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HOV LANE PERFORMANCE MONITORING: 2000 REPORT EXECUTIVE SUMMARY

by

Jennifer Nee
TRAC Research Engineer

John Ishimaru
TRAC Senior Research Engineer

Mark E. Hallenbeck
TRAC Director

Washington State Transportation Center (TRAC)
University of Washington, Box 354802
University District Building
1107 NE 45th Street, Suite 535
Seattle, Washington 98105-4631

Washington State Department of Transportation
Technical Monitor
Jim Shanafelt
Assistant State Traffic Engineer

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16. ABSTRACT

High occupancy vehicle (HOV) lanes, also known are carpool lanes and diamond lanes, are designated for use by carpoolers, transit riders, ridesharers, and motorcyclists that meet the occupancy requirement. By restricting access, the HOV lanes benefit users by allowing them to travel the freeway system at a faster speed, thus saving time and experiencing grater travel time reliability in comparison to motorists on general purpose (GP) lanes. To accurately evaluate the system's effectiveness, a sate policy requires an annual HOV system report to document system performance, examining the HOV lanes' person-carrying capability, travel time savings, and trip reliability benefits in comparison to adjacent GP lanes, as well as the lanes' violation rates.

This report describes the results of an extensive monitoring effort of HOV lane use and performance in the Puget Sound area in 2000. It presents an analysis of data collected to describe the number of people and vehicles that use those lanes, the reliability of the HOV lanes, travel time savings in comparison to general purpose lanes, violation rates, and public perceptions. This information is intended to serve as reliable input for transportation decision makers and planners in evaluating the impact and adequacy of the existing HOV lane system in the Puget Sound area and in planning of other HOV facilities.

Descriptions of the tool set and methodology for analyzing HOV facility usage and performance in terms of vehicle and person throughput, travel time, and speed reliability measures are provided in a separate report, *Evaluation Tools for HOV Lanes Performance Monitoring*.

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Data collected throughout the Puget Sound region show that the HOV facilities are very successful at this task. Available data show the following for most HOV facilities:

- Substantial travel time savings exist in comparison to general purpose lane travel.
- HOV lanes are operating much more reliably than general purpose lanes.
- HOV lanes are successfully moving large numbers of travelers, particularly in the peak periods when general purpose lane congestion is highest.
- HOV person and vehicle volumes are increasing substantially in the peak period.
- An increasing percentage of peak period travelers are taking advantage of ride sharing (transit and carpool) travel modes.

While not all HOV facilities are equally successful, taken as a whole the HOV lane system is successfully meeting the policy goals it was designed to accomplish. In fact, some regional HOV lanes are so successful that they are starting to show signs of stress from high use. The most obvious sign of stress is recurring congestion at specific locations. At these

locations, consideration of geometric improvements and/or changes in operating conditions may be required.

This Executive Summary briefly overviews the current performance of the Puget Sound freeway HOV system. This performance includes the person and vehicle volumes the system is carrying, the presence of congestion, and changes observed in these performance measures. Directions on how to read the graphics presented in this summary and details on specific HOV facility performance in the region are presented in the main body of this report.

HOV FACILITY USE

In a two-year span (1998-2000), HOV use increased throughout most of the region. On average, peak period1 HOV lane person throughput on the corridors studied grew by roughly 17 percent in two years, and vehicle throughput grew by about 16 percent. As tables ES-1 and 2 show, while this growth was not evenly distributed across all HOV facilities, it was widespread. Of the locations that were monitored, the highest growth rates were on I-5, south of Everett, and on I-405 through Kirkland and Redmond, although several other facilities showed significant increases in HOV lane use. Both person movements and vehicle volumes increased.

1 In this report, "peak period" is defined as either the 3-hour morning period from 6:00 AM to 9:00 AM or the 4-hour evening period from 3:00 PM to 7:00 PM.

Table ES-1: Changes in AM Peak Period (6:00-9:00) HOV Use

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During the two years studied, HOV growth was so strong that the mode split of ride sharing transportation options (transit plus carpool) in the peak periods and peak directions increased by 1 to 8 percent. With all study locations combined, an estimated one third of peak period travelers in these corridors use shared ride modes. This indicates that regional policy efforts to encourage shared ride transportation are succeeding.

