Primer for *HOV Performance Monitoring, Evaluation, and Reporting Handbook*

HOV Pooled-Fund Study

U.S. Department of Transportation
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Disclaimer

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Introduction

Welcome to the Primer for *HOV Performance Monitoring, Evaluation, and Reporting Handbook*. This primer presents key elements for developing and conducting HOV performance monitoring programs. The primer is targeted toward policy makers and other individuals interested in the effective and efficient operation of high-occupancy vehicle (HOV) lanes.

More detailed information is available in the comprehensive *HOV Performance Monitoring, Evaluation, and Reporting Handbook*. The primary audience for the handbook is transportation professionals responsible for planning, designing, funding, operating, enforcing, monitoring, and managing HOV lanes.

The HOV Performance Monitoring, Evaluation, and Reporting project represents one of the studies sponsored by the HOV Pooled-Fund Study group and the Federal Highway Administration (FHWA). Participating state transportation agencies include California, Georgia, Maryland, Massachusetts, Minnesota, New Jersey, New York, Tennessee, Virginia, and Washington.

The HOV Pooled-Fund Study group is sponsoring other handbooks and primers of interest to transportation professionals and policy makers. Topics addressed in other projects include HOV lane eligibility requirements and operating hours, HOV lane safety considerations, and HOV lane enforcement.

The goal of the HOV Pooled-Fund Study (HOV PFS) is to assemble regional, state, and local agencies, and the Federal Highway Administration (FHWA) to:

- identify common issues among agencies;
- suggest projects and initiatives;
- select and initiate projects;
- disseminate results;
- assist in solution deployment; and
- track innovations and practice.

Participating state transportation agencies include California, Georgia, Maryland, Massachusetts, Minnesota, New Jersey, New York, Tennessee, Virginia, and Washington.

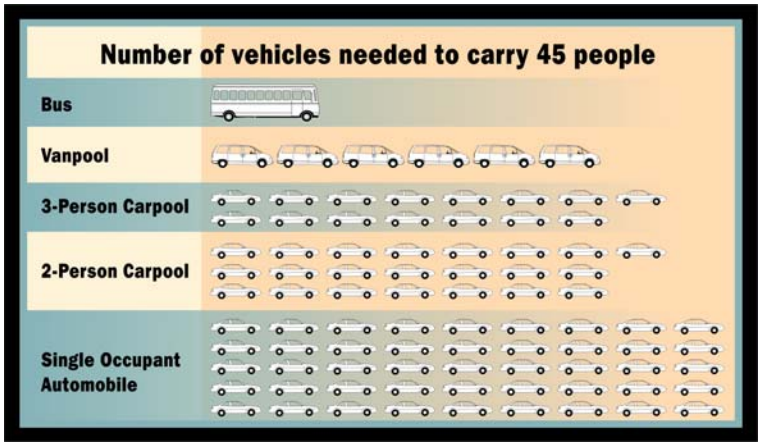
Defining HOV Facilities

High-occupancy vehicle (HOV) facilities represent one approach used in metropolitan areas throughout the country to help improve the people-moving capacity rather than vehicle-moving capacity of congested freeway corridors. The travel time savings and improved trip time reliability offered by HOV facilities provide incentives for individuals to change from driving alone to carpooling, vanpooling, or riding the bus.

The development and operation of HOV facilities have evolved over the past 30 years. Today there are some 130 HOV freeway projects in the 31 metropolitan areas in North America.

HOV facilities are developed and operated to provide buses, carpools, and vanpools with travel time savings and more predictable trip times to encourage individuals to choose one of these modes over driving alone. The person movement capacity of a roadway increases when more people are carried in fewer vehicles.

HOV facilities are usually found in heavily congested corridors where the physical and financial feasibility of expanding the roadway is limited. Supporting services, facilities, and incentives are also used to further encourage individuals to carpool, vanpool, or ride the bus. Examples of supporting elements include new and expanded bus services, park-and-ride and park-and-pool lots, regional rideshare programs, and employer-based programs. Further, high-occupancy toll (HOT) vehicles and low-emission and energy-efficient vehicles are allowed to use HOV lanes in some areas.



Number of Vehicles Needed to Carry 45 People

Benefits of HOV Monitoring Programs

Federal Interest in Monitoring and Evaluating HOV Facilities

Federal agencies, primarily the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA), are interested in HOV performance monitoring for a number of reasons. Federal funding is typically used to support the design, right-of-way acquisition, construction, and operation of freeway HOV lanes and busways. As a result, FHWA and FTA have an interest in maintaining the federal investment in these facilities and in maximizing the effective and efficient use of HOV lanes.

Provisions of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) require that the agencies responsible for operating HOV lanes conduct monitoring programs if certain exempt vehicles are allowed to use the lanes. These exempt categories include tolled vehicles and low-emission and energy-efficient vehicles.

The operating agency is required to limit or discontinue use of the HOV lane by these vehicles if allowing access has degraded the operation of the HOV lane. The operation of an HOV lane is defined as being degraded if vehicles using the facility fail to maintain a minimum average operating speed 90 percent of the time over a consecutive 180-day period during the morning or evening weekday peak-hour periods. The minimum operating speeds are defined as 45 mph when the posted speed limit is 50 mph or greater and not more than 10 mph below a posted speed limit of less than 50 mph. Additional information on monitoring requirements is available in the FHWA HOV Program Guidance.

Uses and Benefits of HOV Performance Monitoring Programs

The results of HOV project evaluations are of interest to a variety of individuals and groups. These groups include agency operation and management personnel, federal agency staff, decision makers, special interest groups, the media, and the general public.

Multiple benefits may be realized from HOV performance monitoring programs. Performance information supports the ability to determine if the goals and objectives of a project are being achieved. Performance monitoring also provides information needed to make operating decisions, including changes in the operation of an HOV facility. Information from HOV monitoring programs is of use in planning future projects. Communicating the use and benefits of HOV lanes to the public and to policy makers is also important to build and maintain support for these facilities.

