Washington State
Department of Transportation

The 2010 Congestion Report

Gray Notebook Special Edition

WSDOT's comprehensive analysis of system performance on state highways, 19 November 2010

Paula J. Hammond, P. E.
Secretary of Transportation

Moving Washington
A Program to
Fight Congestion

Looking at 2009 Data

In this edition

Published as part of the September 30, 2010, edition of the Gray Notebook, GNB 39
www.wsdot.wa.gov/accountability

Foreword

Performance highlights in this edition of WSDOT's Annual Report on Congestion

We are pleased to present you with the Washington State Department of Transportation's 2010 Congestion Report. This report is WSDOT's annual analysis of travel statewide with an emphasis on the major freeways in the Puget Sound region and assessment of WSDOT's congestion relief projects and strategies.

Congestion on Washington State's highways decreased in 2009 compared to 2007. Travelers spent an average of an hour less in congestion. Delay on some of the most heavily traveled Puget Sound corridors was reduced by 38%. Much of this decline is due to the combination of factors including the economic recession and WSDOT's congestion relief projects and strategies.

WSDOT continues to fight congestion aggressively through Moving Washington – a three-pronged strategy comprised of operating the transportation system efficiently, managing travel demand, and strategically adding capacity by delivering projects. These three strategies are having an impact, and are improving travel for Washington drivers:

- **Operating the existing system efficiently** Low cost high benefit strategies include dynamic travel time signs with route choices, variable message signs, signal retiming, arterial signal coordination, ramp metering, etc. Advanced ITS techniques such as Smarter Highways (Active Traffic Management), High Occupancy Tolling projects, and the Incident Response program, contribute to the existing transportation infrastructure so it can operate more efficiently.
- **Managing travel demand** Strategies including telecommuting, vanpools, transit, Commute Trip Reduction, and Growth and Transportation Efficiency Centers (GTECs) all encourage drivers to use less congested routes and reduce trips driving alone.
- **Adding capacity** By September 30, 2010, WSDOT had completed 70 congestion relief projects funded through the 2003 and 2005 gas tax packages valued at $2.4 billion. These projects are reducing the time that Washington drivers spent in traffic. For example, the I-405 South Bellevue widening project improved travel times by 16 minutes during the morning peak period in 2009 compared to 2007.

As the economy improves, it will be accompanied by increased travel demand. WSDOT stands ready to address these challenges. Looking to the future, major congestion relief projects, including the Alaskan Way Viaduct, SR 520 Floating Bridge, Columbia River Crossing, and projects in the I-405 Corridor Program, remain to be delivered. Smarter highways, using technologies such as active traffic management, will be implemented on more miles of the central Puget Sound region's busiest corridors. This technology was introduced onto I-5 in August 2010 and is scheduled to be implemented on SR 520 and I-90 in November 2010 and spring 2011 respectively. Next year's annual Congestion Report will report on the benefits of these improvements and how they have affected system performance.

Table of Contents
Contributors

One of the I-5 northbound Smarter Highway gantries south of downtown Seattle shortly after debuting in August 2010.

The work of many people goes into the writing, editing, and production of WSDOT's annual Congestion Report. This list of contributors reflects the efforts of data analysts, engineers, planners, project leads, and many more individuals behind the scenes. Information is reported on a preliminary basis as appropriate and available for internal management use; it is subject to correction and clarification. Online versions of this publication are available at www.wsdot.wa.gov/accountability

Contributors to the 2010 Congestion Report

Faris Al-Memar, Ted Bailey, Matt Beaulieu, Katherine Boyd, Daniela Bremmer, Dave Bushnell, Vince Fairhurst, Sreenath Gangula, Hien Giang, Manouchehr Goudarzi, Mark Hallenbeck, Robin Hartsell, Monica Harwood, Craig Helmann, John Ishimaru, Kumiko Izawa, Jamie Kang, Ruth Kinchen (King City Metro), Rachel Knutson, Basma Makari, Diane McGuerty, Delwar Murshed, Tyler Patterson, Charles Prestrud, Benjamin Smith (Sound Transit), Marjorie Vanhoorelbeke, Harold White, Tyler Winchell, Mike Wold (King County Metro), Duane Wright, Anna Yamada, Shuming Yan

Performance Analysis Team – Laura Cameron, Sreenath Gangula, Dan Genz, Rachel Knutson, Todd Lamphere, Colleen Rozillis, Tyler Winchell

Graphics – Chris Britton, Steve Riddle

Publishing and Distribution – Linda Pasta, Trudi Philips, Deb Webb

For information, contact
Daniela Bremmer, Director
WSDOT Strategic Assessment Office
310 Maple Park Avenue SE, PO Box 47374, Olympia, WA 98504-7374
Phone: 360-705-7953 :: E-mail: bremmed@wsdot.wa.gov

Measuring Delay and Congestion Annual Report

Congestion Report Dashboard of Indicators

2010 Congestion Report Dashboard of Indicators	2006	2007	2008[5]	2009	Difference 2007 vs. 2009*
Demographic and economic indicators					
State population (millions)	6.4	6.5	6.6	6.7	+2.8%
Average gas price per gallon (July)	$3.08	$3.05	$4.36	$2.81	-7.9%
Unemployment rate (annual)	4.9%	4.6%	5.4%	8.9%	+4.3%
Rate of annual economic growth[1]	2.8%	4.4%	2.0%	N/A	N/A
Real personal income (billions)[1]	245.3	256.8	259.9	257.3	+0.2%
Systemwide congestion indicators					
Less travel					
Statewide vehicle miles traveled (VMT), in billions	56.5	57.0	55.6	56.5	-0.9%
Statewide per capita VMT, in miles	8,867	8,779	8,440	8,467	-3.6%
Less of the system congested					
Lane miles of state highway system congested[3]	1,030	1,011	930	950	-6.0%
Percent of state highway system congested[3]	5.7%	5.6%	5.2%	5.2%	-0.4%
Less delay					
Total vehicle hours of delay on state highways, in millions of hours[2]	37	32	32	25	-21%
Annual hours of per capita delay on state highways[2]	5.7	4.9	4.8	3.8	-22%
Reduced costs (2009 dollars in millions)					
Estimated economic costs of delay on state highways[2,6]	$878	$767	$762	$608	-21%
Corridor-specific congestion indicators					
Congestion on 38 high-demand commute routes in the central Puget Sound (compared to two years earlier)					
Number of routes where the duration of the congested period improved[4]	1	8	31	34	N/A
Number of routes where average peak travel time improved	3	9	30	31	N/A
Number of routes where 95% reliable travel time improved	2	10	26	28	N/A
WSDOT congestion relief projects					
Number of completed Nickel and TPA mobility projects as of September 30th of each year (cumulative)	12	34	46	70	36
Cumulative project value (dollars in millions)	$172	$708	$1,154	$2,400	$1,692

Data sources include: WSDOT, Office of Financial Management; Economic and Revenue Forecast Council; Bureau of Economic Analysis, U.S. Department of Energy - Energy Information Administration; Bureau of Labor Statistics – Consumer Price Index.

***Note:** Analysis in the Congestion Report examines 2007 and 2009 annual data, to more accurately capture congestion trends. 2006 and 2008 data is provided for information only. **1** Real Gross Domestic Product for Washington is measured in chained 2000 dollars. Real personal income for Washington is measured in chained 2005 dollars. **2** Based on maximum throughput speed thresholds (85% of posted speed). **3** Based on below 70% of posted speed; see page 14 for an explanation on lane miles. **4** For central Puget Sound Corridors, duration of congestion is calculated with 45 mph as threshold. **5** 2008 data not available for four of the 38 routes. For more information see gray box on p. 15 of the 2009 Annual Congestion Report. **6** Inflation adjusted through the Consumer Price Index.

Measuring Delay and Congestion Annual Report

2010 Congestion Report Executive Summary: Looking at 2009 data

The 2010 annual Congestion Report examines 2009 calendar year data focusing on the most traveled commute routes in the central Puget Sound region, and where data are available around the state. The Congestion Report's detailed analysis shows where and how much congestion occurs, and the trends on the state highway system.

Economic recession, and WSDOT's Moving Washington projects and strategies, helped reduce congestion in 2009

The dynamics of the economic recession, and the completion of numerous WSDOT Moving Washington projects helped reduce congestion on state highways in 2009. Overall, individuals in Washington traveled over 300 miles less in 2009 compared to 2007 with per capita vehicle miles traveled (VMT) dropping from 8,779 miles to 8,467 miles.

Statewide, travel delay on state highways declined by roughly 21% in 2009 compared to 2007. On major Puget Sound corridors travel delay was reduced by 38%. Commute times and reliability also improved on most of the tracked high-demand commute routes in the central Puget Sound.

2010 Congestion Report Executive Summary of measures and results

↑ Trend is moving in a favorable direction. ↔ Trend is holding. ↓ Trend is moving in an unfavorable direction.

	Trend		Page
Statewide indicators: Percent system congested, Hours of delay, and vehicle miles traveled			
Total statewide delay Statewide delays, relative to posted speeds and maximum throughput speeds (70%-85% of posted speed), decreased by 15% and 21% respectively. The reduction in delays indicates that many highways across the state became less congested between 2007 and 2009.	Total statewide vehicle hours of delay declined by 21% relative to maximum throughput speeds.	↑	13
Per capita delay On a statewide per capita basis, between 2007 and 2009, delay was reduced from about 4.9 hours per person per year to 3.8 hours per person per year, as measured using maximum throughput speeds.	Per capita delay declined by 22% between 2007 and 2009 relative to maximum throughput speed.	↑	13
Percent of the system congested Roughly 5.6% of state highways (in lane miles) were congested in 2007, meaning they dropped below 70% of posted speeds. This measure dropped to 5.2% in 2009, mirroring the decrease in travel seen throughout the country. As expected, most of the congested state highways are in urban areas.	Percent of state highways that are congested show a .4% decrease from 2007 (5.6%) to 2009 (5.2%).	↑	14
Vehicle miles traveled (VMT) Total VMT on all public roads dropped by 0.9% between 2007 and 2009 while it increased by 1.8% between 2008 and 2009. VMT on state highways dropped by 1.6% between 2007 and 2009 while it increased by 2.3% between 2008 and 2009. Associated with this, statewide (all public roads) per capita VMT dropped by 3.6% between 2007 and 2009 while improving by 0.3% between 2008 and 2009.	Per capita VMT on all public roadways declined by 3.6% between 2007 and 2009.	↑	14
Central Puget Sound corridors: Hours of delay and vehicle miles traveled			
Vehicle hours of delay on major central Puget Sound corridors Between 2007 and 2009, vehicle hours of delay relative to the posted speeds (60 mph) and maximum throughput speeds decreased by approximately 27% and 38% respectively. All surveyed corridors saw reduced delay.	Travel delay dropped by 38% relative to maximum throughput speeds.	↑	15
Vehicle miles traveled (VMT) dropped overall in the central Puget Sound in 2009. On the selected major Puget Sound corridors, VMT dropped by 0.3% in 2009 compared to 2007. The steepest drop was over 4% seen on I-90 while VMT on I-5 dropped the least at 0.6%.	VMT dropped by 0.3% in 2009 compared to 2007.	↑	15
Central Puget Sound corridors: Throughput productivity			
Throughput productivity compares the observed average vehicle flow (vehicles per hour per lane – vphpl) for a selected location to the observed highest average five minute vehicle flow at that location. All eight selected Puget Sound monitoring locations show improvements in vehicle throughput from 2007 to 2009. I-405 at SR 169 in Renton continues to experience the greatest loss in productivity, as congested conditions result in a 38% reduction in vehicle throughput during the morning peak period in 2009.	All eight locations saw improvements in throughput productivity between 2007 and 2009.	↑	16

Executive Summary of Measures & Results – continued

2010 Congestion Report Executive Summary of measures and results

⇧ Trend is moving in a favorable direction. ⇔ Trend is holding. ⇩ Trend is moving in an unfavorable direction.

	Trend		Page
Travel times analysis: High demand Puget Sound commute routes			
Average peak travel times improved on 31 of the 38 surveyed high demand commute routes between 2007 and 2009, with improvements ranging from one to 16 minutes. Average travel times increased on three SR 520 EB evening commutes by several minutes (Seattle to Bellevue, Seattle to Redmond, and Bellevue to Redmond) during the same period and remained unchanged on four.	Average peak travel times improved on 31 commutes, remained the same on 4, and became worse on 3 when comparing 2009 to 2007.	⇧	18
Duration of congested period The duration of congestion—defined as the period of time in which average speeds fall below 45 mph—improved on 34 routes between 2007 and 2009 with improvements ranging from 15 minutes to 3 hours 20 minutes. One route did not show a change in the duration of congestion, and three routes do not have average speeds fall under the 45 mph threshold.	Duration of congestion improved on 34 commutes, remained the same on 1, no congestion on 3 when comparing 2009 to 2007.	⇧	18
95% reliable travel times Between 2007 and 2009, 28 of the 38 high demand commutes saw improvements in 95% reliable travel time, with improvements ranging from 1 to 21 minutes. Six commutes saw reliable travel times worsen between one and six minutes, while reliable travel times remained unchanged on four commutes.	Reliable travel times improved on 28 commutes, remained the same on 4, and became worse on 6 when comparing 2009 to 2007.	⇧	27
Additional performance analyses for the high demand Puget Sound commute routes			
Range of percentiles reliability analysis Reliability percentile analysis looks at travel times at the 50th percentile (median), 80th percentile, 90th percentile, and 95th percentile values for the 38 high demand routes. The percentile analysis also provides a way to track changes in travel times over the years at a finer level, in order to evaluate operational improvements.			27
Percentage of days when speeds were less than 35 mph — Stamp graphs The most visual evidence of peak periods improving in 2009 can be seen in the graphs on pages 31-32. These 'stamp graphs,' comparing 2007 and 2009 data, show the percentage of days annually that observed speeds are at or below 35 mph (severe congestion).			30
Travel time comparison graphs The bar graphs on pp. 44-46 show four of the travel time performance indicators during the peak five minutes interval for weekday: travel times at posted speeds, travel time at maximum throughput speeds (50mph), average peak five minute travel times, and 95% reliable travel times. For each of the surveyed high-demand commutes general purpose (GP) and HOV travel times are shown. The graphs also illustrate the travel time advantages HOV lane users have compared to GP lane users.			44
Travel time analysis: 14 additional Puget Sound commutes			
In addition to the high demand commute routes, WSDOT tracks 14 other commutes in the central Puget Sound where data are available. Average travel times for nine of these 14 routes improved by 1 to 4 minutes between 2007 and 2009. Three routes showed an increase in average travel times with two unchanged in 2009 compared to 2007. In terms of the 95% reliable travel time, seven of the routes saw improvements in travel times ranging from 1 and 8 minutes between 2007 and 2009, with five getting worse by couple of minutes while the remaining two show no change.	95% reliable travel times improved on 7 of 14 commutes, remained the same on 2, and became worse on 5 between 2007 and 2009.	⇧	33
Travel time analysis: Spokane commutes			
For 2009, Incidents remain the major cause of delay in the corridor. The significant reduction in 95% reliable travel time can be attributed to higher than normal travel times documented in 2007 due to a major I-90 construction project. Reliable travel times for Spokane remain good, being less than 1 minute than travel times at posted speeds. Spokane traffic volumes on I-90 decreased this past year with a peak flow near Altamont Street of 109,000 vehicles per day. This is a decrease of 4.4% since 2007. An overall decrease was measured not only in volume but also vehicle miles traveled which decreased by 7% during the peak periods in 2009 as compared to 2007.	Average peak travel time decreased on both routes. Reliable travel times also decreased on both tracked Spokane commutes.	⇧	34

Executive Summary of Measures & Results – continued

2010 Congestion Report Executive Summary of measures and results

↑ Trend is moving in a favorable direction. ↔ Trend is holding. ↓ Trend is moving in an unfavorable direction.

