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HOV LANE PERFORMANCE MONITORING: 2000 REPORT EXECUTIVE SUMMARY

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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 greater travel time reliability in comparison to motorists on general purpose (GP) lanes. To accurately evaluate the system's effectiveness, a state 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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Table of Contents

Section **Page**

List of Figures

Figure **Page**

List of Tables

Table **Page**

HOV LANE PERFORMANCE MONITORING:
2000 REPORT
EXECUTIVE SUMMARY

HOV lanes are designed to provide extra person-moving capacity within the Puget Sound region without significantly increasing the amount of land required for transportation infrastructure. HOV lanes are intended to provide a travel time incentive for travelers who either carpool or ride public transit because these modes of travel provide high levels of throughput and personal mobility in much less space than that needed by single occupant automobiles.

Data collected throughout the Puget Sound region show that the HOV facilities are very successful. 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 general policy goals of providing mobility within the limited right-of-way available. In fact, some regional HOV lanes are so successful at attracting users 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 the region. On average, peak period[1] 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 (a roughly 40 percent growth in person throughput), and on I-405 through Kirkland and Redmond (a 30 percent increase), although several other facilities showed significant increases in HOV lane use. Both person movements and vehicle volumes increased.

During the two years studied, HOV growth was so strong that the percentage of people using shared ride transportation options (transit plus carpool) in the peak periods and peak directions increased by between 1 and 8 percent, depending on the corridor. 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.

[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

Location	Person Volume Increase (1998 – 2000)		Vehicle Volume Increase (1998 – 2000)		Percent of Travelers Using HOV 2000	Change in Percent of Travelers Using HOV (1998-2000)
	Actual	Percent	Actual	Percent		
I-5 SB @ 112th SE, South Everett	1240	36%	580	46%	24%	4%
I-5 SB @ NE 145th St., Northgate	2590	19%	670	19%	41%	4%
I-5 NB @ Albro Place, South of Seattle CBD	2130	18%	330	9%	38%	4%
I-405 SB @ NE 85th St., Kirkland	2180	36%	770	33%	33%	4%
I-405 NB @ SE 52nd St., Newcastle	390	4%	420	12%	50%	1%
I-405 SB @ Tukwila Way, Southcenter	-450	-14%	-350	-24%	17%	-7%
I-90 WB @ Midspan, Floating Bridge	100	3%	-50	-4%	30%	1%
I-90 WB @ Newport Way, Issaquah	920	39%	330	32%	19%	4%
SR 520 WB @ 84th Ave. NE, Medina	570	16%	60	15%	30%	4%
SR 167 NB @4h Ave N., Kent	490	15%	280	22%	28%	2%

Table ES-2: Changes in PM Peak Period (3:00 – 7:00) HOV Use

Location	Person Volume Increase (1998 – 2000)		Vehicle Volume Increase (1998 – 2000)		Percent of Travelers Using HOV 2000	Change in Percent of Travelers Using HOV (1998-2000)
	Actual	Percent	Actual	Percent		
I-5 SB @ 112th SE, South Everett	3230	47%	750	25%	32%	8%
I-5 SB @ NE 145th St., Northgate	1570	9%	460	9%	37%	3%
I-5 NB @ Albro Place, South of Seattle CBD	1950	12%	560	12%	38%	2%
I-405 SB @ NE 85th St., Kirkland	1800	17%	860	21%	36%	1%
I-405 NB @ SE 52nd St., Newcastle	-70	0%	600	11%	49%	0%
I-405 NB @ Tukwila Way, Southcenter	1950	25%	520	15%	39%	1%
I-90 WB @ Midspan, Floating Bridge	250	5%	-40	-2%	35%	1%
I-90 WB @ Newport Way, Issaquah	580	14%	340	20%	19%	1%
SR 520 WB @ 84th Ave. NE, Medina	1100	24%	220	17%	32%	5%
SR 167 SB @ 4th Ave N, Kent	1280	19%	780	29%	41%	3%

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, other travelers are also taking advantage of the HOV lanes. The PM peak includes a higher percentage of non-commute trips, and 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 means that HOV benefits are being spread broadly through the regional population, rather than just being concentrated in the segment working traditional hours and work weeks.