Participating Agencies

The agencies typically involved with HOV performance monitoring, evaluation, and reporting include state departments of transportation, public transportation agencies, MPOs, and state and local law enforcement agencies. Depending on the type of HOV facility, cities and counties may also participate. Representatives from FHWA and FTA are frequently involved.

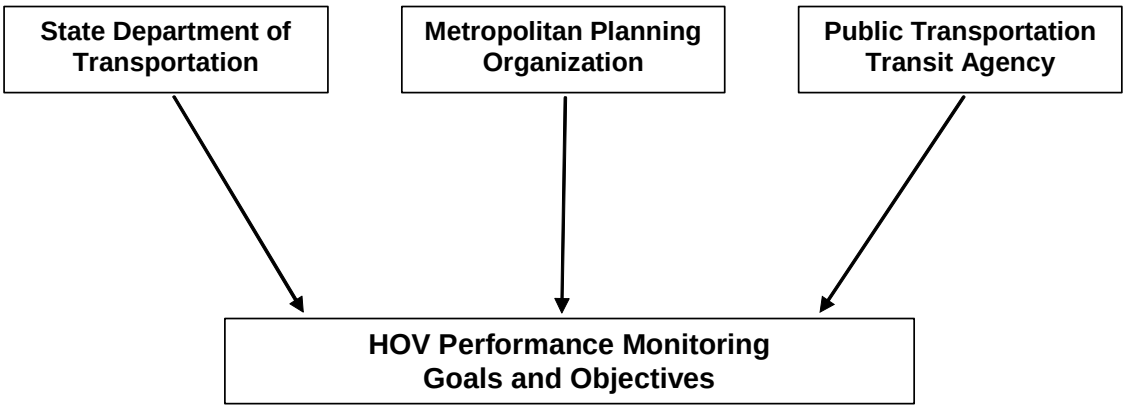
In addition, representatives from rideshare agencies, regional organizations, and the judicial system may participate in multi-agency teams and may assist with HOV performance monitoring activities.

The state department of transportation is typically the lead agency for developing and conducting HOV performance monitoring programs with HOV lanes on freeways and state roadways. The public transit agency is typically the lead agency with busways on separate rights-of-way. Cities and counties may be responsible for monitoring HOV projects on arterials.

A key to the success of many HOV projects, including HOV performance monitoring programs, is the involvement of personnel from all appropriate agencies and groups. Multi-agency teams are often used in planning, designing, implementing, operating, and monitoring HOV facilities. Multi-agency teams help ensure that the objectives and measures of effectiveness focus on major project goals, that the appropriate data collection and analysis techniques are used, and that the results are provided to key groups Multi-agency teams can also facilitate shared funding and data collection responsibilities for HOV performance monitoring programs.

Coordinating HOV Monitoring with Transportation Plans

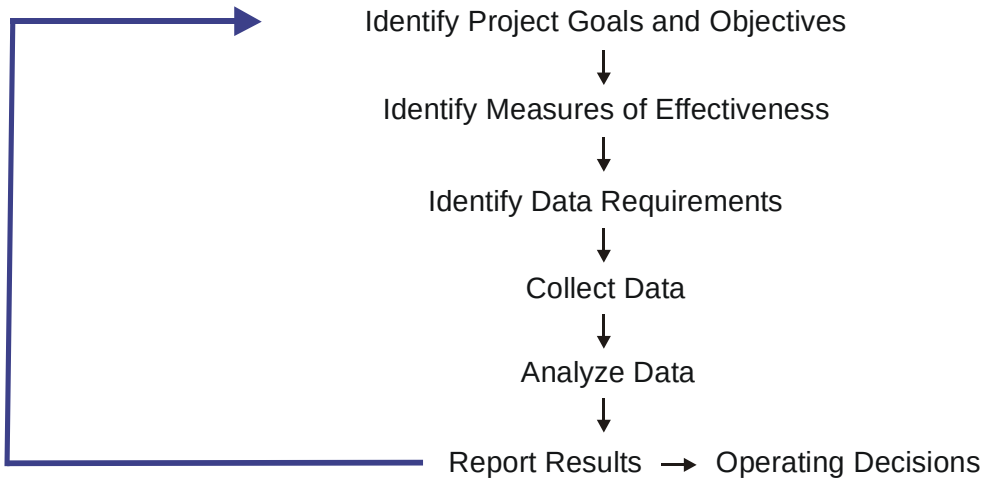
Coordinating HOV performance monitoring programs with related efforts of the state department of transportation, the MPO, the public transportation agency, and other appropriate agencies and groups in a metropolitan area is important. The development of goals and objectives related to the HOV system are guided by the missions, goals, and objectives of these agencies and the goals and objectives outlined in the appropriate transportation and transit plans. These plans include the long-range statewide and metropolitan transportation plans required by federal law, long-range and short-range public transportation plans, regional plans, and corridor or facility-specific plans.



Relationship of HOV Performance Monitoring Goals and Objectives to State and Metropolitan Goals and Objectives

HOV Performance Monitoring Process

HOV performance monitoring programs follow the same process used to evaluate any transportation project. The first step in the process is to identify the goals and objectives for the HOV facilities in an area. These goals and objectives should flow from those articulated in state, metropolitan, and local transportation policies and plans. Measures of effectiveness are then identified for each objective, along with the corresponding data requirements. Data collection efforts are undertaken and the results are processed and analyzed. The results of the monitoring and analysis process are reported to the various stakeholder groups through a variety of methods. The results are used to make operating decisions, to determine if the project objectives are being met, and to enhance future planning activities and investment decisions.



Steps in Developing and Conducting an HOV Performance Monitoring Program

HOV Objectives

The first step in the development of an HOV performance monitoring program is to ensure that there is agreement on the project goals and objectives. It is important to ensure that the objectives are measurable, as the remainder of the evaluation program will focus on gathering and analyzing information to determine if the objectives have been met.

The examples of common HOV objectives presented below relate primarily to HOV facilities open to buses, vanpools, and carpools. If tolled vehicles, low-emission and energy-efficient vehicles, or other types of vehicles exempt from the occupancy requirements are allowed to access an HOV facility, objectives and measures of effectiveness should be developed for their use.

