assigned personnel. Special enforcement is provided as needed. When provided, enforcement is the primary responsibility of the assigned personnel.
4. No full time assigned personnel. Lane monitored as part of regular program. Periodic saturations conducted.
5. For the initial 6 months of operations on I-90 a 3-trooper team was utilized to provide an emphasis to enforcement. After this initial period, 3 troopers monitor the general geographical area and are not specifically assigned to the HOV lane.
6. Troopers assigned to the general geographical area, not specifically to HOV lanes. Every 3 to 4 weeks a motorcycle patrol provides saturation enforcement for 3 to 4 days.
7. The Port Authority of New York and New Jersey police are responsible for enforcement of the contraflow lane on Route 495. In addition, the New Jersey State Police provide an enforcement presence at the New Jersey Turnpike exit for the Lincoln Tunnel.

Table 11. Violation Levels, Penalties, and Enforcement Methods

City	Estimated Peak-Hour Violation Rates[1]	Fine for HOV Violators Initial fine/fine for repeat Violations	Enforcement Methods: Special Vehicle Pullover Areas	Enforcement Methods: Violators Diverted from HOV Lane	Other	Considering Use of Cameras or Other Innovative Approaches for HOV Lane Enforcement (Yes/No)
Exclusive Facilities, Separate Right-of-Way						
Ottawa, Ontario Canada						
Ottawa-Carleton Transitway	1%[2]	$ 53.75			Use Shoulder	No
Pittsburgh, PA						
South Busway	1%[2]	$300[2]				-
East Busway	1%[2]	$300[2]				-
Exclusive Facilities, Freeway Right-of-Way						
Hartford, CT						
I-84	-	$ 40	X			No
Houston, TX						
I-45N (North)	1%	$ 75	X	X		Yes
I-45S (Gulf)	1%	$ 75	X	X		Yes
I-10 (Katy)	35%[3]	$ 75	X	X		Yes
US 290 (Northwest)	1%	$ 75	X	X		Yes
Los Angeles, CA						
San Bernardino Fwy. Busway	11%	$100-150/$150-500[4]			Use Shoulder	Yes
Minneapolis, MN						
I-394	2-5%	$44/$55/$66	X			No
Pittsburgh, PA						
I-279	-	$82.50/$82.50			Stop as exit	No
San Diego, CA						
I-15	3-5%	$57/$120			Use shoulder	Yes
Washington, D.C.						
I-395	2%	$50	X		Ticket by Mail and HERO Program[5]	Yes
I-66	17%	$50	X		Ticket by Mail and HERO Program[5]	Yes

Table 11. Violation Levels, Penalties, and Enforcement Methods (Continued)

City	Estimated Peak-Hour Violation Rates[2]	Fine for HOV Violators Initial fine/fine for repeat Violations	Enforcement Methods: Special Vehicle Pullover Areas	Enforcement Methods: Violators Diverted from HOV Lane	Other	Considering Use of Cameras or Other Innovative Approaches for HOV Lane Enforcement (Yes/No)
Concurrent Flow Facilities						
Denver, CO						
US 36-Boulder Turnpike	-	-			Use Shoulder	No
Fort Lee, NJ						
I-95	30%	$50/$50[6]	X	X		Yes
Honolulu, Hawaii						
Moanalua Freeway	-	$40			Use Shoulder	Yes
H-1	-	$40			Use Shoulder	Yes
Los Angeles, CA						
Rt. 55 Commuter Lane	2-6%	$100-150/$150-500[4]	X	X	Enforcement areas being improved	Yes
I-405 Commuter Lane	5%	$100-150/$150-500[4]	X			Yes
Rt. 91 Commuter Lane	5%	$100-150/$150-500[4]		X		Yes
Miami, FL						
I-95	40%[2]	$52/$52		X	Use shoulders	Yes
Orlando, FL						
I-4	75%	-				No
Phoenix, AZ						
I-10	-	$250[7]		X		No
San Francisco, CA						
I-280	8%	$50-100/$100-500[4]		X		Yes
Oakland Bay Bridge	2%	$50-100/$100-500[4]		X		Yes
US 101	5%[2]	$50-100/$100-500[4]		X		Yes
San Jose, CA						
Montague Expressway	9%	$50-100/$100-500[4]		X		No
Rt. 101	5-10%	$50-100/$100-500[4]		X		No
San Tomas Expressway	7%	$50-100/$100-500[4]	X			No
Rt. 237	6-10%	$50-100/$100-500[4]		X		No