In general, the increases observed in person throughput during the 3-hour morning peak period were slightly smaller in percentage terms than those in the 4-hour afternoon peak. While the majority of HOV users in both peaks appear to be commuters, the fact that increases in afternoon HOV person throughput exceeded increases in morning HOV throughput indicates that non-commuters are also taking advantage of the travel savings from HOV lanes. This is good; it means that HOV benefits are being spread throughout the regional population, not just the segment working traditional hours and work weeks.

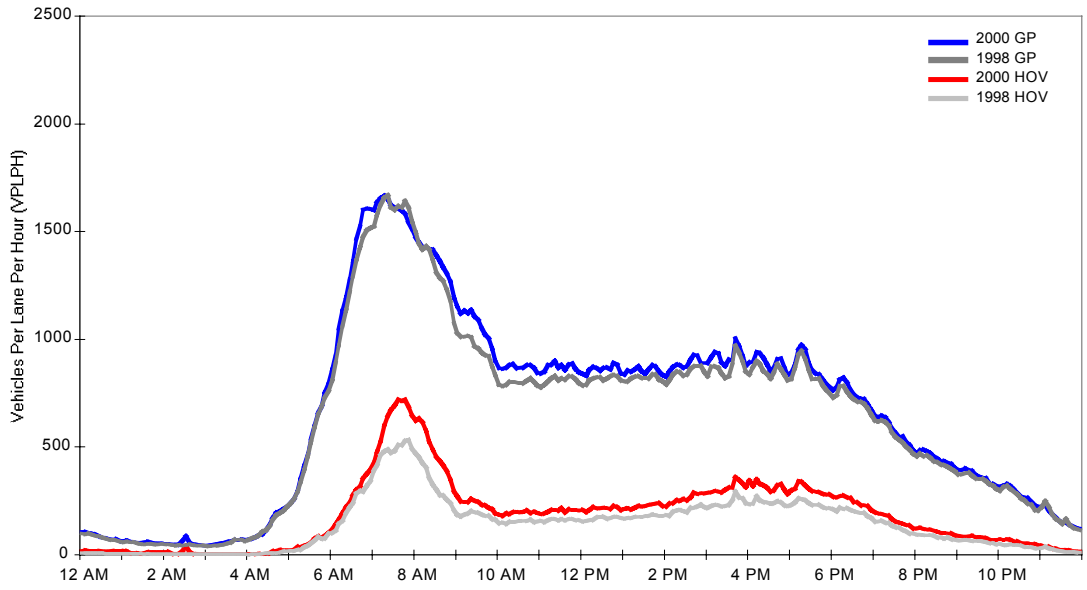
The only major exception to the growth trend is I-405, southbound in the morning, south of the SR 167 interchange through Tukwila. This location showed a decline in HOV use and a decline in ride sharing mode split. It is not clear why this HOV segment is not heavily used. The northbound segment of I-405 at this location does experience substantial, and increasing, HOV traffic.

The only other low growth HOV facility is I-405 southbound, in the evening through Newcastle. This roadway segment experienced a modest increase in HOV lane vehicle traffic, but person throughput remained essentially unchanged.

Another facility with interesting results is I-90. On the western portion of this corridor, represented by volumes at mid-span in the reversible roadway, vehicle volumes declined slightly, but person throughput increased 3 to 5 percent during the two peak periods.

Combined HOV mode split for I-90 (including both reversible and mainline lanes) increased from 1 to 4 percent in the peak directions. In contrast, on this same freeway east of the I-405 interchange, the growth of HOV vehicle traffic to and from Issaquah was substantial. HOV vehicle volumes increased over 30 percent westbound in the morning and 20 percent eastbound in the evening. Yet despite these increases, HOV mode split remained essentially the same as that for the floating bridge segment of I-90. These small changes in mode split, despite large increases in HOV use, were the result of high growth rates in general purpose, single occupancy vehicles on I-90 east of the I-405 interchange.

Figure ES-1 illustrates how I-90 vehicle volumes coming westbound from Issaquah have grown. Note the significant growth in morning peak period HOV travel westbound, while the congested GP lanes show growth only in the shoulders of the peak period and during the middle of the day.



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Figures ES-2 and ES-3 show typical growth patterns for more congested corridors. ES-2 illustrates the southbound flow on I-5 approaching the Express Lanes, while ES-3 illustrates the southbound I-405 movement near Newcastle.