Objectives associated with allowing tolled vehicles may relate to improving the efficiency of an HOV lane, generating revenue to fund additional transit and highway improvements in the corridor, and introducing or testing electronic toll collection (ETC) or variable pricing. Objectives related to allowing low-emission and energy-efficient vehicles might focus on encouraging the purchase and use of these types of vehicles, and supporting efforts to improve air quality.

National Overview of Typical HOV System Objectives

An FTA-sponsored research project in the early 1990s examined before-and-after studies completed on HOV projects in the U.S. This information was updated during the development of the NCHRP *HOV Systems Manual* in the late 1990s. The following nine objectives were identified as examples of HOV objectives used by different agencies in the country.

- The HOV facility should improve the capability of a congested freeway corridor to move more people by increasing the number of persons per vehicle.
- The HOV facility should increase the operating efficiency of bus service in the freeway corridor.
- The HOV facility should provide travel time savings and a more reliable trip time to high-occupancy vehicles utilizing the facility.
- The HOV facility should not unduly impact the operation of the general-purpose freeway lanes.
- The HOV facility should increase the per lane efficiency of the total freeway facility.
- The HOV facility should be safe and should not unduly impact the safety of the general-purpose freeway lanes.
- The HOV facility should have public support.
- The HOV facility should be a cost-effective transportation improvement.
- The HOV facility should provide favorable impacts on air quality and energy consumption.

Measures of Effectiveness

After the objectives have been clearly defined, the next step is to identify the appropriate measures of effectiveness or evaluation criteria that correspond to each objective. These measures should focus on the key elements of the objectives, so that the information needed to determine if the objective has been achieved can be collected and analyzed.

Examples of common measures of effectiveness associated with HOV objectives are highlighted here.

- **Objective** – Improve the capacity or throughput of a congested travel corridor.
  Measures of Effectiveness:
  - The percent increase in average vehicle occupancy (AVO).
  - The percent increase in vanpools, carpools, and bus riders.
- **Objective** – Provide travel time savings and trip time reliability to HOVs using the HOV lane.
  Measures of Effectiveness:
  - Peak direction, peak period travel time savings by using the HOV lane over the general-purpose freeway lanes.
  - Improve trip time reliability.
- **Objective** – Increase operating efficiency of bus services in the corridor.
  Measures of Effectiveness:
  - Improve bus schedule adherence/on-time performance.
  - Improve vehicle productivity (operating cost per vehicle mile, operating cost per passenger, and operating cost per passenger mile).
- **Objective** – Increase the use of an HOV lane by allowing HOT vehicles.
  Measure of Effectiveness:
  - The number of HOT vehicles using the HOV lane.
- **Objective** – Generate revenues to support transportation and transit improvements in the corridor.
  Measure of Effectiveness:
  - The level of revenue generated.
- **Objective** – Introduce the use of ETC and value pricing to travelers.
  Measures of Effectiveness:
  - Number of ETC transponders sold.
  - Survey results related to public perception of value pricing.
- **Objective** – Increase the purchase and use of low-emission and energy-efficient vehicles by allowing access to HOV lanes.
  Measures of Effectiveness:
  - Registration levels for these vehicles.
  - The number of vehicles using an HOV lane.
  - Survey results related to public perception of low-emission and energy-efficient vehicles.

Data Requirements

The measures of effectiveness are assessed by collecting and analyzing data on different elements related to the performance of the HOV lanes, the general-purpose freeway lanes, and supporting facilities and services. The data requirements typically associated with various objectives and measures of effectiveness are summarized here.

Required Data

- Updated HOV facility inventory.
- Vehicle volumes by type of vehicle in the HOV lanes and general-purpose freeway lanes.
- Vehicle occupancy counts in the HOV lanes and general-purpose freeway lanes.
- Travel times in the HOV lanes and general-purpose freeway lanes.
- Travel speeds in the HOV lanes and general-purpose freeway lanes.
- Trip time reliability in the HOV lanes and general-purpose freeway lanes.
- Bus ridership levels in the HOV lanes and general-purpose freeway lanes.
- Park-and-ride and park-and-pool lot use.
- Occupancy violations, access violations, HOT violations, and other violations.
- Number and nature of crashes in the HOV lanes and general-purpose freeway lanes.
- Perceptions of users, non-users, the public, and policy makers.
- Measures relating to capital and operating costs.
- Measures relating to vehicle emissions and air quality.

Data Collection

HOV Facility Inventory

An up-to-date inventory of HOV facilities in an area should include information on the location and lengths of HOV lanes, access points, operating hours, vehicle eligibility requirements, vehicle-occupancy levels, and other key features. This information may be maintained in table format, as part of a geographic information system (GIS), or as part of another database. Information on park-and-ride and park-and-pool lots, bus routes, and other supporting elements, may also be included in the inventory.

Vehicle and Vehicle-Occupancy Counts

Data on vehicle volumes and vehicle classification are usually obtained either through special field surveys or from advanced transportation management systems (ATMS) or other technology-based systems. Vehicle volumes and vehicle classification data is needed for the HOV facility and the general-purpose freeway lanes. Consideration should also be given to conducting counts along a freeway without an HOV to provide a control facility. The manual count technique relies on field personnel counting vehicles by type for the HOV and general-purpose freeway lanes. In some metropolitan areas, data on vehicle volumes and vehicle classification may be available from ATMS or transportation management centers (TMCs).

The number of HOT or toll-paying vehicles using an HOV lane is obtained from the toll collection records. (ETC) transactions are automatically recorded. The number of transactions for a specific time period are obtained from the operator.

If low-emission and energy-efficient vehicles, and other exempt vehicles, are allowed to use an HOV lane they should be included in the vehicle classification counts. Depending on the state, low-emission and energy-efficient vehicles must have special license plates or decals.