	Trend		Page
HOV lane performance			
HOV Lane reliability standard The reliability standard requires the HOV lane to maintain a speed of 45 mph for 90% of the peak hour. In 2007, five of 14 HOV commute corridors met the reliability standard; eight of 14 HOV commute corridors met the reliability standard in 2009. Of the six that did not, five of the seven evening peak commutes have such high traffic volumes that the corridors are below the HOV performance standard; one of the seven morning peak commutes is also below the performance standard.	8 of 14 HOV commute corridors met the reliability standard in 2009.	↑	35
Person throughput Most HOV lanes continue to be more effective at moving more people during peak periods than general purpose (GP) lanes. At the monitoring locations, the average HOV lane carries about 33% of the people on the freeway in the morning and evening peak periods. At six of the ten monitoring locations HOV lanes move more people than adjacent GP lanes.	In 2007, HOV lanes carried more people than average GP lanes at 8 of 10 monitoring locations; in 2009 it was 6 of 10.	↓	37
HOV Lane travel times Average travel times and 95% reliable travel times are almost always faster in HOV lanes than in general purpose (GP) lanes. In 2009 average HOV lane travel times beat GP lane travel times on 39 out of 48 routes. Forty-four HOV routes provide better reliability (95% reliable travel time) than their general purpose lane counterparts.	In terms of average travel time, HOV lanes are faster than GP lanes in 39 of 48 routes.	↑	38
On-going tracking of performance for operational strategies			
NEW Operate efficiently: Incident Response (IR) annual report This year's Congestion Report introduces an annual look at the 2007 and 2009 data. This articles introduces the refined definitions for incident classification, and presents new research addressing congestion caused by incidents.			50

Introduction

Highlights from the Annual Congestion Report

Individuals drove 300 miles less during 2009 in Washington with per capita vehicle miles traveled declining by 4% since 2007.

Statewide vehicle hours of delay declined by 21% between 2007 and 2009, saving Washington drivers and businesses an estimated $159 million in lost productivity due to delay.

In 2009, less of the highway system was congested than in 2007 (5.6% in 2007 vs 5.2% in 2009). In terms of real numbers, 950 of 18,260 lane miles were congested in 2009.

Vehicle hours of delay on major Puget Sound corridors declined by 38% between 2007 and 2009.

Travel times and reliability improved on most of the 38 tracked high demand commute routes in the Puget Sound: average travel times improved on 31 commute routes and reliable travel times improved on 28 routes. The duration of the congested period decreased on 34 of the commute routes.

Moving Washington projects are being implemented at strategic locations on the state highway system to help fight congestion.

Washington drivers spent less time stuck in traffic in 2009

The dynamics of economic recession, and the completion of numerous WSDOT congestion relief projects helped reduce congestion on state highways in 2009. On a per person basis, people in Washington spent around one hour less in congestion in 2009 (3.8 hours of delay per person) compared to 2007 (4.9 hours of delay per person). Overall, travel delay on state highways was reduced by roughly 21% in 2009 compared to 2007. On some of the most heavily traveled Puget Sound corridors, delay was reduced by 38%. Commute times also improved on most of the 38 major high-demand commute routes in the central Puget Sound.

The reduction in congestion is primarily a result of decreased travel demand during 2009. Despite the stabilization of gas prices during 2009, the reduction in travel was further influenced by the economic recession that resulted in job losses which hit Washington hard. As a result, individuals in Washington drove 300 miles less in 2009 compared to 2007.

Congestion and the economy

When Washington's economy recovers, economic growth will likely result in more drivers spending more time on the road. It is not surprising that congestion is often used as an indicator of economic health: a strong economy drives growth in travel demand which results in increasing congestion. More specifically, the growth in travel demand, particularly during peak periods, consumes the limited capacity of the highway system, leading to increased congestion. This recurring congestion occurs during peak travel periods for a simple reason – the number of vehicles trying to use the highway system exceeds the available capacity. Non-recurring congestion, resulting from incidents such as weather, roadway construction, collisions, or vehicle breakdowns, further reduces the operating efficiency of the highway system. The Federal Highway Administration (FHWA) estimates that recurring congestion makes up 42% of the total, with non-recurring events accounting for the remaining 58% of congestion.

Although congestion can be used as an indicator of economic growth, it also has negative economic consequences. Statewide delay compared to maximum throughput speeds cost drivers and businesses $767 million in 2007. In 2009, delays due to congestion had been reduced sufficiently to save drivers $159 million: the 2009 cost of delay was about $608 million.

Moving Washington: WSDOT's balanced program to fight congestion

Faced with these realities, WSDOT applies three balanced strategies to fight congestion – operate efficiently, manage demand, and add capacity strategically. By strategically adding capacity, WSDOT targets bottlenecks and chokepoints in the transportation system. However, because of limited resources, WSDOT understands that adding capacity cannot be the only solution for solving the congestion problem. That is why WSDOT uses operational strategies to maximize the efficiency of the existing transportation system (operate efficiently). WSDOT manages demand by providing alternatives to drive-alone commutes between and within modes of travel and encouraging the traveling public to use them. Performance results show that Moving Washington strategies and projects are making a difference around the state to relieve congestion. For details of specific examples, please see pp. 47-65.

Overview of WSDOT's congestion performance measures

This year's annual Congestion Report examines 2009 calendar year data

The 2010 annual congestion report examines 2009 calendar year data focusing on the most traveled commute routes in the central Puget Sound region, and where data are available around the state. The Congestion Report's detailed analysis shows where and how much congestion occurs, and whether it has grown on state highways. The report compares system data over a two-year period (2007 vs. 2009) to more accurately identify changes and trends seen on the state highway system often missed looking at a one-year comparison.

WSDOT's congestion measurement principles

WSDOT collects real-time data for 52 commute routes in the Puget Sound region, two commute routes in Spokane, and on other highways statewide. In the central Puget Sound region alone, data are collected from over 5,000 loop detectors embedded in the pavement of the 709 centerline miles. Using this quality controlled data, WSDOT analyzes system performance by using a variety of performance measures. In tracking and communicating performance results, WSDOT adheres to congestion measurement principles which call for the use of accurate, real-time data rather than modeled data in order to better communicate with the public, and using language and terminology that is meaningful to the public ("Plain English").

WSDOT's Congestion measurement principles

- Use real-time measurements (rather than computer models) whenever and wherever possible.
- Use maximum throughput as the basis for congestion measures.
- Distinguish between and measure both congestion due to incidents (non-recurrent) and congestion due to inadequate capacity (recurrent).
- Show how reducing non-recurrent congestion from incidents will improve the travel time reliability.
- Demonstrate both long-term trends and short-to-intermediate-term results.
- Communicate possible congestion fixes using an "apples-to-apples" comparison with the current situation. For example, if the trip takes 20 minutes today, how many minutes less will it be if WSDOT improves the interchange?
- Use "Plain English" to describe measurements and results.

Key congestion performance measures

Measure	Definition
Average peak travel time	The average travel time on a route during the peak five-minute interval for all weekdays of the calendar year.
95% Reliable travel time	Travel time with 95% certainty (i.e. on-time 19 out of 20 work days).
Maximum Throughput Travel Time Index (MT^3I)	The ratio of average peak travel time compared to maximum throughput speed travel time.
Percent of days when speeds are at or below 35 mph	Percentage of days annually that observed speeds for one or more five minute interval is at or below 35 mph (severe congestion) on key highway segments.
Vehicle throughput	Measures how many vehicles move through a highway segment/spot location in an hour.
Lost throughput productivity	Percentage of a highway's lost vehicle throughput due to congestion when compared to the maximum five-minute weekday flow rate observed at a particular location of the highway for that calendar year.
Delay	The average total daily hours of delay per mile based on the maximum throughput speed of 50 mph measured annually for weekdays as cumulative (total) delay.
Percent of the system congested	Percent of total state highway lane miles that drop below 70% of the posted speed limit.
Duration of congestion	The time period in minutes when speeds fall below 45 mph.
HOV Lane reliability	An HOV lane is deemed "reliable" as long as it maintains an average speed of 45 mph for 90% of the peak hour.
Person throughput	Measures how many people, on average, move through a highway segment during peak periods.
Before and After analysis	Before and After performance analysis of selected highway congestion relief projects and strategies.
Average incident clearance time (Statewide)	Operational measure defined as the time from notification of the incident until the last responder has left the scene for all incidents responded to by WSDOT Incident Response personnel statewide.

Overview of performance measures, continued

Measures that matter to drivers: speed, travel times, and reliability

Travel times and reliable travel times are important measures to commuters and businesses in Washington State. Measuring the time to get from point A to point B is one of the most easily understood congestion measures and is one that matters to drivers whenever they make a trip. Reliability matters to drivers because it is important to be on time all the time.

WSDOT's Congestion Report examines 52 tracked commute routes in the Puget Sound region, reporting in detail on 38 high-demand routes, as well as two Spokane commute routes and travel times for HOV lanes. The metrics used in the travel time analysis include the average peak travel time, 95% reliable travel time, the duration of congestion, and the percent of weekdays when average travel speeds are at or below 35 mph. The performance of an individual route is compared to data from previous years.

With the 2009 Congestion Report WSDOT introduced expanded reliability analysis looking at a range of travel time percentiles. This analysis provides a way to track travel time changes at a finer level in order to evaluate operational strategies.

Real-time travel times for key commutes around Puget Sound, Spokane, and Vancouver are available to the public and updated every five minutes on the WSDOT web site at www.wsdot.wa.gov/traffic/seattle/traveltimes/.

Measuring vehicle miles traveled (VMT)

WSDOT examines vehicle miles traveled (VMT) as its volume metric for each commute route: VMT during peak hours in urban areas and all day across the state. WSDOT continues to examine factors such as the use of public transportation, population change, employment rates, and fuel prices as they relate to volume and travel time changes.

VMT allows WSDOT to quantify travel along a route. It is simply the vehicle count multiplied by a length of roadway. Because traffic volumes vary along a route, each location's traffic volume is multiplied by the representative length of the route, and these values are added up to obtain a route's VMT. WSDOT uses this measure to better understand the number of trips taken on certain commute routes, as well as total miles traveled on state highways, to predict future demands and establish improvement needs.

Traffic volume is a vehicle count at a given roadway location. It is measured by a detector in each lane at the location. WSDOT has loop detectors spaced at roughly half-mile intervals throughout the central Puget Sound freeway network, and at various locations on the highway system statewide.

In 2008, the Legislature established per capita VMT as the primary measure connecting congestion and greenhouse gas emissions. WSDOT was directed to help the state achieve its goal of reducing VMT as part of the effort to reduce emissions (see page 15 for more information).

WSDOT uses maximum throughput as the basis for congestion performance measurement

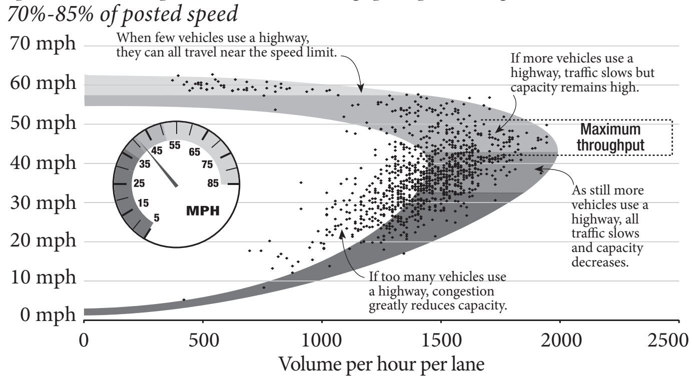
From the perspective of operating the highway system as efficiently as possible, the speed at which the highest number of vehicles can move through a highway segment (maximum throughput) is more meaningful than posted speed as the basis of measurement. It is logical for WSDOT to aim towards providing and maintaining a system that yields the most productivity or efficiency, rather than focus on providing a system that is free flowing but in which fewer vehicles can pass through a segment during peak travel periods.

Maximum throughput is achieved when vehicles travel at speeds between 42 and 51 mph (roughly 70% to 85% of a posted 60 mph speed). At maximum throughput speeds, highways are operating at peak efficiency because more vehicles are passing through the segment than there would be at posted speeds. This happens because drivers at maximum throughput speeds can safely travel with a shorter following distance between vehicles than they can at posted speeds.