The only major exception to the growth trend is I-405, south of the SR 167 interchange through Tukwila, southbound in the morning,. 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, although the addition of the Sounder train service from Tacoma to Seattle through Kent and Auburn in September of 2000 may have contributed to the decline in HOV use on this short section of I-405. 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 through Newcastle in the evening. 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 (Mercer Island to Seattle), represented by volumes at mid-span in the reversible roadway, combined HOV mode split for I-90 (including both reversible and mainline lanes) increased from 1 to 4 percent in the peak directions. On this section of roadway, vehicle volumes declined

slightly, but person throughput increased 3 to 5 percent during the two peak periods. 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 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.

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). This means that 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.

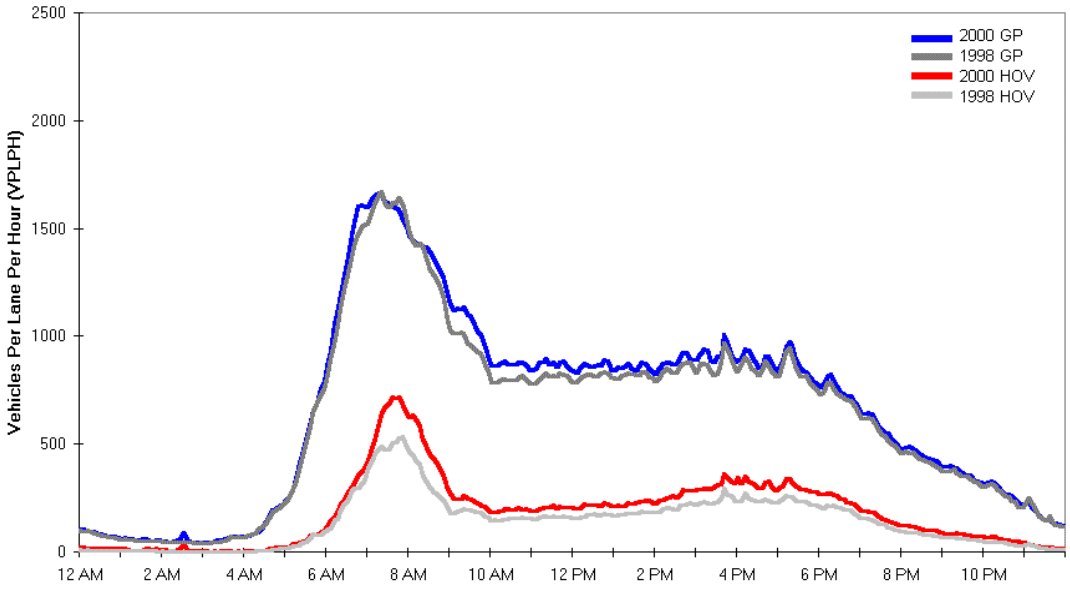

Figure ES-1: I-90 Volumes Per Lane, Westbound at Newport Way, West of Issaquah

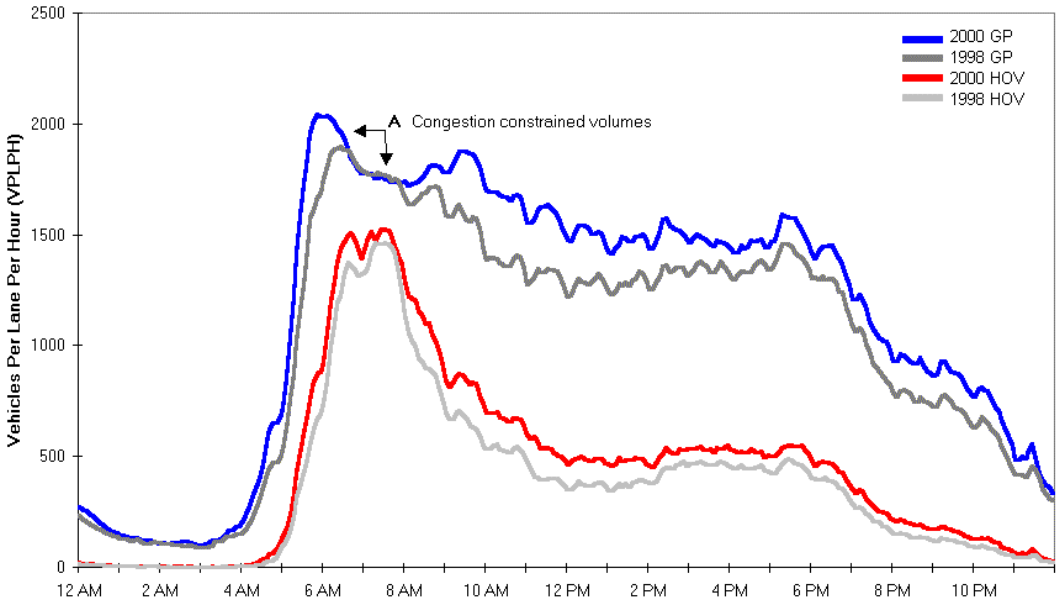

Figure ES-2: I-5 Volumes Per Lane, Southbound at NE 137th St., Northgate

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.