Figure ES-2 shows that I-5 AM peak period general purpose traffic is constrained by congestion (see Point A). GP growth can only occur in the early morning or later in the day. HOV volume growth can occur throughout the morning peak, although HOV growth is also growing more quickly in the shoulders of the peak period than in the traditional peak hour.

Figure ES-3 shows that general purpose vehicle volumes on I-405 are even more constrained than on I-5. Volumes are almost constant throughout the day, with little opportunity for growth, as the facility operates near capacity. HOV volumes have grown substantially throughout the peak period, although these volumes are also starting to approach capacity.

HOV LANE SPEED AND RELIABILITY

About half of the metropolitan region's HOV corridors fail the performance standard adopted by the Regional HOV Policy Advisory Committee. This standard states that HOV facilities should operate at or above 45 mph 90 percent of the time. Figure ES-4 illustrates an HOV facility that fails this standard. I-90, SR 167, and SR 520 all meet or exceed this standard. I-5 and I-405 fail this standard in both northern and southern corridors. The failures are generally caused by a combination of two major factors:

- friction between slow moving general purpose lanes and the HOV lane separated from those lanes by only a paint stripe
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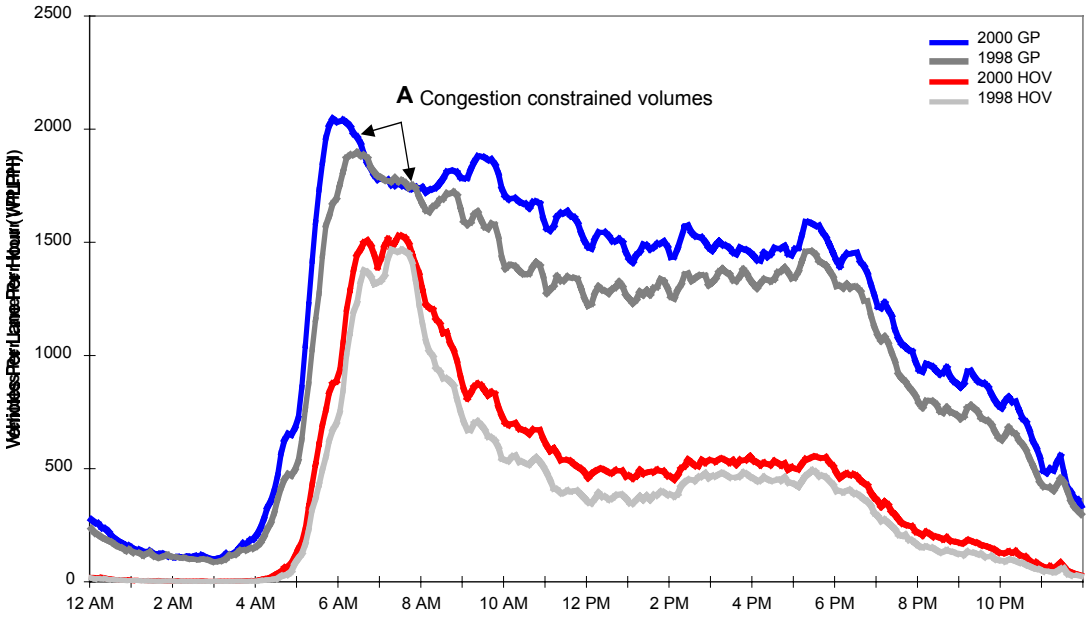