Maximum throughput speeds vary from one highway segment to the next depending on prevailing roadway design and traffic conditions, such as lane width, slope, shoulder width, pavement conditions, traffic composition, conflicting traffic movements, heavy truck traffic, presence or absence of median barriers, etc.

Understanding maximum throughput: An adaptation of the speed/volume curve

I-405 northbound at 24th NE, 6am-10am weekdays volume in May 2010
Speed limit 60 mph; Maximum throughput speed ranges between: 70%-85% of posted speed



Data source: WSDOT Northwest Region Traffic Office.

Overview of performance measures, continued

WSDOT state highway congestion measurement speed thresholds

Measure	Threshold	Description
Posted speed	60 mph	Vehicles are moving through a highway segment at approximately the posted speed. However since there are fewer vehicles on the highway, the highway segment is not reaching its maximum productivity under these conditions.
Maximum throughput speeds	70%-85% of posted speed (About 42-51 mph)	Vehicles are moving slower than the posted speed and the number of vehicles moving through the highway segment is higher. These speed conditions enable the segment to reach its maximum productivity in terms of vehicle volume and throughput (based on the speed/volume curve). This threshold range is used for highway system deficiency analysis.
Duration of congested period (urban commute routes)	Duration triggered when vehicle speeds drop below 75% of posted speeds (45 mph)	The average weekday peak time period (in minutes) when average vehicle speeds drop below 45 mph. Drivers have less-than-optimal spacing between cars, and the number of vehicles that can move through a highway segment is reduced. The highway begins to operate less efficiently under these conditions than at maximum throughput.
Percent of state highway system congested	Less than 70% of posted speeds	Percent of total state highway lane miles that drop below 70% of the posted speed limit.
Severe congestion	Less than 60% percent of posted speed (at or below 35 mph)	Speeds and spacing between vehicles continue to decline on a highway segment and highway efficiency operates well below maximum productivity.

The maximum throughput speed is not static and can change over time as conditions change. Ideally, maximum throughput speeds for each highway segment should be determined through comprehensive traffic studies and validated by field surveys. For surface arterials, maximum throughput speeds are difficult to predict because they are influenced by conflicting traffic movements at intersections.

WSDOT uses the maximum throughput standard as a basis for measurement to assess travel delay relative to a highway's most efficient condition at optimal flow speeds (about 51 mph). For more information on changes in travel delay performance, please see p. 13.

WSDOT also uses maximum throughput as a basis for evaluating the system through the following measures:

- Total delay and per capita delay
- Percent of the system that is congested
- Lost throughput productivity
- Maximum Throughput Travel Time Index—MT³I (For a more detailed discussion of this measure, please see p. 21)
- Duration of the congested period

Measuring total delay and per capita delay

Delay is typically calculated as the difference between actual travel times and travel times at posted speeds. WSDOT uses maximum throughput speeds, rather than posted speeds, to measure delay relative to the highway's most efficient operating condition. WSDOT measures travel delay statewide and on five major commute corridors in the central Puget Sound. In addition to measuring the total hours of delay, WSDOT also evaluates annual per capita delay and the cost of delay to drivers and businesses.

Measuring the percent of the highway system that is congested

This measure allows WSDOT to evaluate what percentage of the system that the agency manages is indeed congested. This measure is calculated by dividing the number of lane miles where speeds drop below 70% of posted speeds by total lane miles. This measure also differentiates what proportion of the congested lane miles are in urban areas versus rural areas of the state.

Evaluating vehicle throughput productivity

Highways are engineered to move specific volumes of vehicles based on the number of lanes and other design aspects. Highways are not necessarily operating at their maximum efficiency when all vehicles are moving at 60 mph (the typical urban highway posted speed limit in Washington). As congestion increases, speeds decrease, and fewer vehicles pass through the corridor being measured. Throughput productivity may decline from a maximum of about 2,000 vehicles per hour per lane traveling at speeds between 42-51 mph (100% efficiency) to as low as 700 vehicles per hour per lane (35% efficiency) when traveling at speeds less than 30 mph.

Measuring travel time reliability

WSDOT uses the 95th percentile reliable travel time as its key reliability metric for the high demand Puget Sound commute routes. Percentile measures are resistant to outlier values,

Overview of performance measures / Highway System Plan

generally the highest values. Using a range of percentiles allows WSDOT to track changes in reliable travel times over the years at a finer level, to better evaluate operational improvements. Changes in the 80th and 90th percentiles are likely to represent travel times that are the result of routine incidents and other factors that the agency can influence with operational strategies. See pp. 27-29 for detailed reliability data and p. 48 for more on operational strategies such as active traffic management.

WSDOT examines 'high occupancy vehicle' HOV lane performance

WSDOT uses several measures to evaluate HOV lane performance. WSDOT and the Puget Sound Regional Council (PSRC) adopted a reliability standard for HOV lanes which states that for 90% of the peak period, HOV lanes should maintain an average speed of 45 mph. This is the basis for WSDOT's HOV reliability measure. WSDOT also measures person throughput to gauge the effectiveness of HOV lanes in carrying more people compared to general purpose (GP) lanes. WSDOT also reports on HOV lane travel times as compared to GP lane travel times.

Before & After analyses of congestion relief strategies and projects

As of September 30, 2010, WSDOT has completed 282 projects funded by the 2003 and 2005 gas tax packages, of which 70 were congestion relief projects. To measure how well these investments are mitigating congestion, WSDOT has implemented Before and After project studies to analyze impacts on travel times and delay. On highway segments without in-pavement loop detectors, data is collected by using automated license plate recognition cameras or moving test vehicle. Before and After performance evaluations will be expanded to all congestion relief projects in the coming years. These studies will evaluate the benefits of Moving Washington strategies and projects that operate efficiently, manage demand, and add capacity strategically. For more information on Moving Washington, please see pp. 47-65.

Evaluating operational strategies: Incident Response

New for this year's Congestion Report is a look at the Incident Response (IR) Program's annual performance data for calendar year's 2007 vs. 2009. Quarterly updates will continue to be published in the main *Gray Notebook*. For more information on this important congestion management tool, please see p. 50.

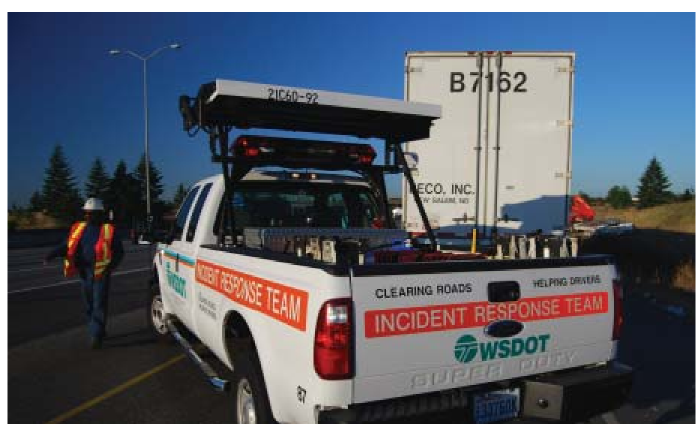
Highway System Plan updates

In the 2010 update to the Highway System Plan (HSP), WSDOT sets out the strategic goals and strategies it will use to manage Washington's highway system under the budget constraints currently facing the agency and the state. A key goal is to optimize the capacity of existing highway facilities whenever possible by improving the road's maximum throughput.

WSDOT identifies locations which could benefit from mobility improvements by examining where congestion most affects the flow of through–traffic on the main roadway. When average speeds for mainline traffic flow at peak hours are less than 70% of the posted speed – below maximum throughput – the location is considered for improvements.

The locations proposed in the Highway System Plan were identified by analyzing computer models. These models do not reflect the impact of congestion associated with local roads, ramps, interchanges, weather, special events, construction, collisions, or other incidents. WSDOT does take many of these other factors into consideration when conducting more detailed analysis, however, as it develops the most cost-effective solutions to include in the agency's updated Highway System Plan.

Computer modeling is especially helpful in long-range planning, predicting conditions at locations where peak-hour travel speeds would fall below 70%of the posted speed decades from now, in 2020 and 2030. Of these locations, the highway segments with the most significant delay regionally were chosen as study corridors for the update of the Highway System Plan. WSDOT will be focusing its attention on low-cost solutions that can improve throughput at these locations.



WSDOT Incident Response teams clear roads and help drivers across the state.

Statewide Congestion Indicators and Travel Delay

Statewide Travel Delay

Travel delay is estimated both relative to the posted speed limit and relative to maximum throughput speeds. For both methods, WSDOT measures the sum of vehicle delay in hours across an average 24 hour day to demonstrate the extent, severity, and duration of congestion. (See pages 9 and 11 for detailed discussion of these measures.)

Statewide delay decreases by 21% between 2007 and 2009

People spent fewer hours delayed in congestion in 2009 than in 2007. Time lost relative to posted speed decreased 15%; delay relative to the system's optimal speeds decreased 21%. Most of the delay was concentrated in the major urban areas as shown in the map on page 14.

Per person statewide, time lost due to delay was reduced from about 4.9 hours/person/year to 3.8 hours/person/year relative to maximum throughput speeds.

Cost of delay to Washington drivers and businesses drops by $159 million

Statewide delay compared to optimal flow speeds cost drivers and businesses $767 million in 2007. In 2009, that amount had dropped by $159 million to $608 million in delay. When measured against posted speeds, delay cost drivers and businesses $1,045 million in 2009, $185 million less than in 2007 ($1,230 million).

Calculating the cost of delay

The cost of delay is calculated by applying monetary values to the estimated hours of delay incurred by passenger and truck travel plus additional vehicle operating costs. The value of time for passenger trips was assumed to be half of the average wage rate.

Statewide per capita delay drops in 2009
Hours of delay per year

	2007	2009	%Δ
Delay per capita (Relative to maximum throughput speed)	4.9	3.8	-22%
Delay per capita (Relative to posted speed)	7.9	6.6	-16%
Statewide population	6,488,000	6,668,200	+2.8%

Data source: WSDOT Urban Planning Office.

Congestion, or delay, imposes costs for the lost time of travelers and higher vehicle operating costs from things such as wasted fuel and other effects of stop-and-go driving. Truckers, shippers, and their customers also bear large costs from traffic delay. Delay's direct and indirect impacts include:

- Increased needed time for personal travel
- Increased needed time for business travel
- Increased vehicle operating expense
- Direct shipper/recipient productivity lost
- Indirect (downstream) productivity lost
- Diminished opportunities for local economies to attract new businesses and residents
- Increased vehicle emissions from stop-and-go driving

Only the first three items were included in this year's estimates of delay.

Travel delay on state highways declines in 2009
All state highways: average weekday delay comparison (daily and annual) and estimated cost of delay on state highways (annual)
Comparing 2007 and 2009

	Daily average vehicle hours of delay (weekdays)			Total annual weekday vehicle hours of delay (in thousands)			Annual cost of delay on state highways (in millions of 2009 dollars)		
Actual travel compared to:	**2007**	**2009**	**% Δ**	**2007**	**2009**	**% Δ**	**2007**	**2009**	**% Δ**
Maximum throughput speeds (70%-85% of posted speed)	128,050	101,740	-21%	32,013	25,435	-21%	$767	$608	-21%
Posted speed	204,850	174,260	-15%	51,206	43,565	-15%	$1,230	$1,045	-16%

Data source: WSDOT Urban Planning Office.

Statewide Congestion Indicators and Travel Delay

Statewide Travel Delay and Other Statewide Congestion Indicators

The percentage of congested state highway lane miles decreased between 2007 and 2009

In 2009, 5.2% of the state highway system's total lane miles were congested: 950 of 18,260 highway lane miles saw speeds drop below 70% of their posted speed.

In 2008, 930 of 18,070 highway lane miles were congested: this percentage is also 5.2%. In 2007, 1,010 of 18,027 lane miles were congested. In the two years covered by this report, 233 (1.3%) more lane miles were added to the system, but 60 fewer miles were congested.

Percent of the state highway system that is congested decreased in 2009

For all lane miles	2007	2009
All state highways	5.6%	5.2%
Urban state highways	5.1%	4.7%
Rural state highways	0.5%	0.5%

Data source: WSDOT Urban Planning Office.

Note: Percent of lane miles that have average speeds below 70% of posted speed.

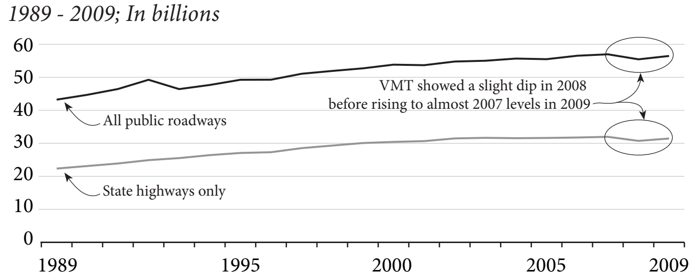
Statewide vehicle miles traveled fluctuates between 2007 and 2009

The annual vehicle miles traveled (VMT) on all public roadways in Washington decreased by nine-tenths of a percent in 2009 (56.46 billion) compared to 2007 (56.96 billion), including the rebound of 1.8% from the 2008 VMT of 55.45 billion.

Similarly, the VMT on state highways in Washington decreased by 1.6% in 2009 (31.46 billions) compared to 2007 (31.97 billion), including a rebound of 2.3% from the 2008 VMT of 30.74 billion.