Example of Vehicle and Passenger Counts in Houston

Travel Time and Travel Speed Data

Travel time data measures the time it takes a vehicle to travel a certain distance. Travel time data are collected for the HOV lane and the general-purpose freeway lanes so that comparisons can be made related to travel time savings from using the HOV lanes. A number of methods may be used to collect travel time data. The traditional method, typically called the test vehicle, floating car, or maximum car technique,

involves a test vehicle making a number of trips in the HOV lane and the general-purpose freeway lanes.

The use of ATMS and TMCs provides opportunities in some areas to obtain travel time and travel speed data from these systems. Archived data from traffic operations systems may be used to compute travel speeds or travel times in HOV lanes and general-purpose freeway lanes.

Bus Routes and Ridership

Information on bus routes, services, the frequency of service, the number of buses, and the type of buses can be obtained from the public transportation agency or agencies in the area. Information can also be obtained from private bus operators, charter services, and school districts if they operate service on the HOV lanes. These agencies and operators can also provide ridership information. In addition, bus ridership is typically estimated during the vehicle-occupancy counts noted previously.

Park-and-Ride and Park-and-Pool Lot Use

Information on the use of park-and-ride and park-and-pool facilities is typically obtained through periodic manual counts. Usually, the number of vehicles parked at each facility is recorded during the middle of the day (between 9:00 a.m. and 3:00 p.m.) on weekdays.

HOV Facility User and Non-User Surveys, Focus Groups, and Interviews

A variety of market research techniques may be used to obtain information on the previous mode of carpoolers, vanpoolers, and bus riders, as well as perceptions about HOV lanes from users and non-users. These techniques include focus groups, telephone and mail out/mail back surveys, Internet surveys, on-board surveys of bus riders, and interviews with key stakeholders. Focus groups may be conducted with individuals from different user groups to gain insights on perceptions relating to HOV lanes, possible changes in operation, and potential public information strategies. Mail surveys may be used to obtain information from carpoolers, vanpoolers, and motorists in the general-purpose freeway lanes.

Crash Data

Crash data for the HOV lanes, the adjacent general-purpose freeway lanes, and on the control freeways is needed to assess measures of effectiveness related to safety. In most areas, crash information is obtained

from the state department of transportation, the state or local department of public safety, and the state, local, or transit enforcement agency.

Violation Rates

The violation rates, which reflect the number of vehicles not meeting the minimum HOV lane occupancy requirements, provide a general indication of the degree of public understanding and support for the facility and if the facility is being used for the intended purpose. Violation rates are typically monitored in different ways. The number of citations issued by the agency responsible for enforcing the HOV lanes provides one measure. Second, the vehicle and occupancy counts provide information on the number of vehicles not meeting the minimum occupancy requirements. Third, with HOT projects, toll violators are recorded by ETC. Finally, areas with peer-enforcement programs, such as the HERO program in Seattle, monitor the number of calls received to the telephone hotline.

Dallas Area Rapid Transit Police Officer

Data Archiving, Storage, and Management

To use the data collected through the methods described previously, a process must be established for archiving, storing, and managing the data. It is important that this process be well thought out and documented prior to initiating actual data collection activities. These procedures will guide the data reduction process.

The data collection methods will influence the data archiving, storage, and management process. The archiving and retention process for data collected through actual field monitoring and observations is different from the process used with data obtained from advanced transportation management systems, which typically requires increased computer capabilities. Key steps in the process include establishing a lead agency, establishing the actual procedures, identifying funding sources, and establishing procedures for accessing and using the data.

Data collected in the field or through advanced transportation management systems must be transferred into databases and other software programs for further analysis. Based on the data archiving, storage, and management process, standard procedures should be established and used to transfer data collected in the field or obtained from other sources. These procedures should ensure the integrity and accuracy of the data.

The data collected by the field crews on vehicle volumes, vehicle classification, vehicle occupancy, travel times, and other measures are usually transferred to office personnel for processing and analysis. Data collected using a manual device and a count form will need to be manually entered into a spreadsheet or database. Data collected using computers or other electronic devices are downloaded or transferred into a central computer or database. Data obtained through advanced transportation management systems may be transferred from one computer system to another.

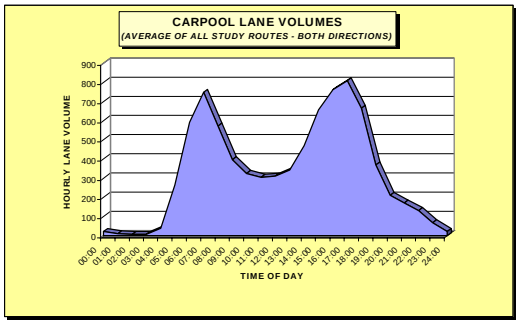
The accuracy and integrity of data collected as part of an HOV performance monitoring program is critical. Elements in a data quality control program include checking to ensure data are entered and transferred correctly, establishing and applying validity checks to identify suspect or invalid data, reviewing comments from field crews or data collection logs, and identifying and correcting any problems at specific manual or automatic data collection sites.

Data Analysis Techniques

The appropriate data analysis techniques are matched to the measures of effectiveness. Examples of data analysis methods typically used with HOV monitoring programs are highlighted here.

Vehicle Volumes

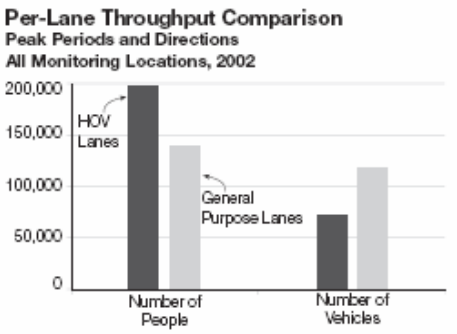
Vehicles volumes for the HOV lane and the general-purpose freeway lanes are presented for the specific points along the corridor where the data is collected. The vehicle volumes are typically summarized for the morning and afternoon peak hours and peak-periods. A 24-hour count may also be provided if the HOV lanes operate on a 24/7 basis.