Table 11. Violation Levels, Penalties, and Enforcement Methods (Continued)

City	Estimated Peak-Hour Violation Rates[1]	Fine for HOV Violators Initial fine/fine for repeat Violations	Enforcement Methods: Special Vehicle Pullover Areas	Enforcement Methods: Violators Diverted from HOV Lane	Other	Considering Use of Cameras or Other Innovative Approaches for HOV Lane Enforcement (Yes/No)
Concurrent Flow Facilities						
Seattle, WA						
I-90	-	$47/$47[8]		X	Hero Program	Yes
SR 520	-	$47/$47[8]		X	Hero Program	Yes
I-5	19%[2]	$47/$47[8]		X	Hero Program	Yes
I-405	-	$47/$47[8]		X	Hero Program	Yes
Vancouver, Canada						
H-99	-	-			Use Shoulder	No
Washington, D.C.						
I-95	-	$50	X		Ticket by mail and HERO program[5]	No
Contraflow Facilities						
New York City, NY						
Rt. 495	-	$65/$65[9]		X		Yes
Long Island Expressway	-	$65/$65[9]	X	X		No
Gowanus Expressway	-	$65/$65[9]	X	X		No

Note:
1. The violation rate refers to the percentage of vehicles using the HOV facility that do not meet the minimum occupancy requirement and therefore are in violation of the usage regulations.
2. No 1989 information provided. Data shown are from the 1985 survey conducted by a technical committee of the Institute of Transportation Engineers and contained in the report, "The Effectiveness of High-Occupancy Vehicle Facilities," 1988, Table 15, page 25.
3. The violation rate on the Katy Transitway during the period from 7:00 - 8:15 a.m. (the 3+ occupancy requirement operating period) averaged 35% in 1989. For the overall a.m. peak-period the violation rate averaged 14% and in the p.m. peak-period it averaged 0.7%.
4. $150-$200 for second offense, $250-$500 for third violation; plus individual must pay any court costs.
5. In 1989 the Virginia Legislature authorized the Virginia State Police to issue tickets by mail to violators of the HOV lanes occupancy requirements. The program has been in operation for almost a year. Currently, the State Patrol is stopping vehicles that violate the HOV lane occupancy requirement to record information on the driver. The actual citation is then sent to the driver through the mail.
6. In addition to $50 fine, violators also receive 2 points toward license revocation; 12 points leads to license revocation.
7. The $250 fine in Phoenix is the maximum fine for a civil violation. The local jurisdiction may impose a lesser fine, however, and the state adds a 37% surcharge on whatever fine is levied.
8. In addition to the $47 fine, the violation goes on driving record as a moving violation.
9. In addition to the $65 fine, violators also receive 2 points toward license revocation.

V. PROPOSED HOV PROJECTS AND PROJECT EXTENSIONS

New HOV projects and extensions to existing facilities are being planned, designed, and implemented in many metropolitan areas. A summary of some of these projects, including a general description and the anticipated completion date, is provided in Table 12. This listing is not intended to be all inclusive; it represents some of the projects which have been identified as reasonably committed with the potential to be operational by the year 2000. Obviously, the projects are subject to change.

Implementation of all the projects listed in Table 12 will result in approximately 542 additional miles of HOV lanes by the year 2000. This represents a significant increase from the 332 miles of HOV lanes in operation as of April, 1990. If all the projects listed are completed, some 874 miles of HOV facilities will be in operation in North America by the year 2000.