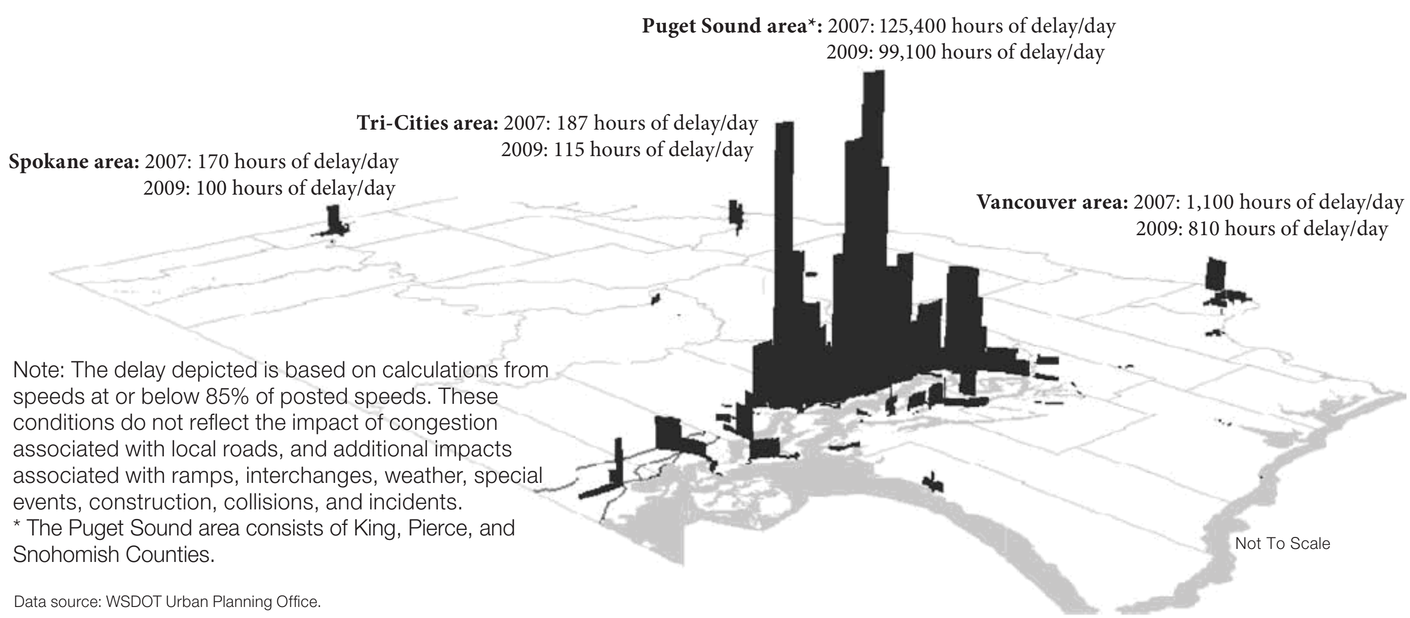
It follows that annual per capita VMT in Washington dropped 3.6% overall between 2007 (8,779 VMT per capita) and 2009

Annual vehicle miles traveled statewide
1989 - 2009; In billions



Data source: Statewide Travel and Collision Data Office (STCDO).

Schematic representation of statewide delay distribution on the state highway system
Delay estimates for major urban areas, 2007 compared to 2009

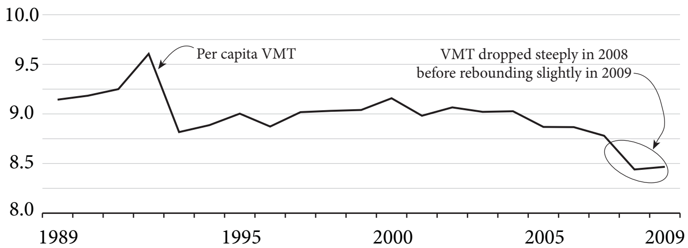


Note: The delay depicted is based on calculations from speeds at or below 85% of posted speeds. These conditions do not reflect the impact of congestion associated with local roads, and additional impacts associated with ramps, interchanges, weather, special events, construction, collisions, and incidents.
* The Puget Sound area consists of King, Pierce, and Snohomish Counties.

Data source: WSDOT Urban Planning Office.

Travel Delay on Major Puget Sound Corridors

Annual per capita vehicle miles traveled
1989 - 2009; In thousands



Data source: WSDOT Statewide Travel and Collision Data Office, Washington State Office of Financial Management.

(8,467 VMT per capita), including the modest rebound of 0.3% from the 2008 low of 8,440 VMT per capita.

WSDOT continues its efforts to understand and respond to the factors that influence VMT, to help the state achieve its goal of reducing per capita VMT 18% by 2020 as directed by RCW 67.01.440. The agency is refining its VMT forecasts while developing strategies to reduce greenhouse gas emissions from the transportation sector. WSDOT will report to the Governor and Legislature on this work in December 2010.

Reductions in delay seen on major central Puget Sound corridors

Consistent with the statewide patterns of delay reduction, daily vehicle hours of delay on major freeway corridors in the central Puget Sound region also decreased between 2007 and 2009. Average weekday vehicle hours of delay, relative to both the posted speed limit (60 mph) and maximum throughput speeds (50 mph), decreased by approximately 27% and 38% respectively. Delay on individual corridors decreased between 16% and 45% relative to posted speeds, and between 23% and 69% relative to maximum throughput speeds. I-90 and SR 167 experienced the largest decrease in delay relative to posted speeds (-45% and -42%) and to maximum throughput speeds (-69% and -68%). However, because the lengths and widths of these corridors are different, it is not meaningful to compare and rank the corridors.

Overall, VMT dropped in the central Puget Sound

Vehicle miles traveled (VMT) between 2007 and 2009 dropped in the central Puget Sound region. The steepest reduction was 4.3% seen on I-90, while VMT on I-5 dropped at just 0.6%. The decrease in travel in part explains the reduction in travel delay.

Central Puget Sound freeways: average weekday delay comparison, 2007 and 2009

	Lane miles		Vehicle hours of delay/weekday: Relative to posted speed (60 mph)			Vehicle hours of delay/weekday: Relative to maximum throughput speed (50 mph)			Vehicle miles traveled/weekday (VMT in thousands)		
State route	**2007**	**2009**	**2007**	**2009**	**%Δ**	**2007**	**2009**	**%Δ**	**2007**	**2009**	**%Δ**
I-5	395	411	20,167	15,329	-24%	10,568	6,982	-34%	7,744	7,698	-0.6%
I-90	101	101	2,141	1,187	-45%	659	201	-69%	1,580	1,512	-4.3%
SR 167	60	60	2,734	1,598	-42%	1,138	360	-68%	947	963	1.7%
I-405	209	213	12,966	9,165	-29%	7,654	4,546	-41%	3,507	3,554	1.3%
SR 520	61	61	3,577	3,017	-16%	2,180	1,689	-23%	1,019	1,022	0.3%
Total	**826**	**846**	**41,584**	**30,296**	**-27%**	**22,199**	**13,779**	**-38%**	**14,797**	**14,749**	**-0.3%**

Data source: WSDOT Urban Planning Office.

Notes: The article on delay examines individual corridors while the travel times analysis examines commutes which can include multiple corridors; the delay article examines VMT for all weekdays, while the travel time analysis looks at VMT for weekdays during AM peak (5 am to 10 am) and PM peak (2 pm to 8 pm) periods. VMT in the central Puget Sound region is for GP lanes only.

Throughput Productivity

Measuring Vehicle Throughput Productivity

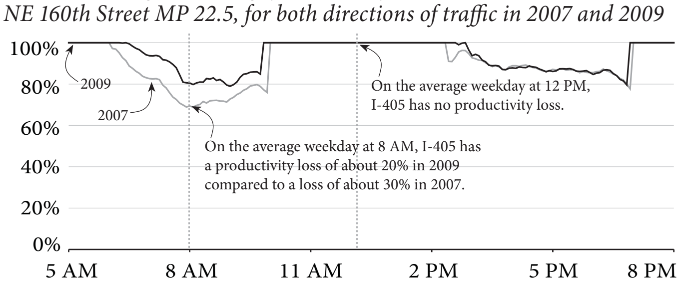
When a highway is congested, it serves fewer vehicles than it was designed to carry. Throughput productivity measures the percentage of a highway's capacity that is lost due to congestion: it is the difference between the maximum five minute flow rate observed during the year and the flow rate that occurs when vehicles move below the maximum throughput speed of 50mph.

Under ideal conditions, the maximum throughput of vehicles moving through a freeway segment can be as high as 2,000 vehicles per hour per lane (vphpl). Under congested conditions, however, the volume of traffic can be as low as 700 vphpl.

Improvement in throughput productivity can be measured in duration and in severity, and shown as a percentage of the achievable 100% maximum throughput capacity. The example below shows that morning congestion in 2009 (the black line) began later than in 2007 (the gray line); it was less severe (the highway operated at almost 80% of capacity in 2009, compared to 69% in 2007); and it ended sooner – for an overall improvement in relative throughput of 10%. For more information on the concept of maximum throughput and why WSDOT uses it as a basis for measuring congestion, see page 10.

Vehicle throughput productivity: example

Based on the highest average five minute flow rates observed on I-405 at NE 160th Street MP 22.5, for both directions of traffic in 2007 and 2009



Data source: WSDOT Urban Planning Office.

WSDOT uses highest observed optimal flow rate to determine throughput productivity

Not all highway lanes can achieve a maximum throughput of 2,000 vphpl because capacity varies depending on prevailing traffic conditions and roadway design. For this reason, the Congestion Report uses the highest average five-minute flow rate recorded in the analysis year as the basis for measuring throughput productivity lost to congestion. By using the highest observed optimal flow rate as the maximum throughput for each monitoring location, throughput analysis can more realistically determine the loss in productivity owed to change in traffic conditions.

Throughput productivity improved at all monitored locations of major Puget Sound freeways in 2009

Although the Puget Sound monitoring locations continue to show throughput productivity is less than 100% during peak periods, productivity has nevertheless improved at all locations. From 2007 to 2009 periods of lost throughput productivity were either less severe or shorter in duration due to lessening congestion. The graphs on page 17 compare observed *average* flow rates to the observed *highest average* five-minute flow rate to show the changes in vehicle throughput productivity for each monitoring location.

The greatest improvements in vehicle throughput were seen on three segments: I-405 at SR 169 in Renton, where throughput increased 17%; on I-90 at SR 900 in Issaquah (11% better); and I-405 at NE 160th Street (10% better). The smallest improvements were on I-5 at I-90 (1%) and SR 520 Evergreen Floating Bridge (2%).

The big gains at I-405/SR 169 might be from the improvement made through I-405/I-5 to SR 169 Stage 1 Widening project (details on pp. 54-55). This still leaves room for further improvements in throughput productivity that could happen as a result of I-405/I-5 to SR 169 Stage 2 Widening project that will be complete in 2011. However, that roadway segment currently operates at 62% of optimal throughput during peak travel times.

Changes in vehicle throughput at selected Puget Sound locations

2007 compared to 2009

	Percent of vehicle throughput lost to congestion		
Location	**2007**	**2009**	**Change**
I-5 at S 188th Street, near SeaTac (MP 153.0)	23%	16%	7%
I-5 at I-90 (MP 164.0)	23%	22%	1%
I-5 at NE 103rd Street, near Northgate (MP 172.0)	26%	20%	6%
I-90 at SR 900, in Issaquah (MP 16.5)	17%	6%	11%
SR 167 at 84th Avenue SE (MP 21.5)	21%	14%	7%
I-405 at SR 169, in Renton (MP 4.0)	55%	38%	17%
I-405 at NE 160th Street, in Kirkland (MP 22.5)	31%	21%	10%
SR 520 at Evergreen Point Floating Bridge (MP 1.5)	27%	25%	2%

Data source: WSDOT Urban Planning Office.

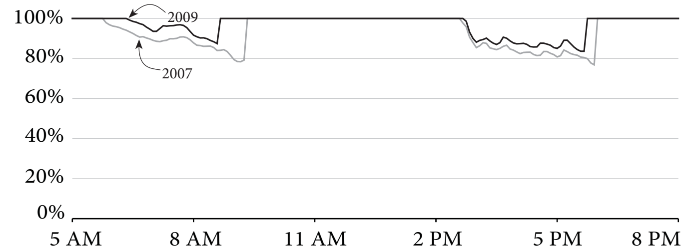
Measuring Throughput Productivity on Puget Sound Freeways

Throughput productivity at selected Puget Sound freeway locations

Based on the highest observed five minute flow rates, 2007 and 2009; Vehicles per hour per lane (vphpl)

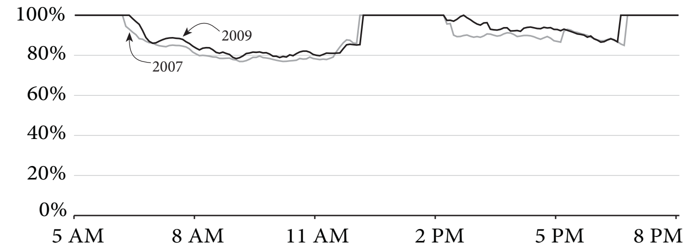
I-5 at S 188th Street (MP 153.0)

Based on highest observed 5 min flow rate; northbound = 1,920 vphpl, southbound = 1,690 vphpl



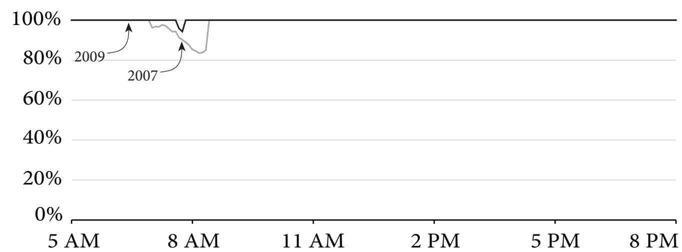
I-5 S at I-90 (MP 164)

Based on highest observed 5 min flow rate; northbound = 1,725 vphpl, southbound = 1,520 vphpl



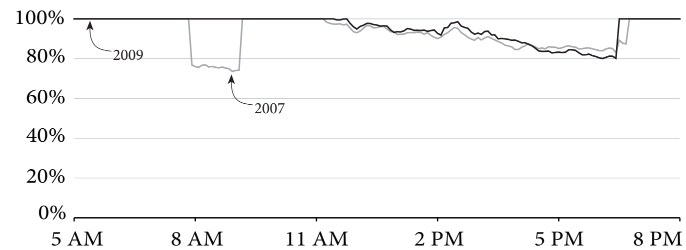
I-90 at SR 900 (MP 16.5)