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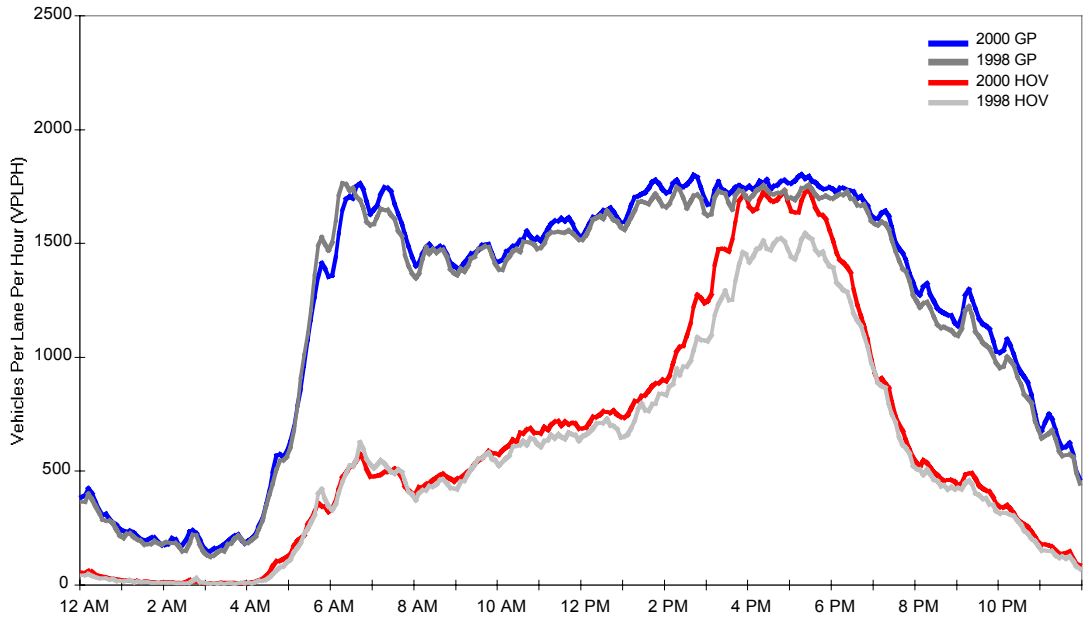

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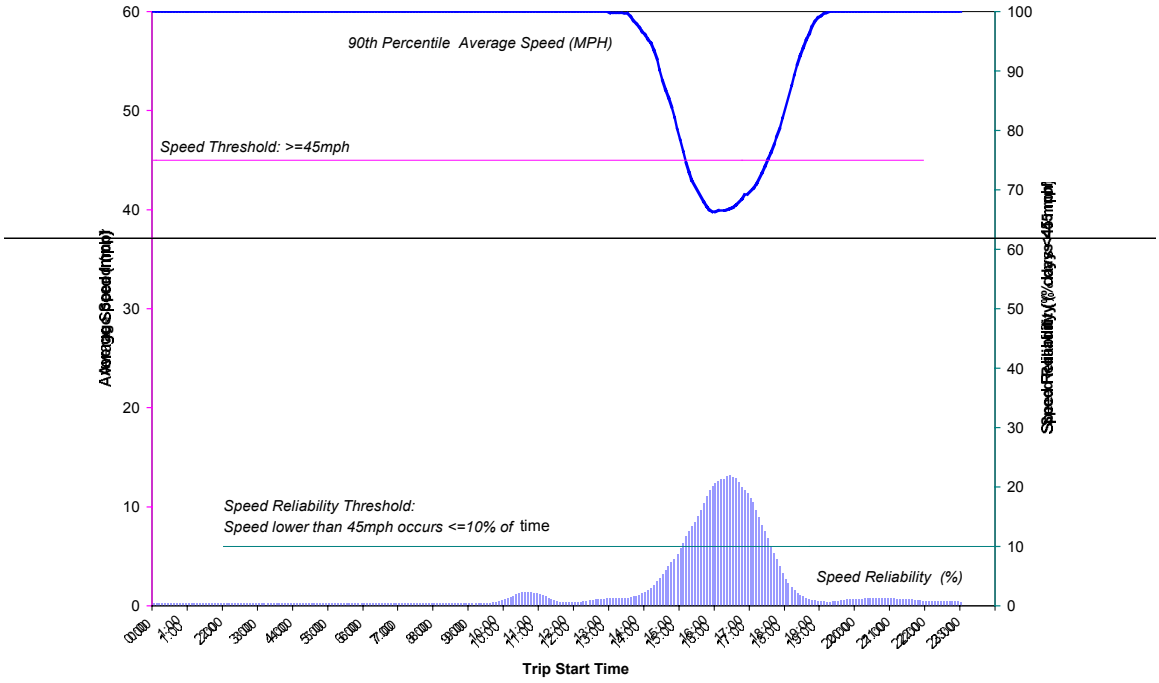

Figure ES-4: Northbound I-5 Average Speed Performance: Northgate to South Everett

FRICTION RELATED SLOWING

When GP lanes move slowly, adjacent HOV lanes normally slow down as well, although they usually maintain a considerable speed advantage. This occurs for two reasons: 1) motorists are uncomfortable with a large speed differential between their cars and cars just a few feet away, and 2) vehicles entering and exiting the HOV lanes must slow to match speeds with the adjacent slow-moving GP traffic during merge/diverge movements.