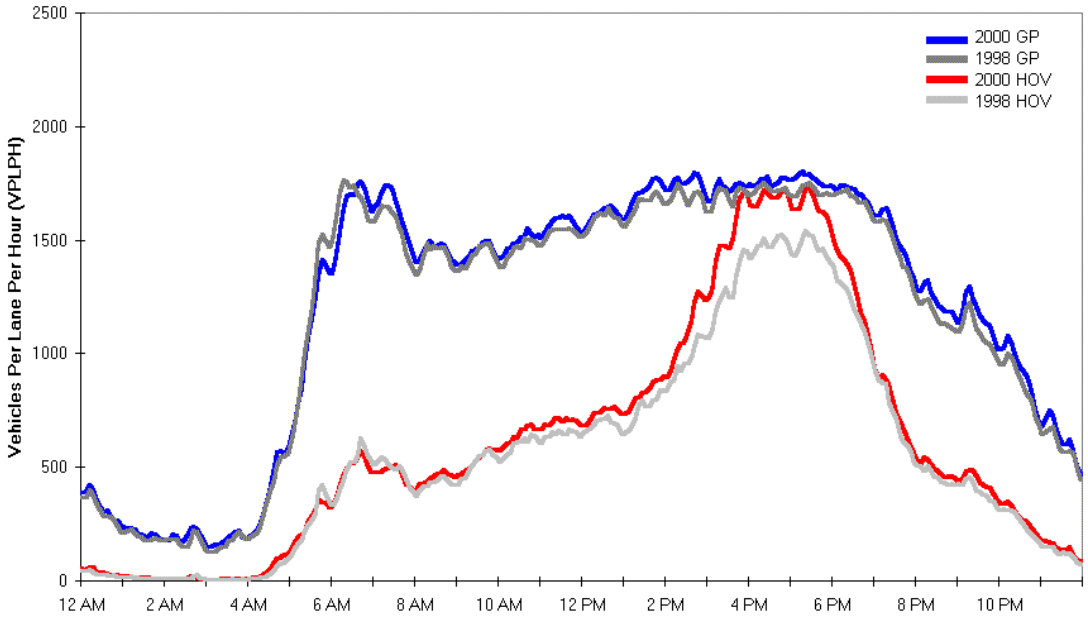

Figure ES-3: I-405 Volumes Per Lane, Southbound at SE 59th St., Newcastle

HOV LANE SPEED AND RELIABILITY

The Regional HOV Policy Advisory Committee set a goal of having HOV facilities operate at 45 mph or better, 90 percent of the time. Several of the region's HOV facilities do not meet this goal during peak periods. Two of the metropolitan region's HOV corridors (I-5 both to the north of Northgate, and south from the Seattle CBD to the top of the Southcenter Hill) suffer from spot congestion along short sections of freeway near the beginning or end of the facility. These congestion bottlenecks can cause significant delay. Figure ES-4 illustrates the

performance throughout the day of one of these HOV facilities. Three other HOV corridors (on I-405 both north and south of the Bellevue CBD, and SR 520 westbound in the afternoon) also fall below this standard, although for different reasons. On I-405, weaving movements into and out of the HOV facility combined with friction between slow moving general purpose lanes and the HOV lane separated from those lanes by only a paint stripe slow HOVs during peak congestion periods. On SR 520, the shoulder HOV lane is particularly susceptible to friction slowdowns, as well as being effected by general purpose vehicles entering at the ramps from 104th and 108th Avenues NE and having to merge through the HOV lane into stop and go general purpose traffic.