Based on highest observed 5 min flow rate; westbound = 1,570 vphpl, eastbound = 1,670 vphpl



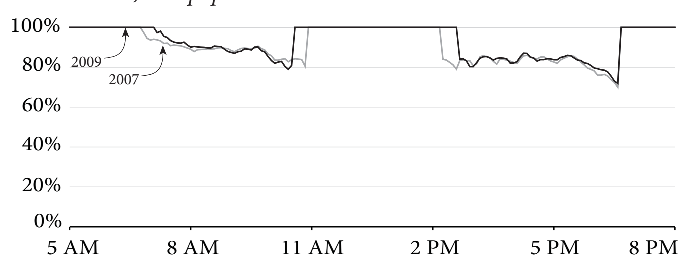
I-5 at NE 103rd Street (MP 172.0)

Based on highest observed 5 min flow rate; southbound = 1,530 vphpl, northbound = 1,600 vphpl



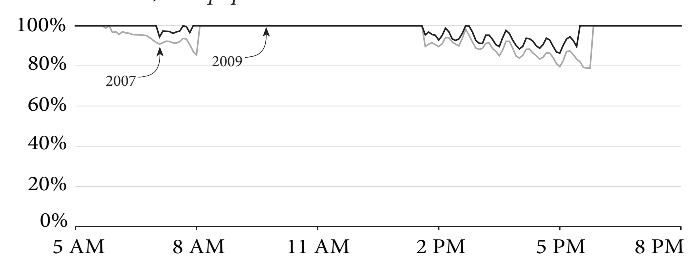
SR 520 at Evergreen Point Floating Bridge (MP 1.5)

Based on highest observed 5 min flow rate; westbound = 1,735 vphpl, eastbound = 1,785 vphpl



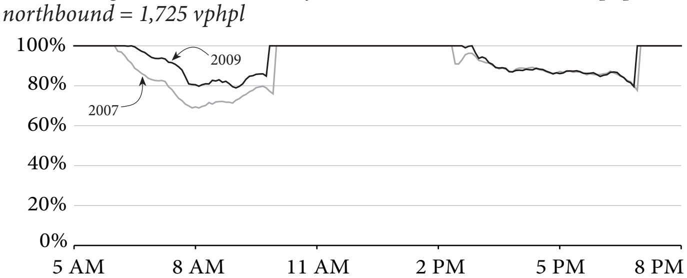
SR 167 at 84th Avenue SE (MP 21.50)

Based on highest observed 5 min flow rate; northbound = 1,550 vphpl, southbound = 1,620 vphpl



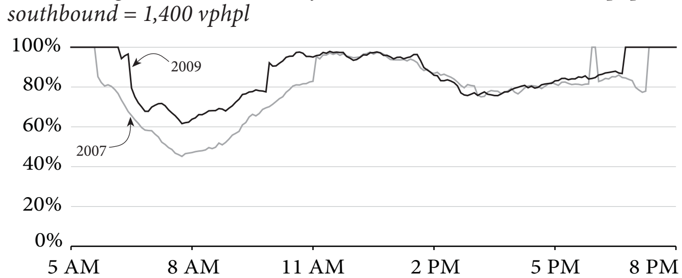
I-405 at NE 160th Street (MP 22.5)

Based on highest observed 5 min flow rate; southbound = 1,750 vphpl, northbound = 1,725 vphpl



I-405 at SR 169 (MP 4.0)

Based on highest observed 5 min flow rate; northbound = 1,600 vphpl, southbound = 1,400 vphpl



Data source: WSDOT Urban Planning Office.

Travel Time Analysis

Travel Time Analysis of Major Puget Sound Commute Routes

WSDOT uses the following performance measures as part of its travel time analysis for general purpose lanes:

- Average travel time
- Reliable travel time using multiple percentile thresholds
- Vehicle Miles Traveled (VMT) for traffic volume
- Average duration of the congested period
- Maximum throughput travel time index (MT^3I)

These measures are reported in the travel time tables on pp. 19-20 and 28-29. In addition to these measures, the travel time analysis also includes the percentage of days when speeds are at or below 35 mph, which WSDOT defines as severe congestion (see the stamp graphs on pp. 31-32).

In addition to the discussion of general purpose lane travel times, the annual Congestion Report includes an analysis of HOV lane travel times beginning on p. 38.

Average travel times drop on 31 of the 38 most-congested Puget Sound commute routes

Compared to 2007, travel times in 2009 improved on 31 of the 38 routes; four were unchanged, and three were longer. The three routes with longer travel times were all on evening commutes heading east on SR 520, and all were small increases of one to two minutes.

The Tukwila to Bellevue morning commute improved the most, dropping 16 minutes, (38%) from 42 minutes to 26 minutes. This is a direct result of the opening of the South Bellevue Widening project's new auxiliary lanes in January 2009, discussed in WSDOT's 2009 Congestion Report, p. 43.

The next biggest improvement was on the Federal Way to Seattle morning commute, which improved by 12 minutes (26%) from 47 to 35 minutes. This route is discussed in detail on page 24.

Other morning route travel time improved between one and seven minutes; evening route travel times improved between one and six minutes. Last year's Congestion Report also found that morning commutes experienced greater improvements than evening commutes.

The duration of the congested period dropped on 34 of the 38 surveyed high demand Puget Sound commute routes

WSDOT defines duration of the congested period (see page 11) as the period of time during which average speeds fall below 45mph, roughly the midpoint of the maximum throughput range of 70% to 85% of the posted speed limit (60mph). The 45 mph threshold is only used in calculating the duration of congested periods.

In 2009, the duration of congestion decreased on 34 routes, and was unchanged on one. Three other routes do not have speeds that regularly drop below 45 mph.

The biggest drop was on the Renton to Auburn evening commute, which went from three and a half hours of congested speeds in 2007 to just 10 minutes in 2009. The second most improved route was the Sea-Tac to Seattle morning commute, which dropped from just over five hours to just over two and a half hours. (See pages 24-26 for more details.) The rest of the decreases ranged from 20 minutes to two hours and 25 minutes.

How WSDOT compares travel times on different routes: Calculating MT^3I

To accurately compare travel times on routes of different lengths, WSDOT uses an index to measure the maximum throughput travel time. For instance, the Bellevue to Seattle evening and the Seattle to Redmond morning commutes discussed on this page had average travel times of 26 and 25 minutes respectively. At a glance, the routes appear roughly equal. However, the first route is 11 miles long and the second is 15; this difference means that using average travel times alone is not a meaningful comparison.

The maximum throughput travel time index (MT^3I) incorporates the expected travel time under maximum throughput conditions, taking into account the length of the route. An MT^3I of 1.0 would indicate a highway operating at maximum efficiency; as the MT^3I value increases, travel time performance deteriorates. In this example, the Seattle to Redmond morning commute has an MT^3I of 1.42, which means that the commute will take 42% longer than it would at maximum throughput speeds.

The Bellevue to Seattle via SR 520 evening route has an MT^3I of 2.07, which means that the commute route takes twice as long as the time it would normally take at maximum throughput speeds. The Bellevue to Seattle via SR 520 evening route is the longer commute of the two – and is currently worst of the 38 most congested Puget Sound commute routes. See page 21 for a more detailed discussion of this route.

Travel Time Analysis of Major Puget Sound Commute Routes, continued

Morning commutes: changes in travel time performance on 18 AM high demand commute routes

Morning (AM) peak period is between 5 am and 10 am; 2007 morning (AM) peak vs. 2009 morning (AM) peak of commuter rush (individual peak times vary) for an annual average weekday
Length of route in miles; all travel times in minutes; peak of commuter rush and duration of congestion expressed in hours and minutes

Route	Direction of travel	Length of route	Peak of commuter AM rush	Travel time on the route at: Posted speed	Travel time on the route at: Maximum throughput speed	Average travel time at peak of AM rush: 2007	2009	%Δ	Maximum throughput travel time MT³ Index: 2007	2009	VMT during peak period: %Δ in VMT	Duration of congestion (how long is average speed below 45mph): 2007	2009	Δ
To Seattle														
I-5 Everett to Seattle	SB	24	7:30	24	28	47	41	-13%	1.66	1.44	1%	2:40	1:40	-1:00
I-5 Federal Way to Seattle	NB	22	7:35	22	26	47	35	-26%	1.80	1.34	3%	4:05	1:50	-2:15
I-90/I-5 Issaquah to Seattle	WB/NB	15	7:45	15	19	25	21	-16%	1.35	1.13	-3%	1:35	*	-1:35
SR 520/I-5 Redmond to Seattle	WB/SB	15	7:45	15	18	22	21	-5%	1.24	1.19	-1%	1:10	0:35	-0:35
I-5–SeaTac to Seattle	NB	13	8:40	13	16	27	22	-19%	1.74	1.42	2%	5:05	2:40	-2:25
I-405/I-90/I-5 Bellevue to Seattle	SB/WB/NB	11	8:35	11	13	17	13	-24%	1.33	1.02	-3%	1:20	*	-1:20
I-405/SR 520/I-5 Bellevue to Seattle	NB/WB/SB	10	7:50	10	13	18	17	-6%	1.43	1.35	-1%	1:40	1:25	-0:15
To Bellevue														
I-5/I-405 Everett to Bellevue	SB	23	7:25	23	28	49	42	-14%	1.74	1.49	2%	2:55	2:00	-0:55
I-405 Lynnwood to Bellevue	SB	16	7:35	16	19	39	33	-15%	2.04	1.72	2%	3:20	2:25	-0:55
I-405 Tukwila to Bellevue	NB	13	7:40	13	16	42	26	-38%	2.60	1.61	16%	4:40	3:20	-1:20
I-5/I-90/I-405 Seattle to Bellevue	SB/EB/NB	11	8:50	11	13	17	15	-12%	1.34	1.18	-6%	2:15	*	-2:15
I-5/SR 520/ I-405 Seattle to Bellevue	NB/EB/SB	10	8:45	10	12	23	20	-13%	1.90	1.66	-1%	3:10	2:40	-0:30
I-90/I-405 Issaquah to Bellevue	WB/NB	9	8:40	9	11	17	15	-12%	1.50	1.32	-3%	3:05	1:40	-1:25
SR 520/I-405 Redmond to Bellevue	WB/SB	7	7:50	7	9	9	9	0%	1.05	1.05	-1%	*	*	*
To Other Locations														
I-405 Bellevue to Tukwila	SB	13	7:40	13	16	22	20	-9%	1.36	1.24	1%	1:45	0:30	-1:15
SR 167 Auburn to Renton	NB	10	7:40	10	12	18	15	-17%	1.53	1.28	4%	3:30	1:50	-1:40
I-5/I-90 Seattle to Issaquah	SB/EB	16	8:45	16	19	20	18	-10%	1.06	0.96	-5%	*	*	*
I-5/SR 520 Seattle to Redmond	NB/EB	15	8:45	15	18	27	25	-7%	1.53	1.42	-2%	2:45	2:20	-0:25

Data source: WSDOT Traffic Operations and the Washington State Transportation Center (TRAC) at the University of Washington.

Notes: In 2009, WSDOT changed its threshold for duration of congestion to begin at 45 mph, instead of 42 mph. All duration numbers for 2003-2007 were re-calculated at this new threshold. Duration of congestion is not limited to the AM peak, if it extends beyond the AM peak. In 2010, the maximum throughput travel time speed for the MT³I was re-set at 50 mph, instead of 51 mph. The MT³I was re-calculated for 2003-2008 data. In 2010, commute lengths have been rounded to integer values for publication purposes only.

The 95th percentile reliable travel times that were shown in this table in the 2009 Congestion Report (p. 17-18) are now reported on pp. 28-29.

* Indicates that speed did not fall below 45 mph of posted speed on a route.

Travel Time Analysis of Major Puget Sound Commute Routes, continued

Evening commutes: changes in travel time performance on 20 PM high demand commute routes

Evening (PM) peak is between 2 pm and 8 pm; 2007 evening (PM) peak vs. 2009 evening (PM) peak of commuter rush (individual peak times vary) for an annual average weekday

Length of route in miles; all travel times in minutes; peak of commuter rush and duration of congestion expressed in hours and minutes

				Travel time on the route at		Average travel time at peak of PM rush			Maximum throughput travel time		VMT during peak period	Duration of congestion (how long is average speed below 45mph)		
									MT³ Index					
Route	Direction of travel	Length of route	Peak of commuter PM rush	Posted speed	Maximum throughput speed	2007	2009	%Δ	2007	2009	%Δ in VMT	2007	2009	Δ
From Seattle														
I-5 Seattle to Everett	NB	24	5:15	24	28	43	41	-5%	1.51	1.44	0%	3:15	2:55	-0:20
I-5 Seattle to Federal Way	SB	22	4:05	22	27	37	32	-14%	1.39	1.21	1%	2:50	1:15	-1:35
I-5 Seattle to SeaTac	SB	13	4:10	13	16	20	19	-5%	1.29	1.22	-1%	1:45	0:25	-1:20
I-5/I-90/I-405 Seattle to Bellevue	SB/EB/NB	11	5:30	11	13	17	17	0%	1.34	1.34	0%	:45	0:45	0:00
I-5/SR 520/I-405 Seattle to Bellevue	NB/EB/SB	10	5:30	10	12	19	20	5%	1.57	1.66	1%	3:20	2:55	-0:25
I-5/SR 520 Seattle to Redmond	NB/EB	15	5:30	15	18	29	31	7%	1.64	1.76	0%	3:25	2:20	-1:05
I-5/I-90 Seattle to Issaquah	SB/EB	16	5:35	16	19	22	21	-5%	1.17	1.12	0%	*	*	*
From Bellevue														
I-405/I-5 Bellevue to Everett	NB	23	5:20	23	28	45	39	-13%	1.60	1.39	3%	3:45	2:55	-0:50
I-405 Bellevue to Lynnwood	NB	16	5:20	16	19	34	31	-9%	1.77	1.62	3%	3:40	3:20	-0:20
I-405 Bellevue to Tukwila	SB	13	4:25	13	16	34	29	-15%	2.10	1.79	3%	6:25	5:25	-1:00
I-405/I-90/I-5 Bellevue to Seattle	SB/WB/NB	11	5:25	11	13	28	24	-14%	2.19	1.88	-1%	4:20	2:40	-1:40
I-405/SR 520/I-5 Bellevue to Seattle	NB/WB/SB	10	5:25	10	13	26	26	0%	2.07	2.07	0%	5:05	4:45	-0:20
I-405/I-90 Bellevue to Issaquah	SB/EB	9	5:30	9	11	18	14	-22%	1.61	1.25	1%	3:55	1:45	-2:10
I-405/SR 520 Bellevue to Redmond	NB/EB	7	5:30	7	8	15	16	7%	1.84	1.97	3%	3:40	2:05	-1:35
From Other Locations														
I-5 Everett to Seattle	SB	24	3:25	24	28	41	37	-10%	1.44	1.30	2%	3:25	3:10	-0:15
I-90/I-5 Issaquah to Seattle	WB/NB	15	5:25	15	19	28	25	-11%	1.51	1.35	-1%	2:05	0:55	-1:10
SR 520/I-5 Redmond to Seattle	WB/SB	15	5:30	15	18	37	33	-11%	2.09	1.86	0%	4:30	3:55	-0:35
I-5 SeaTac to Seattle	NB	13	5:25	13	16	21	20	-5%	1.35	1.29	1%	3:05	1:10	-1:55
SR 167 Renton to Auburn	SB	10	3:45	10	12	19	14	-26%	1.62	1.19	3%	3:10	0:10	-3:00
I-405 Tukwila to Bellevue	NB	13	5:20	13	16	20	20	0%	1.24	1.24	2%	3:15	0:55	-2:20

Data source: WSDOT Traffic Operations and the Washington State Transportation Center (TRAC) at the University of Washington.