These "friction" related slowdowns are actually good from a safety perspective because slower speed differentials between the HOV and GP lanes significantly reduce the likelihood of accidents during merge/diverge movements. In fact, lowering speed differentials increases safety so much that regional transit authorities require their drivers to

limit the speed differentials between transit coaches in the HOV lanes and the adjacent GP lanes. (That is, transit coach drivers are told to slow down to maintain safety, even though this means dropping the HOV lane speed below the standard adopted by the HOV Policy Committee. The HOV Policy Committee is aware of these instructions and approves of their use.)

SPOT CONGESTION

Spot congestion occurs routinely in only a couple of HOV locations. Spot congestion is normally caused by a combination of high HOV vehicle volumes and some type of geometric constriction. The worst spot congestion locations are all on I-5. They are just north of the northern end of the Express lanes (southbound in the morning and northbound in the evening) and on the Southcenter Hill (southbound in the afternoon). These locations are among the highest volume HOV facilities in the region. Congestion in the HOV lanes occurs at these locations an average of more than three days per week. In the north end, in addition to high HOV volumes, congestion results from the turbulence caused by the entrance/exit of traffic to and from the Express Lanes. In the south end, the steep grade of the Southcenter Hill plays a significant role in slowing HOV traffic.

Lower levels of congestion routinely occur on I-405, particularly between the I-90 interchange and Renton. Significant congestion occurs on this portion of I-405 generally less than once every two weeks. Friction related congestion also occurs in the HOV lanes on I-405 approaching the SR 167 interchange as HOVs slow to merge with slow-moving GP traffic in order to access the SR 167 ramps.

Mid-day congestion occurs routinely in only one HOV lane location, northbound on I-5 approaching downtown Seattle. While HOV use is moderately high on this roadway during the middle of the day (frequently above 800 vehicles per hour), the congestion is not caused by HOV movements. Instead, HOV lane performance in this section is affected by the I-90 interchange, the approaching downtown Seattle exits, the reduction to two lanes of through-vehicle capacity on northbound I-5, and the ending of the HOV lane restriction just downstream of this location.

CONGESTION TRENDS

Changes in travel times and service reliability are hard to measure because the data available for this report are slightly different from the data used in 1998. For example, we can now measure HOV lane performance near the top of the Southcenter Hill, while we could not do this in 1998. However, despite these data issues, it is possible to determine that minor increases in delay were apparent on several of the measured facilities. These increases occurred on I-5 both north and south of the city, and on I-90. SR 520 experienced no change in HOV performance, while I-405 performance improved in some places (southbound, both north and south of Bellevue) but declined in others (northbound, both north and south of Bellevue). Similarly, SR 167 performance improved northbound but worsened southbound.

None of these changes resulted in a dramatic change in system reliability. Facilities that previously struggled to meet the recommended 45 mph standard continue to have problems meeting the standard. Similarly, roads that previously met standards, such as I-90, still meet those standards despite the slight worsening of conditions. In all but one case (I-5 southbound leaving the Seattle downtown), HOV lanes still provide substantial travel time

and reliability savings. For this one corridor, it appears that the HOV speeds up the Southcenter Hill are so slow, and GP traffic from Albro to the Southcenter Hill are so consistently good, that on most days using the HOV lanes produces only modest travel time benefits. However, during the morning portion of this commute, the HOV facility (northbound) provides considerable travel time and reliability advantages over the GP lanes. (Also note that the worst congestion on this commute starts at the Southcenter Hill, and continues south, often stretching as far south as Tacoma, while our ability to measure performance ends at the top of the Southcenter Hill.)