Table 12. Listing of Proposed HOV Facilities

City, Freeway, Type of Project	Project Length (miles)	Anticipated Date of Operation
Charlotte, North Carolina		
US 73, Exclusive reversible lanes	3	1996
Dallas		
I-30, Contraflow lanes using moveable barrier	5.2	1991
I-635, Combination two-direction exclusive lanes and exclusive reversible single lane facility	21	late 1990's
Denver, CO		
I-25, 2-lane reversible facility	12	mid - 1990's
Ft. Lauderdale, FL		
I-95, Concurrent flow lanes	25	1990, 1991
Hartford, CT		
I-91, Concurrent flow lanes	9	1991
Houston, Texas		
I-45N (North) Extension of reversible exclusive lane	10.6	1990, 1994, 1997
I-45S (Gulf), Extension of reversible exclusive lane	9	1993
I-59S (Southwest), Reversible exclusive lane	14.4	mid-1990's
I-59N (Eastex), Two direction exclusive facility	20	mid-to-late 1990's
Los Angeles/Orange County		
I-5, 2-direction exclusive lanes	21	Early 1990's
Route 57, Concurrent flow lanes	10	1993
San Bernardino Freeway Busway extension	6	mid-to-late 1990's
I-210, Concurrent flow lanes	18	mid-1990's
I-110 (Harbor Freeway), Exclusive lanes	12	mid-1990's
I-105 (Century Freeway), Exclusive lanes	17	mid-1990's
Route 118, Concurrent flow lanes	10	mid-to-late 1990's
Route 91 (ORA), Concurrent flow lanes	19	13 miles - 1993 6 miles - 1996
Route 91 (LA), Concurrent flow lanes	6	1992
I-405 (LA), Concurrent flow lanes	23	10 miles - 1994 13 miles - 1997
Route 605 (ORA), Concurrent flow lanes	2	1993
Route 605 (LA), Concurrent flow lanes	8	1993
Minneapolis-St. Paul, MN		
I-394, Combination of 2-lane reversible exclusive facility and diamond lanes	11	1993
U of M Intercampus busway, Two-direction exclusive facility	3	mid-to-late 1990's
Norfolk/Virginia Beach, Virginia		
I-64, Exclusive lanes	10	mid-1990's
Route 44, Concurrent flow lanes	10	will reopen when I-64 HOV lanes open
Ottawa, Canada		
Extension to transitway system, additional sections in the planning stage	4	Early 1990's
Phoenix, Arizona		
State Route Loop 202 (East Papago Freeway)	9	1992
I-10, Extensions to concurrent flow lanes	8	3 miles - 1992 5 miles - 1995
Sacramento, CA		
Route 99, Concurrent flow lanes	11	3 miles - 1990 8 miles - 1993

Table 12. Listing of Proposed HOV Facilities (continued)

City, Freeway, Type of Project	Project Length (miles)	Anticipated Date of Operation
San Diego, CA		
I-5, Concurrent flow lanes	13	late 1990's
San Francisco, CA		
Route 580, Exclusive reversible lane	4.2	
I-80, Concurrent flow lanes	35.2	
I-680, Concurrent flow lanes	14.4	
I-101, Concurrent flow lanes	15.2	
San Jose, CA		
Route 101, Extension to concurrent flow lanes	7.7	1990
Route 101, Extension to concurrent flow lanes	5.9	mid 1990's
Route 280, Extension to concurrent flow lanes	9.6	1990
Route 80, Concurrent flow lanes	4	1990
Seattle, WA		
I-90, 2-lane reversible exclusive facility	10	1992
I-5, Extensions to existing lanes (6 projects)	26	1991-1995
I-405, Extension to concurrent flow lanes (3 projects)	26	1992
Vancouver, Canada		
H-7 (Barnet Highway), Concurrent flow lanes	6	1993
Washington, D.C./Northern Virginia		
I-95, Extension of exclusive reversible lanes	19	mid - 1990's
I-66, Concurrent flow lanes	7.5	1991
Dulles Toll Road, Concurrent flow lanes	10	1991

VI. CONCLUSION

This report provides a summary of available information on the design, operating, and enforcement characteristics, and current utilization rates of HOV facilities in the United States and Canada. The continued increase in the number of operating high-occupancy vehicle (HOV) lanes throughout North America indicates that these types of facilities have become a more accepted method of addressing congestion issues in many metropolitan areas. A consensus appears to exist that, in the proper environment, HOV lanes can be an effective means of increasing the person-movement capacity within a corridor. However, HOV facilities are not appropriate for all situations, nor does their implementation eliminate the need to also pursue other strategies.

As the number of HOV facilities continues to increase, the understanding of issues associated with the planning, design, implementation, and operation of HOV projects has also increased dramatically. However, even with this increased understanding, there are still a number of issues where experience is lacking or where there is not agreement over the most appropriate approach. Some of the areas where additional experience or research are needed are discussed in this section.

Support Facilities

Data from the different HOV projects seem to indicate that the presence of park-and-ride lots, transit transfer centers, direct access ramps, and other support facilities enhance the performance of the HOV facility. Park-and-ride lots provide convenient collection areas for both bus riders and carpool and vanpool users. The number and size of park-and-ride facilities varies among the different HOV projects. Parking lots of less than 300 spaces appear to be most common, although a number of exclusive HOV lanes are served by park-and-ride lots with over 1,000 spaces. Although a number of techniques exist, estimating the demand for park-and-ride facilities remains an inexact science.