Note: In 2009, WSDOT changed its threshold for duration of congestion to begin at 45 mph, instead of 42 mph. All duration numbers for 2003-2007 were re-calculated at this new threshold. Duration of congestion is not limited to the PM peak, if it extends beyond the PM peak. In 2010, the maximum throughput travel time speed for the MT³I was re-set at 50 mph, instead of 51 mph. The MT³I was re-calculated for 2003-2008 data. In 2010, commute lengths have been rounded to integer values for publication purposes only.

The 95th percentile reliable travel times that were shown in this table in the 2009 Congestion Report (p. 17-18) are now reported on pp. 28-29.

* Indicates that speed did not fall below 45 mph of posted speed on a route.

Travel Time Analysis of Major Puget Sound Commute Routes, continued

Vehicle miles traveled up on half of high-demand routes

Vehicle miles traveled (VMT) increased on 19 of the 38 routes in 2009, reversing the general trend toward lower VMT in 2007 and 2008. The remaining 19 routes experienced lower or unchanged VMT.

During the morning commute, all north-south routes exhibited increased VMT while VMT on all east-west routes decreased. One possible explanation is that reduced regional demand for travel reduced congestion. This would improve the flow of traffic and allow more vehicles to move through the freeways during peak periods. The reduced freeway congestion could be drawing vehicles away from city streets, resulting in increased VMT on north-south routes. The decrease in VMT on east-west routes may be because there are no alternate routes to I-90 and SR 520 across Lake Washington. (See also the gray panel on page 26.)

The "worst" route: The Bellevue to Seattle via SR 520 evening commute

In 2009, the evening commute from Bellevue to Seattle via SR 520 replaced the morning commute from Tukwila to Bellevue as the route with the worst travel time compared to its length. The average travel time on this evening commute was 38 minutes, or twice the time needed when traveling at maximum throughput speeds. Of the 38 commute routes tracked, it had the highest ratio of average travel time to maximum throughput travel time at 2.07. The gray panel at right explains how WSDOT calculates this ratio and uses it to compare results on different routes.

Congestion on the Tukwila to Bellevue morning commute was greatly reduced after a series of congestion relief projects along I-405, which dropped the maximum throughput travel time index well below 2.0. The Bellevue to Seattle via SR 520 evening commute had been fairly consistent (at an average-to-maximum throughput travel time ratio of about 2.0) for the previous five years, but it has remained stagnant while the other route improved.

WSDOT is planning to address the Bellevue to Seattle SR 520 evening commute, along with several other congested routes on SR 520. The SR 520 Bridge Replacement and HOV project will provide two general purpose lanes and one HOV lane in each direction on the bridge, rebuild ramps and overpasses to improve traffic flow, add wider shoulders to allow stalled vehicles to move out of traffic, and provide a bike and pedestrian path across the lake.

In addition, as part of the Urban Partnership Agreement, WSDOT is working to introduce the "Four Ts" to help improve the flow of traffic on the bridge: tolling, technology, transit, and transportation demand management. Tolling is planned to begin in spring 2011, and variable speed signs are already in place. WSDOT is negotiating for the purchase of an additional 40 to 60 buses to add transit coverage across the bridge. WSDOT, Puget Sound Regional Council, King County Metro, and other partners are promoting transportation demand management for more efficient travel, such as carpools, vanpools, bicycling, walking, teleworking, and compressed work weeks.

Traffic starting to build on the freeways in Bellevue.

Factors Affecting Travel Times: 2007-2009

Factors affecting travel times in 2009 include economic recession and WSDOT mobility projects

As noted in WSDOT's semi-annual travel time reports published in *Gray Notebooks 34* (June 2009) and *36* (December 2009), economic factors and congestion relief projects were the two main factors affecting travel times in 2009.

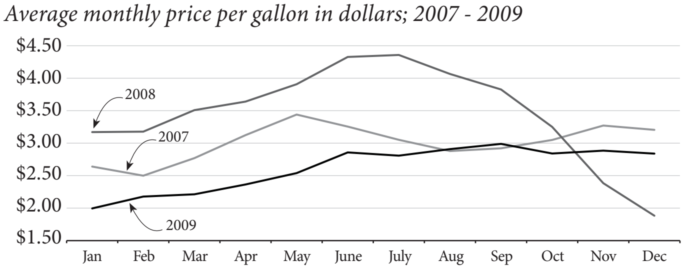
The 2007-2009 recession – from December 2007 through June 2009 – was the deepest on record since the Great Depression, in terms of job losses and other factors. At 18 months, it was also the longest. Before the recession, Washington had experienced healthy economic conditions, with low unemployment and a variety of thriving industries. But as in the rest of the country, consumer spending and employment growth have been slow to return to pre-recession levels – contributing to lessened travel demand across the region.

Gas prices declined 13% between 2007 and 2009

After spiking in July 2008 at the price of $4.36 a gallon, gas prices returned to lower levels in 2009, with an average annual price of $2.62 a gallon. 2009 price levels stayed mostly below those seen in 2007, when the average annual price was $3.01 a gallon. This 13% drop in gas prices between 2007 and 2009 implies that gas prices may not have played a significant role in the decreasing travel times and congestion during the period reviewed.

Average monthly gasoline prices in Washington

Average monthly price per gallon in dollars; 2007 - 2009



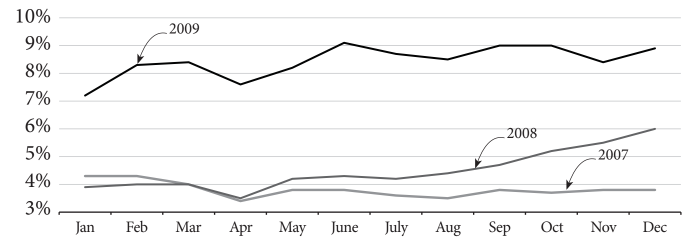
Data source: U.S. Dept. of Energy's Energy Information Administration.

Unemployment rates remain high

The average unemployment rate in the Seattle-Bellevue-Everett metropolitan area for 2009 was 8.4%, more than double that of the 2007 average rate of 3.8%. Unemployment in 2007 was particularly low in this region, hovering at or below the full employment rate for most of the year (around 4%). Both businesses and government agencies laid off workers during this recession, and have been slower-than-average to rehire. Many daily commuters on central Puget Sound highways in 2007 were out of work in 2009, traveling less frequently or outside of peak periods. This drop in travel demand can account for some of the improvement in travel times and some reduction in traffic volumes.

Unemployment rate for the Seattle-Bellevue-Everett metropolitan area

2007 - 2009



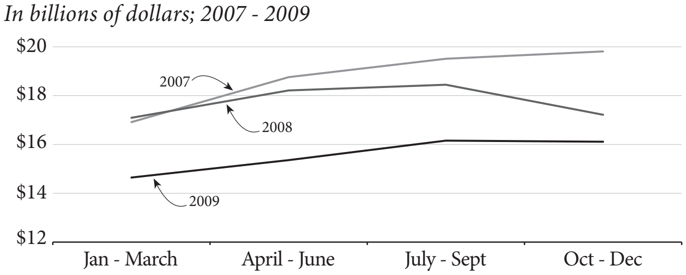
Data source: U.S. Dept. of Labor Bureau of Labor Statistics.

Taxable retail sales down 17% between 2007 and 2009

Taxable retail sales are one way to measure consumer confidence. In the Puget Sound region, 2009's taxable retail sales were lower by 17% compared to 2007, indicating a slowing demand for consumer goods. This suggests that the average consumer was making fewer trips to retail centers. The number and frequency of trucks traveling area roadways to deliver goods to retailers may have also been depressed, further reducing travel times and traffic volumes.

Taxable retail sales for selected Puget Sound counties

In billions of dollars; 2007 - 2009



Data source: Washington State Department of Revenue, Quarterly Business Review, Table 3A.

Note: Selected counties include: King, Snohomish, Pierce, and Kitsap.

Washington real personal income down $2.5 billion compared to 2007 levels

Washington's real personal income is a measure of income received by all state residents from all sources in a given year. Between 2007 and 2009, real personal income fell by 1%, from $256.9 billion in 2007 to $254.3 billion in 2009. This $2.5 billion reduction in income may also have contributed to the reduction in travel in the Puget Sound region.

Employment and population trends reflect the struggling regional economy

While Washington's natural population growth (births minus deaths) is steady, population growth due to migration from

Factors Affecting Travel Times: 2007-2009, continued

other states or countries has slowed somewhat, according to the state's Office of Financial Management.

On a city-by-city basis, population for the central Puget Sound region shows generally small increases. Issaquah showed the highest real growth at 9% (Auburn and Renton numbers reflect annexations) adding over 2,000 people. Commutes on I-90 with Issaquah as home nevertheless showed improvement between 2007 and 2009.

Almost all cities in this region lost jobs. The greatest percentage of jobs lost was in southwestern King County, which lost a little over 5,000 jobs total (-2%). These lost jobs may have contributed to reduced congestion on the Seattle/Federal Way and Seattle/SeaTac routes, since some of the lost trips on those routes may have traveled from one southwestern King County city to another for work. Seattle and Bellevue weathered the downturn fairly well by comparison with some cities, with only -1% and -2% losses, respectively.

Redmond had the strongest job market of the regional cities, growing by about 5,000 jobs (6%). The two routes with Redmond as a destination both showed some small improvements in travel time measures.

Population and employment changes at selected Puget Sound locations

2007 compared to 2009

	Population			Number of Jobs		
	2007	2009	% Δ	2007	2009	% Δ
Seattle	586,200	602,000	3%	478,351	473,280	-1%
Bellevue	118,100	120,600	2%	124,001	121,144	-2%
Southwestern King County cities						
Auburn[1]	44,300	60,820	37%	38,441	39,061	2%
Des Moines	29,090	29,270	1%	5,648	5,546	-2%
Federal Way	87,390	88,580	1%	31,104	28,482	-8%
Kent	86,660	88,380	2%	64,473	60,490	-6%
Renton[2]	60,290	83,650	39%	51,438	55,446	8%
SeaTac	25,530	25,730	1%	28,849	26,438	-8%
Tukwila	18,000	18,170	1%	47,006	46,112	-2%
Total[3]	**351,260**	**358,863**	**2%**	**266,959**	**261,575**	**-2%**
Eastern King County cities						
Issaquah	24,710	26,890	9%	18,909	18,247	-4%
Kirkland	47,890	49,010	2%	32,478	30,631	-6%
Newcastle	9,550	9,925	4%	1,753	1,644	-6%
Redmond	50,680	51,890	2%	85,758	90,704	6%
Sammamish	40,260	40,670	1%	5,160	5,143	0%
Total	**173,090**	**178,385**	**3%**	**144,058**	**146,369**	**2%**
Northern King County and Snohomish County						
Shoreline	53,190	54,320	2%	16,161	16,374	1%
Snohomish	686,300	704,300	3%	247,670	241,569	-2%

Data source: Puget Sound Regional Council, Seattle, WA - 2009 Covered Employment Estimates by City; Office of Financial Management - Forecasting Division.

1 Auburn annexed 15,748 people between April 1 2007 and April 1 2009. Actual population growth between 2007 and 2009 was 772 people or 2%.

2 Renton annexed 19,989 people between April 1 2007 and April 1 2009. Actual population growth between 2007 and 2009 was 3,371 people or 6%.

3 Total population numbers for 2009 were adjusted to reflect actual growth, not growth from annexations.

WSDOT congestion relief projects improve travel times

In the past two years, WSDOT has completed several congestion relief projects on central Puget Sound highways, resulting in several dramatic drops in travel times.

I-405 Corridor improvement projects

Between 2007 and 2009, WSDOT completed two major projects on the I-405 corridor, both south of Bellevue: the South Bellevue Widening project (November 2009), and the Renton Stage 1 Widening project (December 2009). As discussed in the June 30, 2010, *Gray Notebook 38*, p.26, and in WSDOT's 2009 Congestion Report, p.43, both of these projects added lanes on I-405. As a result, the average travel time of the Bellevue to Tukwila evening commute improved by five minutes with a 2% increase in VMT between 2007 and 2009, while the Tukwila to Bellevue morning commute improved by 16 minutes, with a 16% increase in VMT.