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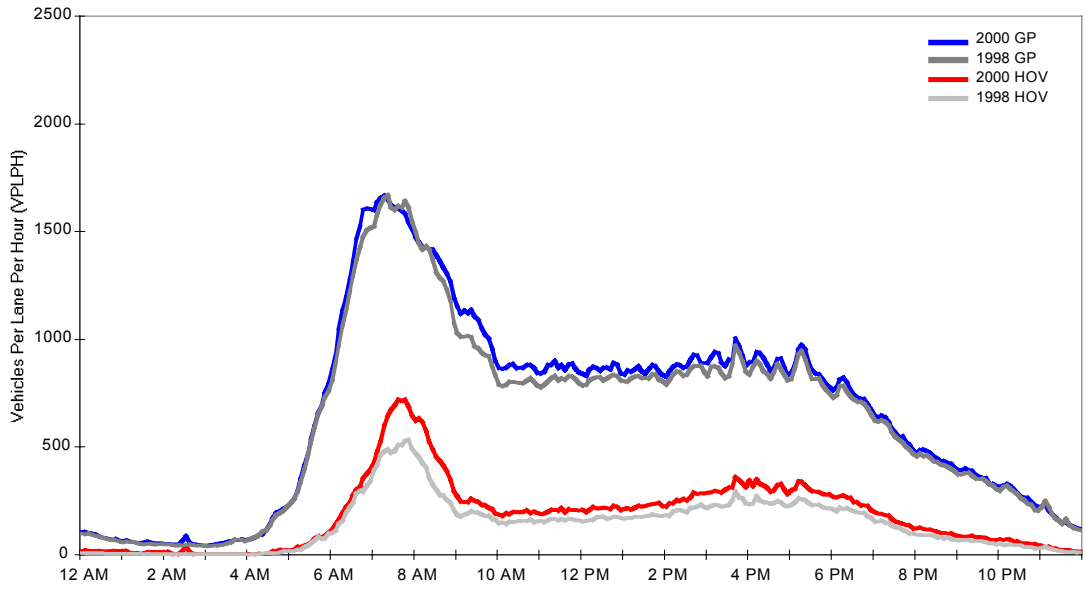

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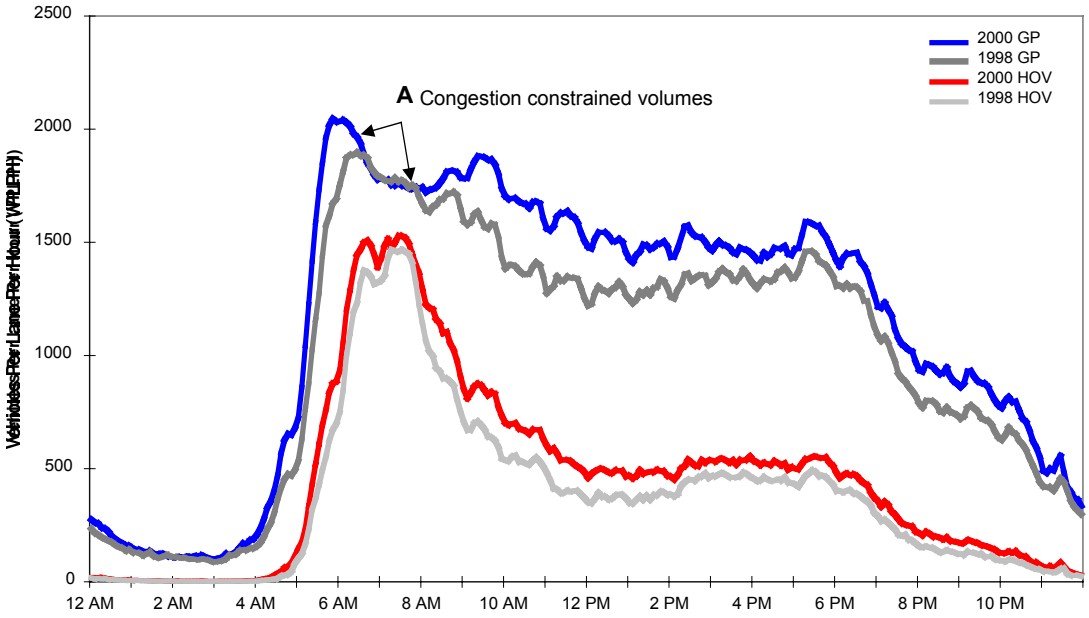