2002 Los Angeles Area HOV Lanes - Vehicle Volumes

Person Volumes and Person Throughput

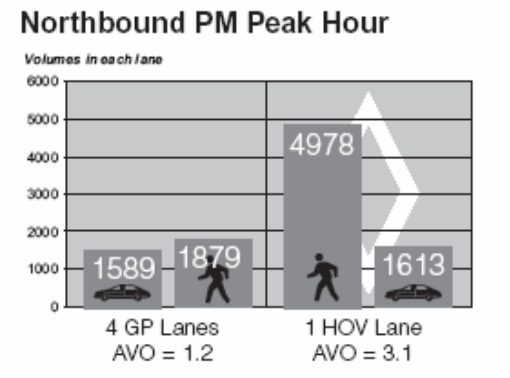
Person volumes are the total number of individuals in all vehicles at the specific data collection points for a specific time period. Person volumes may be presented as the persons per hour per lane (pphpl). The pphpl for the morning and afternoon peak hour is calculated by totaling the number of individuals in all vehicles for the specific hour in the HOV lane. The same calculation is performed for the general-purpose freeway lanes.



2002 Puget Sound HOV Lanes - Person and Vehicle Volumes

Average Vehicle Occupancy

Average vehicle occupancy (AVO) is calculated from the vehicle volume by classification and person throughput data. AVO by vehicle classification, total AVO for the HOV lane, total AVO for the freeway, and total AVO for the facility (HOV and freeway) can be calculated. AVO by vehicle classification is obtained by dividing the person throughput for a specific vehicle type by the number of vehicles in that classification. The total AVO for the HOV lane or the general-purpose freeway lanes is calculated by adding the total occupancy for all vehicles divided by the total vehicles.



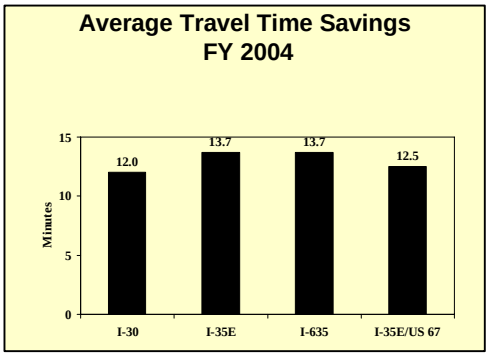
Seattle I-5 North HOV Lane - Person Volumes, Vehicle Volume, and Average Vehicle Occupancy

Travel Times and Travel Speeds

The method for calculating travel times and travel speeds will depend on the data collection technique used. Travel time data collected electronically using the floating car technique is usually processed through a software program that calculates travel time and travel speed and transfers the results to a spreadsheet or database. Travel times collected manually using the floating car technique are manually entered into a spreadsheet or database that is then entered into the software program. Travel time and travel speed data for multiple runs can be averaged and reported for the HOV lane and the general-purpose freeway lanes. Data obtained through advanced transportation management systems typically provides speed data for the HOV lane and the general-purpose freeway lanes.

Travel Time Savings

Travel time savings measure the amount of time a traveler saves by using the HOV lane rather than the general-purpose freeway lanes for the same trip distance. Travel time savings are calculated by taking the difference in travel times between the HOV and the general-purpose freeway lanes. It is typically presented as the number of minutes saved by vehicles in the HOV lane for a specific trip distance, usually the length of the HOV lane.



2004 Dallas Area HOV Lanes - Average Travel Time Savings Over General-Purpose Freeway Lanes

Travel Time Index

The travel time index is a comparison between the travel conditions in the peak period and travel conditions in freeflow periods. A travel time index formula can be used to provide a travel time index for a freeway or an HOV lane. For example, a value of 1.20 indicates that the travel time during the peak period is 20 percent longer than the travel time during the off-peak period.

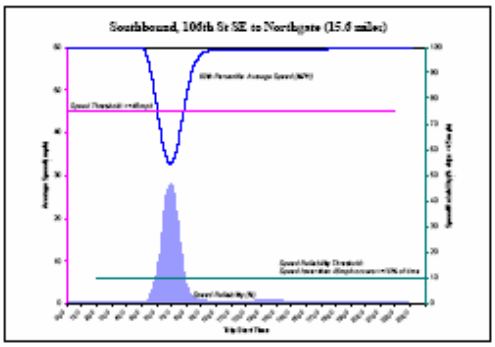
Buffer Index

The Buffer Index is a measure of trip time reliability. It expresses the amount of extra time or the "buffer" needed to be on-time for 95 percent of trips made during a certain time, such as the peak period. The 95 percent measure would amount to being late for work or school one day per month. Indexing the measure provides a time and distance neutral measure. The actual minute values could be used by

an individual traveler for a particular trip length, however.

Travel Speed Reliability

Travel speed reliability provides another possible measure of trip time reliability. A commonly used travel speed reliability measure is the percent of time that travel speeds fall below an average speed of 45 mph. The 45 mph criteria equates to a Level-of-Service (LOS) C for a posted speed limit of 55 mph. Using this measure, travel speed reliability can be assessed for an HOV lane and for the adjacent general-purpose freeway lanes over the same time period, typically the peak hours. Use of this measure is dependent on data available from advanced transportation management systems due to the volume and frequency of travel speeds needed.



Average Weekday HOV Speed Reliability (2002) I-5 North of the Seattle CBD

Transit Vehicles and Ridership

Information on the number of buses using an HOV facility and ridership levels is usually presented numerically and as a percentage of the total vehicles and persons using the facility. In addition, maintaining maps illustrating the bus routes using the HOV lanes is recommended as they provide an excellent method to highlight service improvements and expanded service coverage.

Park-and-Ride and Park-and-Pool Lot Use

Data on park-and-ride and park-and-pool lot use is presented both as the actual number of vehicles parked at a lot and the percentage of lot utilization. The percent of lot utilization is calculated by dividing the number of parked vehicles by the total number of available parking spaces. The total number of vehicles parked at all lots along an HOV corridor and the total utilization for all lots is also usually presented.