Tukwila to Bellevue evening commute does not show the same travel time improvements

Despite the improvement on the Tukwila to Bellevue morning commute after the auxiliary lane was opened, the Tukwila to Bellevue evening commute has shown no change in the average peak travel time between 2007 and 2009. This holds true across the route's 50th, 80th, 90th, and 95th reliability percentiles (see p. 29).

However, the duration of congestion dropped from an average of just over three hours to one hour; the stamp graph (p. 32) also shows a small drop in the number of congested days at the beginning of the evening peak. This implies that while the crest of the evening peak period travel time remained the same, congestion is starting later than it had in the past.

Other Travel Time Improvements

This route also experienced construction impacts between I-5 and SR 167 throughout 2009, which affected travel times in both the morning and evening commutes. The level of congestion during the morning commute in 2007 was so severe that it experienced a huge improvement despite the construction-related congestion in 2009. The improvements on the evening commute, with far less severe levels of congestion, were less obvious due to the construction-related congestion.

SR 167 HOT lanes

The SR 167 HOT lanes pilot project opened in May 2008, converting the HOV lanes to HOT lanes on SR 167 between Auburn and Renton, opening the lanes to driver-only vehicles for a fee. Drivers on the Auburn to Renton morning commute saved three minutes in average travel times in 2009 compared to 2007; the VMT increased by 4% in the same period. The Renton to Auburn evening commute improved five minutes, with a 3% increase in VMT. The new HOT lane has helped move more vehicles at faster speeds; for more details on the performance of this pilot project two years after construction, see page 47.

I-5 – Everett, SR 526 to US 2 HOV Lanes

In 2008, WSDOT widened northbound and southbound I-5 to add new HOV lanes between Boeing Freeway and US 2 (see the September 30, 2008, *Gray Notebook 31*, p. 44). By removing a bottleneck north of Everett, this additional capacity reduced congestion and increased volume, contributing to a two-minute improvement on the Seattle to Everett evening commute, and a six-minute improvement on the Bellevue to Everett evening commute. The duration of congestion on the Bellevue to Everett evening commute dropped by 22% even as VMT increased in the stretch of I-405 in, and immediately north of Bellevue.

Other routes show shorter travel times, but it is unclear what influenced the improvement

I-5 Federal Way/ SeaTac to Seattle morning commute improvements: Maximum throughput efficiencies and benefits

Two morning commutes on I-5 south of Seattle showed big improvements in travel times between 2007 and 2009. The 22-mile Federal Way to Seattle morning commute improved by 12 minutes, while a subset of that route, the 13-mile SeaTac to Seattle morning commute, improved by five minutes. These routes also experienced 3% and 2% increases in VMT, respectively.

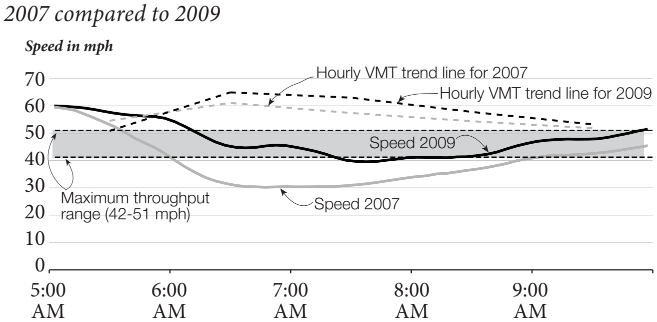
There were no specific WSDOT congestion relief projects deployed or constructed in that corridor to account for the improvements in commute times. The improvements in congestion were seen throughout the corridor, rather than concentrated in one or two specific locations: this suggests that commuters' travel patterns have changed to make traffic flow better. Improved speeds along the corridor, which is operating at much closer to maximum throughput speeds than in 2007, have resulted in improved system efficiency; this has allowed more vehicles to use the system during the 5–10am morning commute, leading to an increase in VMT.

The increase in VMT can be due to latent demand during peak period, or travel that would have previously taken place outside of the peak period. Faster travel times induce drivers on other routes to divert to I-5, and encourage travelers already on I-5 to remain on the freeway.

Travel times on Federal Way to Seattle morning commute improved

WSDOT closely analyzed the average annual speed and volume data for the morning peak (5–10am) between 2007 and 2009. The speeds on this route during the morning peak fell below the maximum throughput range at around 6am in 2007 compared to 7:20am in 2009; congestion, which is based on average speeds below 45 mph (see p.11), lasted about two hours longer in 2007 compared to 2009. The lowest observed annual average speed during the AM peak hour in 2007 was around 30 mph, 10 mph below the lowest observed speed of 40 mph experienced in 2009 (see graph below). The hourly VMT on this 22-mile commute also increased in 2009 compared to 2007. The I-5 Federal Way to Seattle commute route operated closer to maximum throughput speeds in 2009, resulting in a 12-minute reduction in average travel time despite increased VMT.

Annual average weekday peak speed and hourly VMT: Federal Way to Seattle AM commute
2007 compared to 2009



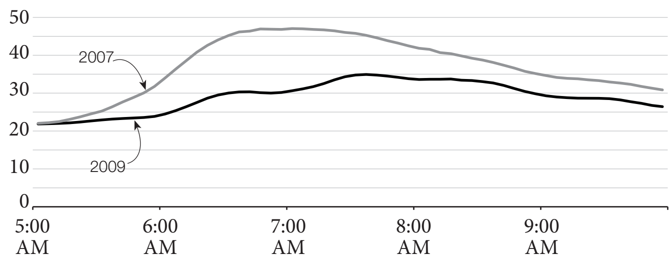
Data source: WSDOT HQ Traffic Office, NWR Traffic Office.

Other Travel Time Improvements, continued

In 2007, Federal Way to Seattle travelers who set off at 7am (the greatest travel time improvement five-minute interval) had a 47 minute commute; in 2009, the same drive took 31 minutes. Shorter travel times can allow later start times for commuters and more uniform traffic flows on I-5 between Federal Way and Seattle, leading to higher throughput and average speeds.

Annual average travel time from Federal to Seattle during AM commute

2007 compared to 2009
Travel time in minutes



Data source: WSDOT HQ Traffic Office, NWR Traffic Office.

Reduced collisions and other factors might have contributed to improved travel time, higher speeds, and increased VMT

In 2009, the Federal Way and Seattle morning commute (5-10am) saw about 30% fewer collisions compared to 2007, while other urban Puget Sound freeway corridors saw 8% fewer collisions. This partially explains the better performance of this commute route. The flow of traffic around maximum throughput speed range would experience significantly fewer back-ups leading to fewer collisions – and in turn, having fewer collisions would help traffic flow more smoothly at speeds in the maximum throughput range.

This corridor, particularly in the morning, experiences higher speeds, more time spent at maximum throughput levels, later-starting congestion, and fewer collisions. Because the system does not become overloaded as frequently, more vehicles are able to use it.

Another important contributing factor is the loss of 2% of all jobs in the area's major employment centers between 2007 and 2009. This loss has almost certainly resulted in fewer commute trips along this corridor to these employment centers, shortening the amount of time that the system was overloaded. In addition, 2009 saw the opening of Sound Transit's light rail system Central Link. It is very likely that some travelers in the

Fewer collisions help reduce congestion on Washington roads

Recurrent congestion is caused by simply having too many cars on the same highway at the same time. Non-recurrent congestion stems from one-time problems such as traffic incidents, bad weather, or sporting events, and can worsen recurrent congestion. Fatality and serious injury collisions are a major cause of non-recurrent congestion, often disrupting traffic for extended periods while emergency crews care for the injured and police perform investigations. These events have an impact on the reliability of travel times.

In 2009, Washington once again saw a reduction in such collisions compared to previous years. In King County, fatal and serious injury collisions dropped 8% from 2007; the total number of all collisions decreased by 9%. This reduction in collisions contributes to the reduction of non-recurrent congestion and contributing to the improvement in reliable travel times on central Puget Sound highways.

There was a similar reduction in fatal collisions nationally: the National Highway Traffic Safety Administration (NHTSA) reported that there were 22% fewer fatalities in 2009 than at the peak in 2005. This is the lowest national fatality rate ever: 1.13 deaths per 100 million VMT. The Washington state fatality rate was also the lowest on record, at 0.87 per 100 million VMT.

Fatal and serious injury collisions on all roads

Year	Statewide	Percent change in 2009	King County	Percent change in 2009
2009	2,712	n/a	680	n/a
2008	2,645	3%	694	-2%
2007	2,856	-5%	736	-8%
2006	3,059	-11%	874	-22%

Total number of collisions on state highways

Year	Statewide	Percent change in 2009	King County	Percent change in 2009
2009	43,108	n/a	14,220	n/a
2008	45,422	-5%	14,821	-4%
2007	48,856	-12%	15,632	-9%
2006	49,838	-14%	16,369	-13%

Data source: WSDOT Transportation Data Office.

Note: In 2010, WSDOT stopped including citizen-reported collisions in collision data. This data represents officer-reported collisions only.

Other Travel Time Improvements, continued

general-purpose-lane traffic on I-5 have chosen to take the new light rail instead. The better flow of traffic is likely encouraging people to continue to use I-5, rather than divert off of the road.

Finally, WSDOT's Integrated Corridor Management program, discussed in the September 2007 *Gray Notebook 27* (page 83), could also be benefiting I-5 traffic. WSDOT has been working closely with local governments to coordinate traffic operations in preparation for major planned events as well as in response to major unplanned events.

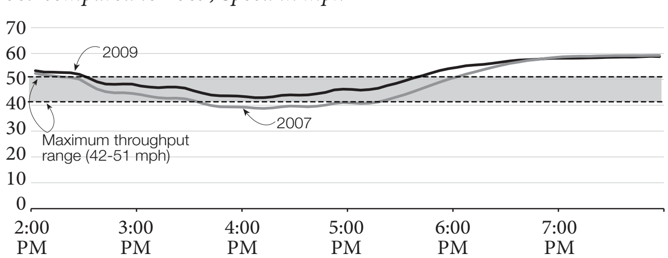
The evening return trips for these routes showed small improvements

The time needed for the Seattle to Federal Way evening commute decreased by five minutes, while the Seattle to SeaTac evening commute decreased by one minute. The graph below shows that the average weekday peak five minute speeds on this route were slightly below the maximum throughput speed range in 2007; in 2009, the lowest observed speed during the afternoon peak (2–8pm) is well within the maximum throughput speed range. For this reason the travel time improvement on evening commute was not as dramatic as the 12-minute decrease observed for morning commute: there is less room for improvement during evening commute.

In other words, Seattle to Federal Way commuters in 2007 who started at 4pm reached Federal Way in 36 minutes, a commute which took 32 minutes in 2009.

Annual average weekday peak speed: Seattle to Federal Way PM commute

2007 compared to 2009; Speed in mph

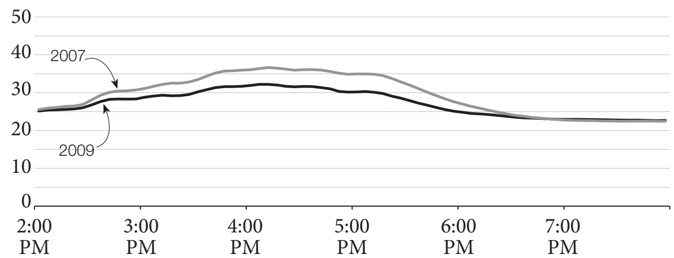


Data source: WSDOT HQ Traffic Office, NWR Traffic Office.

Annual average travel time from Seattle to Federal Way during PM commute

2007 compared to 2009

Travel time in minutes



Data Source: WSDOT HQ Traffic Office, NWR Traffic Office.

Why did the number of vehicle miles traveled increase on some routes?

While travel times improved on most routes, VMT also increased on many routes. Shouldn't faster travel times be associated with lower volumes?

Not always. As discussed on page 10, the principle of maximizing throughput comes into play. Because fewer cars are using the road at one time, traffic flows more smoothly throughout the commute period. Congestion starts later, peaks lower, and sometimes clears up earlier.

When travel times drop on roads, the improvement often draws back drivers that might have driven other routes. Instead of diverting from an overcrowded highway onto city streets, drivers stay on the highway to take advantage of its now-faster travel time. In 2009, routes with VMT increases of 3% or more included travel on I-5, SR 167, or I-405 – freeways with parallel routes on city streets or signalized highways like SR 99. East-west routes along SR 520 and I-90, which lack alternate routes across Lake Washington, did not see these VMT increases, simply because there are no parallel routes for drivers. VMT increases may also be due to drivers shifting from outside the peak period and shoulder times, and from other modes of transportation.

Travel Time Reliability on Major Puget Sound Commute Routes

Travel time reliability percentiles for 38 high demand Puget Sound commute routes

Reliability is an important metric for highway users, because it allows them to plan their travel consistently. When drivers know how many minutes they should allow to reach their destination on time – with average road conditions *and* under the worst conditions – they can make more accurate travel plans. A commuter can plan the daily trip to work at peak hours, a parent can plan the afternoon run to the daycare center, a business knows when a just-in-time shipment must leave the factory, and a transit agency can develop resilient schedules.

How reliability percentiles are used

WSDOT starts by identifying the peak five-minute interval on any given route, and the travel time for the route at the peak, over the 260 weekdays in a calendar year. Averaging all those weekday travel times at the peak interval includes the fastest days (usually holidays) and slowest days (perhaps recorded during a blizzard), and so it is only a broad indicator of how many minutes are needed to complete the route and reach the destination on time. A traveler who must be sure of reaching a destination on time needs to know how long the route will take under nearly the worst conditions.

The 95th percentile reliability score includes 'worst case' travel times: it is the duration that gets drivers to the destination on time 95% of the time. The 80th and 90th percentiles are also more accurate than the average; WSDOT uses them primarily as a tool to track changes in travel times at a finer level. These travel times would allow for routine delays due to a collision or roadwork. The 50th percentile, or median, means that half of all travel times were faster, half slower, than this duration.

WSDOT uses the 95th percentile reliable travel time as its key metric for the 38 high demand Puget Sound commute routes.