I-90 and SR 167 meet or exceed the 45 mph standard with a large margin to spare.

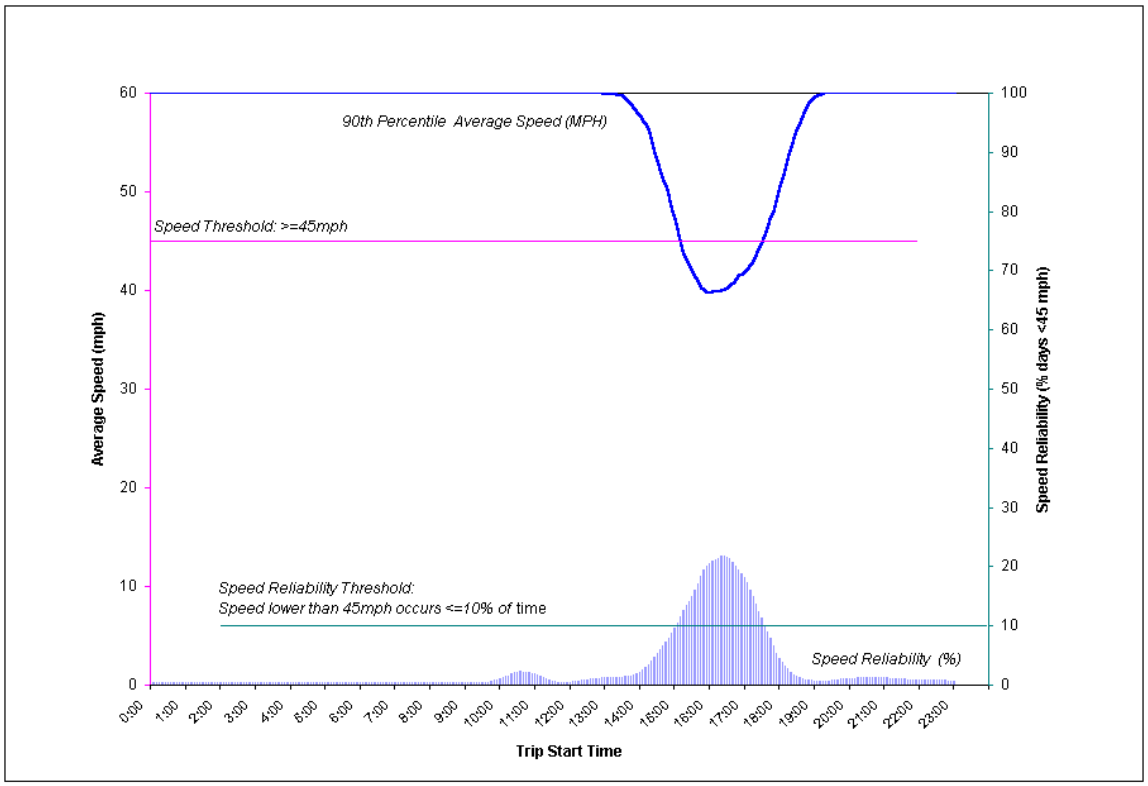

Figure ES-4: Northbound I-5 Average Speed Performance: Northgate to South Everett

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.

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, as does the fact that the HOV lane ends (becoming a GP lane) shortly after the grade levels off. Congestion at this location is further exacerbated by the fact that one GP is an Exit Only lane at the top of the Southcenter Hill, causing an increase in merging for all vehicles.

Lower levels of HOV lane 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 both northbound and southbound 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 just north 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 as far south as near the top of the Southcenter Hill, while sensors did not exist this far south 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 near I-405, but worsened southbound approaching the Auburn.

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 afternoons, 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.)

CONCLUSIONS

HOV lane use in the region is high and continuing to grow. High levels of HOV use combined with geometric constraints limit HOV lane performance in some areas. In some of these cases (I-5 on the Southcenter Hill), ongoing WSDOT construction projects are likely to provide some relief for the observed spot congestion. In others, planned Sound Transit direct access ramps should improve both HOV and GP facility performance. Although these planned fixes will not relieve all HOV lane congestion in the region, even with limited problems, HOV lanes will generally perform well and will attract an increasing percentage of the region's peak-period travelers.