Occupancy Violation Rates

The vehicle-occupancy violation rate, which is typically referred to as the violation rate, measures the number of non-exempt vehicles in the HOV lane not meeting the occupancy requirement. Violation levels on an HOV lane are usually expressed as a rate comparing the number of violators with the total vehicles in the lane. Violation rates are expressed as a percentage by dividing the number of vehicles not meeting the occupancy requirement, excluding exempt vehicles, by the total number of vehicles in the lane.

Occupancy Violation Citations

The number of citations issued by enforcement personnel to drivers of vehicles not meeting occupancy requirements provides another measure of violation levels. The ability to issue citations is influenced by the presence and level of enforcement on a facility, which may vary over time. As a result, this measure is typically reported as the number of citations issued over a specific time period, with a reference to enforcement levels provided during the reporting periods.

Operating Violation Citations

The numbers of citations issued for violating operating requirements, such as entering or exiting an HOV lane illegally, are typically reported for specific time periods. Citations may be issued for moving violations or other infractions.

HOT Violations

Non-payment of tolls with HOT projects is monitored by the operating agencies. The number of toll violators may be reported or the toll violation rate may be calculated by dividing the number of non-paying vehicles by the total number of HOT vehicles using the lane for the same time period.

Crash Rates

Crash data is often summarized as the number of crashes related to vehicle miles of travel (VMT) or passenger miles of travel. Crash rates measure safety trends or crash potential related to vehicle exposure measured in VMT. Annual vehicle crash rates are calculated as vehicle crashes per 100 million VMT. It is recommended that crash rates be documented for a freeway before the HOV lane is implemented.

Mapping the location of crashes in GIS can help identify potential problem spots. If crashes are clustered in similar areas, these locations can be examined for potential changes in operation or design modifications.

Vehicle Emissions and Air Quality

The potential air quality impacts associated with HOV lanes typically focus on vehicle emissions. There are two analysis approaches frequently considered to assess the potential impact of HOV lanes on vehicle emissions. A first approach is to assess vehicle emissions with and without an HOV lane. Emissions in grams of carbon monoxide (CO), oxides of nitrogen (NOx), and particulate matter (PM10) are estimated based on passenger miles traveled with and without the HOV lane. A second approach focuses on air quality models used during the planning process for an HOV lane. If specific air quality models were used during the planning process for an HOV project, these models can be re-run with data from the performance monitoring program.

Benefit-Cost Ratio

The benefit-cost ratio is the analysis technique typically used with objectives relating to a cost-effective transportation improvement. The benefit-cost ratio is defined as the present value of all benefits divided by the present value of all costs. Projects with a benefit-cost ratio of greater than 1.0 are usually considered cost-effective. To calculate a benefit-cost ratio, the capital and operating cost of an HOV project is needed, along with a value (in dollars) of the benefits.

Ongoing HOV Performance Programs

Developing and Implementing a Data Collection Program

Elements to consider in developing and implementing a data collection program include reviewing data requirements and existing data sources, and establishing the data collection techniques, the data collection locations, and the data collection time periods. Other elements focus on identifying a data collection schedule, developing data collection assignments and check lists, conducting training for field personnel, performing pilot test sessions, and conducting the actual data collection efforts.

Frequency of Data Collection and Reporting

The frequency of HOV data collection, analysis, and reporting will be influenced by the type, number, and age of HOV lanes in an area. Other factors influencing a monitoring program include the data collection techniques used, funding availability, and staff resources.

For new HOV lanes, before data on vehicle volumes, vehicle classification, vehicle occupancy, travel time, travel speeds, trip time reliability, bus services and ridership, and crashes should be obtained. If possible, before data should be collected more than once.

Data are typically collected more frequently during the initial operating phase of a new HOV lane or after major changes in operation have occurred. As a facility matures, the data collection schedule typically lengthens, with key data collected quarterly or annually.

Potential Funding Sources

Funding for developing and conducting ongoing HOV performance monitoring programs may come from a variety of federal, state, and local sources. Data collection, monitoring, and evaluation activities are eligible project expenses for HOV lanes constructed using federal funds, federal demonstration projects, and federal metropolitan and statewide planning funds, and state planning and research funds. State departments of transportation, public transit agencies, MPOs, and local agencies provide matching funds for federal programs and may use other revenue sources to support monitoring activities.

Staffing and Resources

The staffing and resources needed to conduct ongoing HOV performance monitoring programs will depend on the number, type, and age of HOV lanes in the area, as well as the data collection techniques, frequency of data collection and analysis, and frequency and method of performance reporting. The approach used to conduct different functions will also influence needed staffing and resources. Possible approaches include conducting all functions within one or more agencies, contracting with a university or university-affiliated group, and contracting with one or more consulting firms.

Reporting HOV Performance

The information generated by HOV performance monitoring programs is of interest and use to numerous stakeholders. These stakeholders include agency staff responsible for operating HOV facilities, agency staff responsible for planning and designing future HOV facilities, federal agency staff and transportation professionals in other areas, agency management personnel, elected and appointed officials, members of the print and electronic media, and the public and special interest groups.

The information presented, the level of detail, and the communication method should be tailored to the needs of the various stakeholder groups. The information presented should focus on the key performance measures. Maintaining consistency among the different reporting approaches can help save staff and financial resources.

Information should be presented in a clear, concise, and readable manner that allows individuals to easily identify the purpose of the data and the changes that have occurred. A good performance monitoring program can be wasted if the results are poorly presented. Spending adequate time and resources to ensure clear and well-presented reporting is essential. Potential communication techniques include on-line data, technical reports and summaries, fact sheets, brochures, PowerPoint presentations, the Internet, and videos and DVDs.