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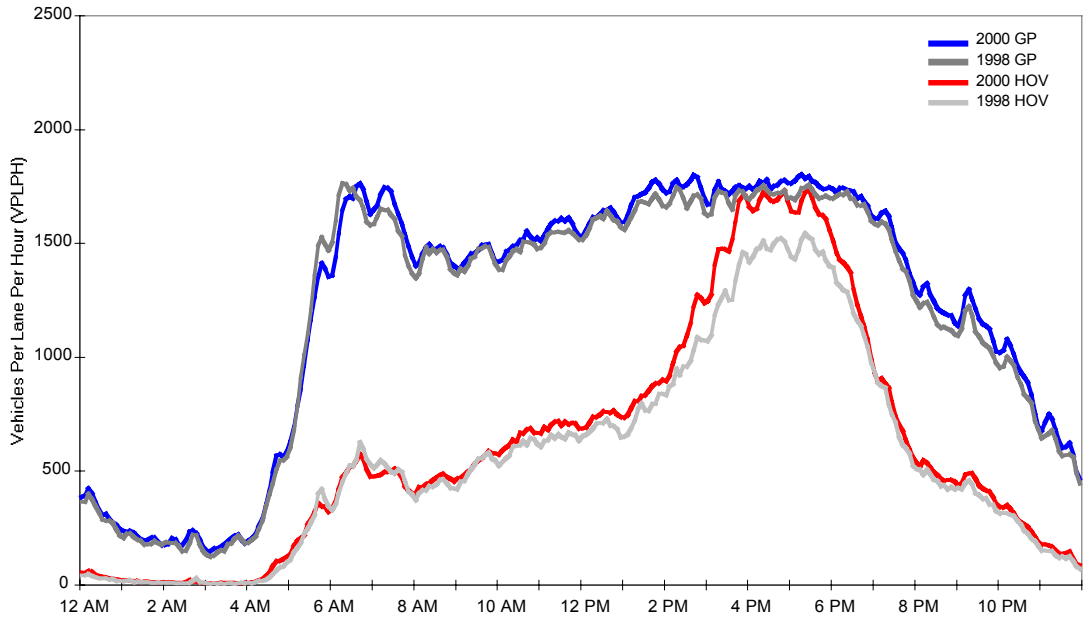

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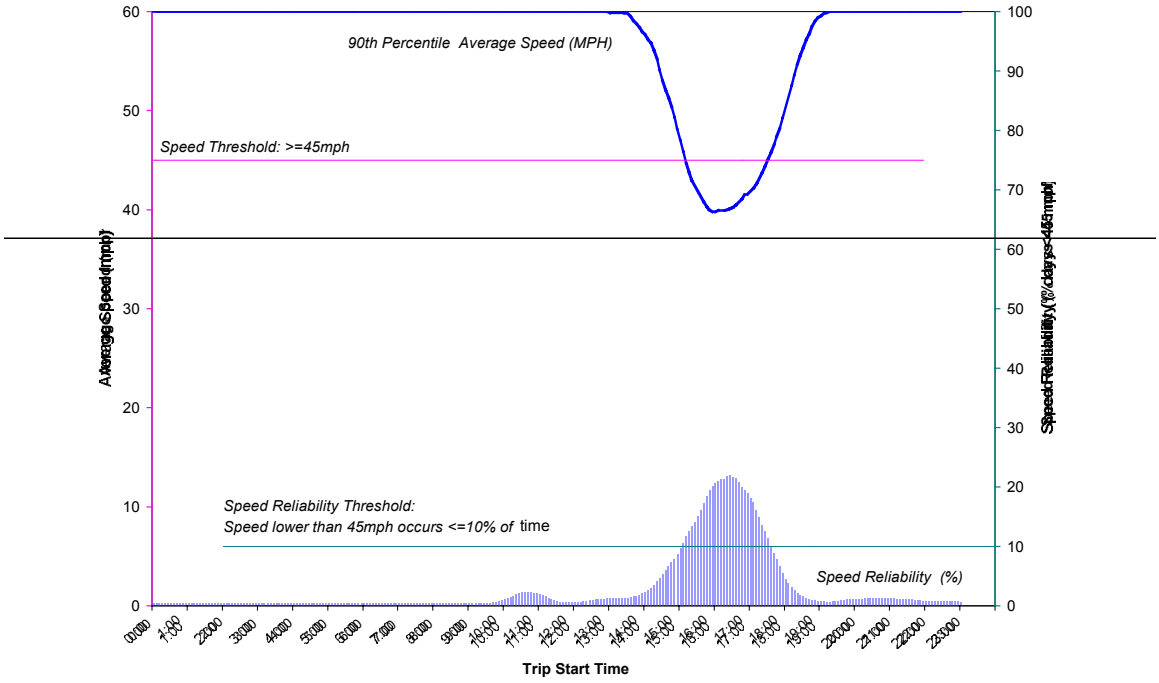