Support Services

Recent experience with HOV projects seems to indicate that the types and levels of support services provided can influence utilization of the facility. Thus, it appears that simply providing the HOV lane is not enough to insure maximum use. Supporting programs focusing on improved bus service, ridesharing programs, and travel demand management (TDM) programs have all been used in different areas to promote and encourage use of the HOV facility. A number of areas are continuing to experiment with a variety of TDM programs, primarily those focusing on providing additional incentives to individuals who use a high-occupancy mode. These include the guaranteed-ride home program, preferential parking and/or reduced parking charges for carpools and vanpools, monetary incentives or additional vacation time for using alternative commute modes, providing access to midday shuttle services, and providing on-site services at the work place. The ongoing monitoring and evaluation of these programs should provide additional experience on the most appropriate types of support services to use with HOV facilities.

Operations and Enforcement

The understanding of the major operational and enforcement issues associated with HOV projects has improved significantly in the past few years. The importance of addressing operational and enforcement concerns in the planning and design stage has been identified as an important consideration. Early consideration of these issues is critical to ensuring that the facility operates in the intended manner and can be easily enforced.

Many areas are continuing to examine the use of different enforcement techniques. The "HERO" program has been implemented in both the Seattle and the Washington, D.C./Northern Virginia areas as one approach to encouraging compliance with the occupancy requirements of the HOV facilities. The program appears to be effective in lowering violation rates and providing an educational tool to promote the use of higher occupancy modes. The ticket by mail program implemented in Virginia in 1989 also appears to be an effective approach to enforcing occupancy requirements. This type of program, which may require legislative changes, is being examined by other areas for possible implementation.

The use of surveillance, communication, and control facilities to assist with the supervision of HOV lane operation and enforcement activities has been implemented in a few areas, and is under consideration in a number of other areas. The use of these techniques is viewed as having a positive impact on operations and enforcement activities of HOV facilities.

The potential use of HOV lanes for the testing of Intelligent Vehicle-Highway Systems (IVHS) has also been raised in many areas. It is felt that the controlled environment provided by exclusive HOV lanes provides an ideal situation for the testing of many of the IVHS concepts. In addition, many of the IVHS technologies may be appropriate for utilization in providing improved communications and information systems that may greatly enhance the use of HOV facilities. This is an area that will continue to be explored over the coming years.

Evaluating HOV Facilities

Evaluating the impact of HOV facilities continues to be a topic of considerable interest and discussion. To date, most evaluation efforts have utilized very general evaluation criteria and, given the nature of the facilities and limited funding, before-and-after studies have often been limited. One of the most comprehensive evaluations of HOV facilities has occurred in Houston, Texas. The ongoing evaluation has been sponsored by the Texas State Department of Highways and Public Transportation (SDHPT) and conducted by the Texas Transportation Institute (TTI). While there is agreement that HOV projects need to be evaluated, a consensus does not appear to exist among transportation professionals regarding the most appropriate measures to be used to evaluate HOV project effectiveness, nor is there agreement on the threshold performance levels that should be used with these measures. A number of different activities, including one element of this UMTA sponsored study being conducted by Texas Transportation Institute, are currently addressing these concerns. The outcome of these efforts is anticipated to be the development of a recommended set of evaluation measures, criteria, thresholds, and data collection methodologies.

Design

It appears that many HOV projects continue to be designed as "special case" facilities. Even within the same urban area, HOV facilities have been designed and operated differently. However, it appears that, both within and among metropolitan areas, design standards for HOV projects are becoming more standardized. This is important to help insure that safe and efficient facilities are designed and operated. Currently, the American Association of State Highway and Transportation Officials (AASHTO) is revising its guidelines on the design of HOV facilities and park-and-ride lots. A technical committee of the Institute of Transportation Engineers (ITE) is also preparing a report on the design features of HOV facilities. In addition, the Texas State Department of Highways and Public Transportation (SDHPT) has completed a set of HOV planning and design guidelines and the California Department of Transportation (Caltrans) is currently completing HOV guidelines for use within the state. All of these documents will provide improved guidelines on the design of HOV lanes and supporting facilities.

Conclusion

This report provides a review of available information on the design, operation, enforcement characteristics, and current utilization rates of HOV facilities in freeways or within separate rights-of-way in North America. In the proper environment, HOV facilities can be an effective means of increasing the person-movement capacity within a corridor. High-occupancy vehicle lanes, implemented in conjunction with other support facilities and services, can play a role in helping to address urban congestion problems.