	Stakeholder Groups					
Reporting Methods	Local Technical Staff	National Technical Staff/ Researchers	Agency Management Personnel	Elected/ Appointed Officials	Media	Public/ Interest Groups
On-Line Data	X	X				
Technical Reports/ Summaries	X	X				
Fact Sheets	X	X	X	X	X	X
Brochures			X	X	X	X
PowerPoint		X	X	X	X	X
Internet	X	X	X	X	X	X
Video/DVD			X	X	X	X

X - Primary Audiences

Stakeholder Groups and Reporting Methods

HOV Monitoring Program Case Study Examples

Northern Virginia

A detailed before-and assessment was conducted on the Shirley Highway (I-395) HOV demonstration project starting in 1969. In the mid-1990s the Metropolitan Washington Council of Governments (WASHCOG) initiated an ongoing monitoring, evaluation, and reporting program on HOV lanes in northern Virginia, in cooperation with the Virginia Department of Transportation (VDOT) and other agencies. The monitoring program covers the 70 miles of HOV lanes in the area.

Vehicle classification and occupancy counts are conducted by field personnel at selected locations along each corridor. In the fall of 2003, WASHCOG started counting exempt low-emission and energy-efficient vehicles with clean special fuel license plates using the HOV lanes. Additional field personnel record the number of vehicles with the clean special fuel license plates at each of the count stations.

Travel time data are collected using the floating car technique. The travel time runs are conducted in tandem with one vehicle using the HOV lane and one vehicle using the general-purpose freeway lanes. Ridership data on bus and rail services in the different corridors is obtained from the public transportation agencies and private operators.

WASHCOG publishes an annual report on the HOV monitoring program. Key data on average automobile occupancy and travel time savings are presented and trend-line data is described.

I-95 HOV Lane in Northern Virginia

Houston

Currently, approximately 104 miles of HOV lanes are in operation in six corridors in Houston. The evaluation procedures and data collection activities associated with evaluating the effectiveness of the Houston HOV lanes have evolved over the years since the opening of the I-45 North contraflow demonstration project in 1979. The Texas Department of Transportation (TxDOT) and the Metropolitan Transit Authority of Harris Count (METRO) have sponsored this effort. The Texas Transportation Institute has conducted the data collection and analysis efforts.

Vehicle and occupancy counts are conducted quarterly on the HOV lanes and the general-purpose freeway lanes. Both vehicle and occupancy counts were initially conducted by field personnel. Tube counters are now used to obtain vehicle counts, while vehicle-occupancy counts are still conducted by field personnel. The number of vehicles parked at the park-and-ride and park-and-pool lots is also counted quarterly.

Travel-time runs were initially conducted using the floating car technique. The data collection method changed after the implementation of TranStar, the advanced transportation management center, and the automated vehicle identification (AVI) system. The speed data from the AVI system is used to estimate travel times for the HOV lanes and the general-purpose freeway lanes.

Surveys of bus users, carpoolers, and vanpoolers using the HOV lanes and single occupant vehicles in the general-purpose freeway lanes have been conducted to obtain information on user's and non-user's perception of HOV lane utilization, reasons for mode choice selection, and general attitudes toward the HOV lanes. Data collection activities were also conducted to monitor the QuickRide value pricing demonstration program.

The METRO transit police are responsible for responding to crashes in the HOV lanes and for maintaining the crash records. METRO Transit Police are also responsible for enforcing vehicle-occupancy levels and provide a summary of the violation rates.

Detailed reports, quarterly summary reports, brochures, and PowerPoint presentations have all been used to present the results of the monitoring activities.

I-10 West HOV Lane in Houston

Puget Sound Region

A monitoring program has been conducted on HOV facilities in the Puget Sound Region since the opening of the I-5 HOV lane in 1983. The monitoring, analysis, and reporting process represents the coordinated efforts of the Washington State Department of Transportation (WSDOT), the Washington State Transportation Center (TRAC), transit agencies, and other groups. The monitoring program covers the approximately 200 miles of HOV lanes in the region.

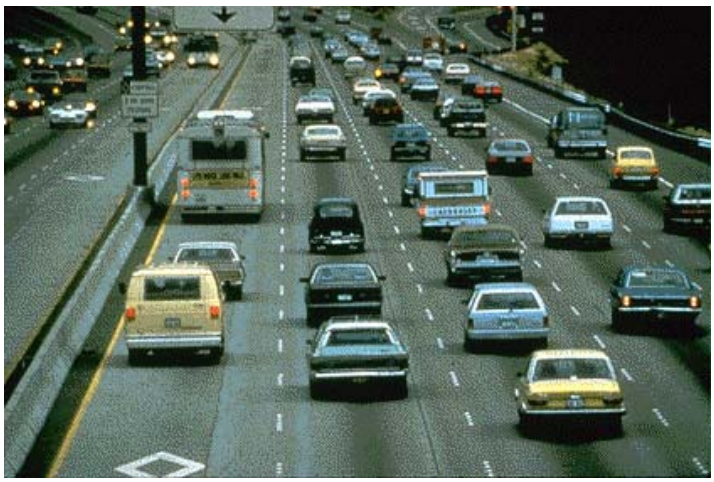
Many of the data collection techniques have progressed from manual methods to the use of electronic sensors and other advanced technologies as part of the FLOW system. The presentation of information from the monitoring program has also evolved from printed reports to extensive use of the Internet, including providing access to different databases.

The FLOW system is a coordinated network of traffic monitoring, measuring, information dissemination, and control devices operated on the Interstate and urban state highways in the region. Monitoring and measuring elements include closed-circuit television and electronic sensors. Information dissemination techniques include variable message signs, highway advisory radio, and the WSDOT Internet site. Control devices include HOV lanes and meters at selected freeway entrance ramps.

The *Washington State Freeway HOV System Policy*, published in 1991, outlines objectives of the HOV system in the state and provides policy guidelines relating to different elements of the HOV system.

The HOV lane monitoring program focuses on four main elements. These elements are vehicle volumes in the HOV and general-purpose freeway lanes, vehicle-occupancy levels, bus ridership, and travel times in the HOV lanes and general-purpose freeway lanes. Enforcement levels and violation rates, and user and non-user attitudes are also monitored. Procedures for acquiring vehicle volume data from the FLOW system, performing analyses, and presenting outputs have been developed and documented by TRAC.