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FRICTION RELATED SLOWING

When GP lanes move slowly, adjacent HOV lanes normally slow down as well, although they usually maintain a considerable speed advantage. This occurs for two reasons: 1) motorists are uncomfortable with a large speed differential between their cars and cars just a few feet away, and 2) vehicles entering and exiting the HOV lanes must slow to match speeds with the adjacent slow-moving GP traffic during merge/diverge movements.

These "friction" related slowdowns are actually good from a safety perspective because slower speed differentials between the HOV and GP lanes significantly reduce the likelihood of accidents during merge/diverge movements. In fact, lowering speed differentials increases safety so much that regional transit authorities require their drivers to

limit the speed differentials between transit coaches in the HOV lanes and the adjacent GP lanes. (That is, transit coach drivers are told to slow down to maintain safety, even though this means dropping the HOV lane speed below the standard adopted by the HOV Policy Committee. The HOV Policy Committee is aware of these instructions and approves of their use.)

SPOT CONGESTION

Spot congestion occurs routinely in only a couple of HOV locations. Spot congestion is normally caused by a combination of high HOV vehicle volumes and some type of geometric constriction. The worst spot congestion locations are all on I-5. They are just north of the northern end of the Express lanes (southbound in the morning and northbound in the evening) and on the Southcenter Hill (southbound in the afternoon). These locations are among the highest volume HOV facilities in the region. Congestion in the HOV lanes occurs at these locations an average of more than three days per week. In the north end, in addition to high HOV volumes, congestion results from the turbulence caused by the entrance/exit of traffic to and from the Express Lanes. In the south end, the steep grade of the Southcenter Hill plays a significant role in slowing HOV traffic.

Lower levels of congestion routinely occur on I-405, particularly between the I-90 interchange and Renton. Significant congestion occurs on this portion of I-405 generally less than once every two weeks. Friction related congestion also occurs in the HOV lanes on I-405 approaching the SR 167 interchange as HOVs slow to merge with slow-moving GP traffic in order to access the SR 167 ramps.

Mid-day congestion occurs routinely in only one HOV lane location, northbound on I-5 approaching downtown Seattle. While HOV use is moderately high on this roadway during the middle of the day (frequently above 800 vehicles per hour), the congestion is not caused by HOV movements. Instead, HOV lane performance in this section is affected by the I-90 interchange, the approaching downtown Seattle exits, the reduction to two lanes of through-vehicle capacity on northbound I-5, and the ending of the HOV lane restriction just downstream of this location.

CONGESTION TRENDS

Changes in travel times and service reliability are hard to measure because the data available for this report are slightly different from the data used in 1998. For example, we can now measure HOV lane performance near the top of the Southcenter Hill, while we could not do this in 1998. However, despite these data issues, it is possible to determine that minor increases in delay were apparent on several of the measured facilities. These increases occurred on I-5 both north and south of the city, and on I-90. SR 520 experienced no change in HOV performance, while I-405 performance improved in some places (southbound, both north and south of Bellevue) but declined in others (northbound, both north and south of Bellevue). Similarly, SR 167 performance improved northbound but worsened southbound.

None of these changes resulted in a dramatic change in system reliability. Facilities that previously struggled to meet the recommended 45 mph standard continue to have problems meeting the standard. Similarly, roads that previously met standards, such as I-90, still meet those standards despite the slight worsening of conditions. In all but one case (I-5 southbound leaving the Seattle downtown), HOV lanes still provide substantial travel time

and reliability savings. For this one corridor, it appears that the HOV speeds up the Southcenter Hill are so slow, and GP traffic from Albro to the Southcenter Hill are so consistently good, that on most days using the HOV lanes produces only modest travel time benefits. However, during the morning portion of this commute, the HOV facility (northbound) provides considerable travel time and reliability advantages over the GP lanes. (Also note that the worst congestion on this commute starts at the Southcenter Hill, and continues south, often stretching as far south as Tacoma, while our ability to measure performance ends at the top of the Southcenter Hill.)