Vehicle-occupancy data is collected by visual inspection at 15 routine data collection sites. Bus ridership information is obtained from the four transit authorities in the region. Public opinion surveys are conducted on a periodic basis. The number of warnings and citations issued for occupancy violations and the number of calls to the regional peer violation reporting telephone hotline (764-HERO) are monitored.



I-5 HOV Lane in the Puget Sound Region

Los Angeles

An extensive evaluation was conducted on the El Monte Busway, which was opened in 1973. As other HOV lanes were implemented in Los Angeles, they were included in the ongoing monitoring efforts by the California Department of Transportation (Caltrans).

Building on previous studies and agency efforts, the Los Angeles County Metropolitan Transportation Authority (LAMTA) initiated an HOV performance program study in 2000. The study was conducted to develop a comprehensive monitoring and evaluation program for the 380-mile HOV system.

The project represented the coordinated efforts of agencies in Los Angeles. The MTA was the lead agency, with support and involvement from Caltrans District 7 and Caltrans Headquarters. A Project Advisory Committee (PAC), composed of representatives from other agencies, helped guide the study. The study was conducted by a consulting team headed by Parsons Brinkerhoff, Inc.

The data needed for the performance program was obtained from existing sources, and additional collection activities were conducted. Vehicle volume information was obtained from the Caltrans Traffic Monitoring Group loop data. Vehicle-occupancy counts were conducted manually by Caltrans staff. Bus ridership was obtained from transit operators.

Caltrans staff performed travel time runs – called tachometer (tach) runs because the travel time and delay data are recorded automatically from the vehicle tachometer – in the HOV lanes and the general-purpose freeway lanes. The Caltrans Moving Vehicle Run Analysis Package was used to extract the data and transfer it into a spreadsheet format for analysis.

Market research activities included focus groups and executive interviews. A mail out/mail back survey was distributed to the owners of vehicles observed using the HOV lanes, the general-purpose freeway lanes, and freeways without HOV lanes. A telephone survey of the general public and an on-board survey of passengers on buses operating in the HOV lanes was conducted.

Data from the Caltrans Traffic Accident Surveillance and Analysis System was used in the performance monitoring program. The economic viability of the existing HOV lanes were examined using a modified version of the Cal-B/C Model, which is the standard for evaluating transportation projects in California.

The I-110 and I-105 HOV Lanes in Los Angeles

Methods used to present the results of the performance monitoring program including periodic newsletters, technical memoranda, and a detailed final report. An executive summary, *Eleven Things You Should Know about Carpool Lanes in Los Angeles County*, was widely distributed to agency management personnel, policy makers, and other groups.

Minneapolis

The I-394 case study provides an example of an extensive before-and-after evaluation, an ongoing monitoring program, and a HOT project assessment. The Minnesota Department of Transportation (Mn/DOT) was the lead agency in these efforts, with assistance from SRF, Inc., and other consulting firms. An extensive before-and-after study of the interim and the final HOV lanes on I-394 was initiated prior to the opening of the interim facility in 1985. The I-394 evaluation program included regular vehicle and occupancy counts on the HOV lane, mainlanes, and parallel facilities. Travel time runs were conducted and accident data and violation rates were monitored. Surveys were conducted of users and non-users, and the different marketing and public information programs were evaluated.

Mn/DOT collects and analyzes key data for the I-394 HOV lanes and the concurrent flow HOV lanes on I-35W on a quarterly basis. Information on the number of vehicles moved in the HOV lane, the general-purpose freeway lanes, and the total facility is presented. The percentage of total person movement, the average automobile-occupancy rate, and the average bus-occupancy rate are also provided. Historical data for the previous four quarters is presented to highlight trend lines and changes in use levels.

A comprehensive evaluation is being conducted on the MnPASS HOT project. The evaluation includes two separate, but coordinated elements; an assessment of the system performance and an assessment of user and non-user attitudes. The system performance component focuses on assessing the impact of the project on the operation of I-394. Speed, travel time, trip time reliability, system throughput, safety, enforcement, and roadway operations are being examined. The reliability and efficiency of the MnPASS toll components are also being evaluated. The attitudinal component is monitoring changes in travel behavior and attitudes associated with the MnPASS project.

Sign Showing Rates for the MnPASS I-394 Lanes in Minneapolis

San Diego

The I-15 Express Lane in San Diego provides an example of a HOT project evaluation. The initial demonstration project, called ExpressPass, and the ongoing HOT project, FasTrack™, represent the joint efforts of the San Diego Council of Governments (SANDAG), Caltrans, the Metropolitan Transit Development Board (MTDB), and the California Highway Patrol (CHP). Personnel from San Diego State University, the University of California, Irvine, and consulting firms assisted with some of the data collection and analysis activities.

The following elements represent examples of the current data collection and analysis activities.

The FasTrack™ Customer Service Center maintains monthly summaries of FasTrack™ account activity. Items tracked include FasTrack™ application requests, complaints/comments, and account maintenance.

Data on vehicle volumes on the I-15 Express Lanes are obtained through inductive loops. The weekday daily average for all vehicles and for HOVs, FasTrak™ vehicles, and tags with invalid reads are summarized on a monthly basis. FasTrak™ records daily toll revenues.

Sign Showing the Rate for the I-15 Express Lane in San Diego

CHP maintains a monthly log of the enforcement levels – hours allotted and hours worked by officers in patrol cars and motorcycles – and the number of citations and verbal warnings issued.

Market research techniques have been used at different times to obtain information from HOV lane users, FasTrak™ patrons, and the general public. In the fall of 1997, a telephone survey was conducted of 1,500 commuters in the San Diego area to obtain information on travel modes, perceptions about the I-15 HOV lane, and the ExpressPass program. A total of 500 ExpressPass customers were included in the survey. In January 2005, SANDAG mailed a survey to 18,000 FasTrak™ customers. The survey contained three questions relating to use of the FasTrak™ Customer Service Center.

For More Information

Visit the TMC Pooled-Fund Study Website at:

http://hovpfs.ops.fhwa.dot.gov/index.cfm

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