2009 Reliability numbers show big improvements

Of the 38 routes, 29 showed across-the-board improvements on all percentile measures. These routes are probably affected by the economic factors discussed on pages 21-23. The route with the greatest improvement was the Tukwila to Bellevue morning commute (see page 23). Other morning commutes with much improved reliable travel times include:

- Everett to Seattle – 10 minutes better
- Everett to Bellevue – 10 minutes better
- Federal Way to Seattle – 16 minutes better

Improved evening commutes include:

- Seattle to Sea-Tac – 13 minutes better
- Seattle to Federal Way – 11 minutes better.

Of the nine routes that did not see across-the-board-improvement in reliability percentiles, five remained consistent between 2007 and 2009, generally within two minutes difference. The remaining four routes were less reliable by three or more minutes on many of the percentiles. All of those routes were on either I-90 or SR 520.

95% Reliability improves on 28 of 38 routes

The 95% reliable travel times closely tracked the general reliability trend: 28 routes improved, four were unchanged, and six were less reliable. Increased travel times ranged from one to six minutes; five of the six were on evening routes. Improvements ranged from one to 21 minutes

The greatest improvement was seen on Tukwila to Bellevue morning commute, which was 21 minutes shorter and the second greatest was on Federal Way to Seattle morning commute, which improved by 13 minutes, with the 95% reliable travel time dropping 20% from 65 to 52 minutes. These routes are discussed in more detail on pages 24-26.

Reliability percentiles in Plain English

Analyzing reliability based on travel times recorded on 260 weekdays in a calendar year during the peak five-minute interval.

	Definition	Why do we measure this?
Average travel time (the Mean)	Average of all the recorded travel times.	Describes the "average" experience on the road that year.
50th percentile travel time (the Median)	Half of recorded travel times were shorter, half longer, than this duration.	The median is not affected by very large times as an average is, so it gives a better sense of actual conditions.
80th percentile travel time	80% of recorded travel times were shorter than this duration.	WSDOT uses this percentile to track changes in reliable travel times over the years at a finer level, to better evaluate operational improvements.
90th percentile travel time	90% of recorded travel times were shorter than this duration.	WSDOT uses this percentile to track changes in reliable travel times over the years at a finer level, to better evaluate operational improvements.
95th percentile travel time	95% of recorded travel times were shorter than this duration.	Allows commuters to plan how much time will be required to make a trip and be on time 19 days a month, on average (late 1 of 20 days).

Travel Time Reliability on Major Puget Sound Commute Routes, continued

Morning commutes: changes in reliable travel time percentiles for 18 high demand AM commute routes, 2007-2009

Morning (AM) peak is between 5 am and 10 am; Length of route in miles; All travel times in minutes; Peak of commuter rush expressed in hours and minutes for an annual average weekday

			Travel times on the route at		2007 percentiles				2009 percentiles				Difference 2007 vs. 2009			
Route	Length of route	Peak of commuter AM rush	Posted speed	Maximum throughput speed	Median 50th	80th	90th	95th	Median 50th	80th	90th	95th	Median 50th	80th	90th	95th
To Seattle																
I-5 Everett to Seattle	24	7:30	24	28	46	58	67	**76**	37	51	60	**66**	-8	-6	-7	**-10**
I-5 Federal Way to Seattle	22	7:35	22	26	48	58	62	**65**	32	42	46	**52**	-16	-16	-15	**-13**
I-90/I-5 Issaquah to Seattle	15	7:45	15	19	25	36	42	**37**	20	24	28	**32**	-6	-13	-14	**-5**
SR 520/I-5 Redmond to Seattle	15	7:45	15	18	22	25	27	**31**	20	24	27	**31**	-1	-1	0	**0**
I-5 SeaTac to Seattle	13	8:40	13	16	28	32	34	**36**	21	26	29	**31**	-7	-6	-5	**-5**
I-405/I-90/I-5 Bellevue to Seattle	11	8:35	11	13	15	20	23	**29**	11	13	16	**19**	-4	-7	-7	**-10**
I-405/SR 520/I-5 Bellevue to Seattle	10	7:50	10	13	17	20	22	**23**	16	20	23	**26**	-2	-1	1	**3**
To Bellevue																
I-5/I-405 Everett to Bellevue	23	7:25	23	28	47	61	68	**78**	39	53	59	**68**	-8	-7	-9	**-10**
I-405 Lynnwood to Bellevue	16	7:35	16	19	38	49	56	**62**	31	43	47	**54**	-8	-6	-9	**-8**
I-405 Tukwilla to Bellevue	13	7:40	13	16	43	52	55	**58**	25	30	32	**37**	-18	-22	-23	**-21**
I-5/I-90/I-405 Seattle to Bellevue	11	8:50	11	13	17	21	23	**25**	14	16	18	**21**	-3	-5	-5	**-4**
I-5/SR 520/I-405 Seattle to Bellevue	10	8:45	10	12	23	28	30	**33**	20	25	28	**29**	-3	-3	-2	**-4**
I-90/I-405 Issaquah to Bellevue	9	8:40	9	11	17	20	24	**26**	14	17	19	**23**	-3	-3	-5	**-3**
SR 520/I-405 Redmond to Bellevue	7	7:50	7	9	8	9	9	**10**	9	9	10	**10**	0	0	0	**0**
To Other Locations																
I-405 Bellevue to Tukwilla	13	7:40	13	16	22	25	28	**31**	19	22	24	**26**	-2	-3	-4	**-5**
SR 167 Auburn to Renton	10	7:40	10	12	16	21	24	**30**	14	16	18	**22**	-2	-4	-6	**-8**
I-5/I-90 Seattle to Issaquah	16	8:45	16	19	19	23	25	**27**	17	18	21	**23**	-3	-5	-5	**-4**
I-5/SR 520 Seattle to Redmond	15	8:45	15	18	28	32	35	**37**	25	30	33	**34**	-3	-2	-2	**-3**

Data source: WSDOT Traffic Office, Washington State Transportation Center (TRAC).

Travel Time Reliability on Major Puget Sound Commute Routes, continued

Evening commutes: change in reliable travel time percentiles for 20 high demand PM commute routes, 2007-2009

Evening (PM) peak is between 2 pm and 8 pm; Length of route in miles; All travel times in minutes; Peak of commuter rush expressed in hours and minutes for an annual average weekday

			Travel times on the route at		2007 percentiles				2009 percentiles				Difference 2007 vs. 2009			
Route	Length of route	Peak of commuter PM rush	Posted speed	Maximum throughput speed	Median 50th	80th	90th	95th	Median 50th	80th	90th	95th	Median 50th	80th	90th	95th
From Seattle																
I-5 Seattle to Everett	24	5:15	24	28	41	51	57	**63**	40	48	53	**56**	-1	-3	-4	**-7**
I-5 Seattle to Federal Way	22	4:05	22	27	34	45	51	**55**	31	35	41	**44**	-3	-10	-10	**-11**
I-5 Seattle to SeaTac	13	4:10	13	16	18	24	27	**30**	14	15	16	**17**	-4	-9	-11	**-13**
I-5/I-90/I-405 Seattle to Bellevue	11	5:30	11	13	14	21	23	**29**	14	22	27	**30**	0	1	3	**1**
I-5/SR 520/I-405 Seattle to Bellevue	10	5:30	10	12	18	23	25	**29**	19	24	30	**33**	1	2	5	**4**
I-5/SR 520 Seattle to Redmond	15	5:30	15	18	28	34	38	**40**	30	37	42	**46**	2	3	4	**6**
I-5/I-90 Seattle to Issaquah	16	5:35	16	19	20	26	30	**33**	19	25	30	**34**	-1	-2	0	**1**
From Bellevue																
I-405/I-5 Bellevue to Everett	23	5:20	23	28	44	53	59	**63**	38	47	51	**55**	-5	-7	-8	**-8**
I-405 Bellevue to Lynnwood	16	5:20	16	19	32	40	48	**52**	30	38	43	**46**	-3	-2	-5	**-6**
I-405 Bellevue to Tukwilla	13	4:25	13	16	34	39	42	**46**	29	35	39	**43**	-5	-4	-4	**-3**
I-405/I-90/I-5 Bellevue to Seattle	11	5:25	11	13	27	35	41	**45**	22	31	37	**40**	-4	-4	-4	**-5**
I-405/SR 520/I-5 Bellevue to Seattle	10	5:25	10	13	26	29	33	**37**	26	29	32	**38**	0	0	-1	**1**
I-405/I-90 Bellevue to Issaquah	9	5:30	9	11	18	20	22	**24**	14	16	18	**19**	-4	-4	-4	**-5**
I-405/SR 520 Bellevue to Redmond	7	5:30	7	8	14	17	22	**24**	15	21	23	**24**	1	3	1	**0**
From other locations																
I-5 Everett to Seattle	24	3:25	24	28	40	48	54	**62**	36	45	50	**53**	-3	-3	-5	**-9**
I-90/I-5 Issaquah to Seattle	15	5:25	15	19	25	36	42	**49**	23	32	41	**47**	-3	-4	-1	**-2**
SR 520/I-5 Redmond to Seattle	15	5:30	15	18	34	47	53	**62**	30	41	48	**53**	-4	-6	-5	**-9**
SR 167 SeaTac to Seattle	13	5:25	13	16	19	26	31	**38**	18	24	30	**36**	-1	-2	-2	**-2**
I-5 Renton to Auburn	10	3:45	10	12	17	25	30	**34**	13	16	20	**25**	-4	-9	-10	**-9**
I-405 Tukwilla to Bellevue	13	5:20	13	16	19	22	24	**27**	19	22	24	**27**	-1	0	0	**0**

Data source: WSDOT Traffic Office, Washington State Transportation Center (TRAC).

Travel Time Analysis: Other views / Introducing Stamp Graphs

What others said about congestion in 2009

State of Metropolitan America

In May 2010, The Brookings Institution released a national report on the demographic and social trends shaping large metropolitan areas in the U.S. This report cited an increase in metro-area commuters using transit, and a drop in commuters traveling to work alone, between 2000 and 2008. This trend was concentrated in nine large metro areas, including the Seattle-Tacoma-Bellevue-area. Out of 100 large metro areas reported, the Seattle area ranked 96th in the number of people driving to work alone (69%), and ranked fifth in the share of commuters using public transit since 2000, improving by 1%. Carpooling and transit were noted as relatively popular modes for travel among Seattle commuters.

CEOs for Cities Report

In September 2010, CEOs for Cities published a report called "Driven Apart," which states that sprawl is lengthening our commutes and explores the key role that land use and variations in travel distances play in determining how long Americans spend in peak hour travel. In this context it criticizes the Texas Transportation Institute Urban Mobility Report's Travel Time Index (TTI). It asserts that the TTI methodology penalizes cities with shorter travel distances and conceals the additional burden caused by longer trips in sprawling metro areas. In addition, it posits that the TTI report exaggerates travel delays, and overestimates the fuel consumption associated with urban travel.

INRIX 2009 Annual Scorecard

Published by INRIX, a private-sector traffic data collection company, the Annual Scorecard for 2009 linked changing congestion conditions to the recession and job loss. It reported that morning congestion was decreasing, while evening congestion increased – calling conditions "as good as it gets." For Seattle, the 2009 "travel time tax" dropped slightly from 2008 (8%), and much more from 2006 and 2007 (36% for each year).

The 2010 Urban Mobility Report

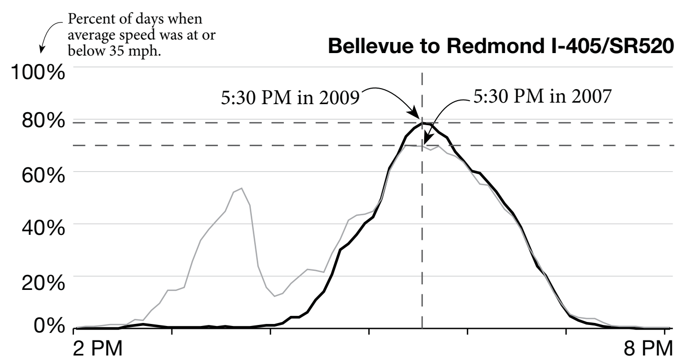
The Texas Transportation Institute's 2010 annual congestion report examining 2009 data was not yet available at the time of this publication. The 2010 Urban Mobility Report, the 20th edition since its beginning in 1984, will combine INRIX historical traffic speed data with public agency traffic count data to produce the latest congestion trends.

Stamp graphs show the duration and frequency of severe congestion

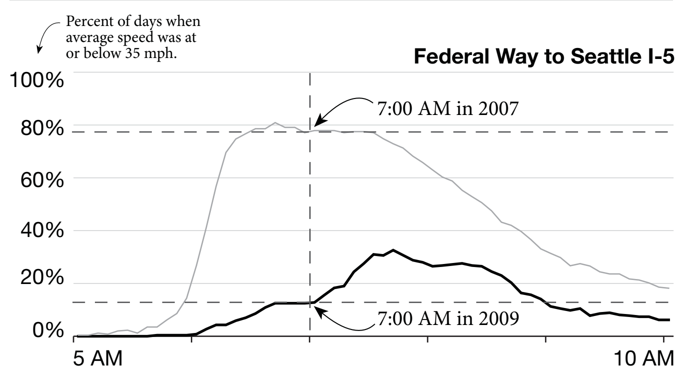
The best visual evidence to show whether the peak period is spreading or contracting can be seen in the "stamp graphs" on the following two pages. The stamp graphs show the frequency of severe congestion on the 38 high demand central Puget Sound commute routes. These graphs, comparing 2007 and 2009 data, show the percentage of days annually that observed average speeds are at or below 35 mph on the key highway segments. For information on how to read stamp graphs, see the illustrations below.

How to read a stamp graph: Percent of days when speeds were at or below 35 mph

How frequently (and when) were the average trip speed at or below 35 mph? How have those conditions changed from 2007 to 2009?



At 5:30 pm in 2007, you had about a 70% chance that traffic would be moving at or below 35 mph. In 2009, the situation became worse (black line above the gray line); your chance that traffic would be moving at or below 35 mph was about 79% in 2009.



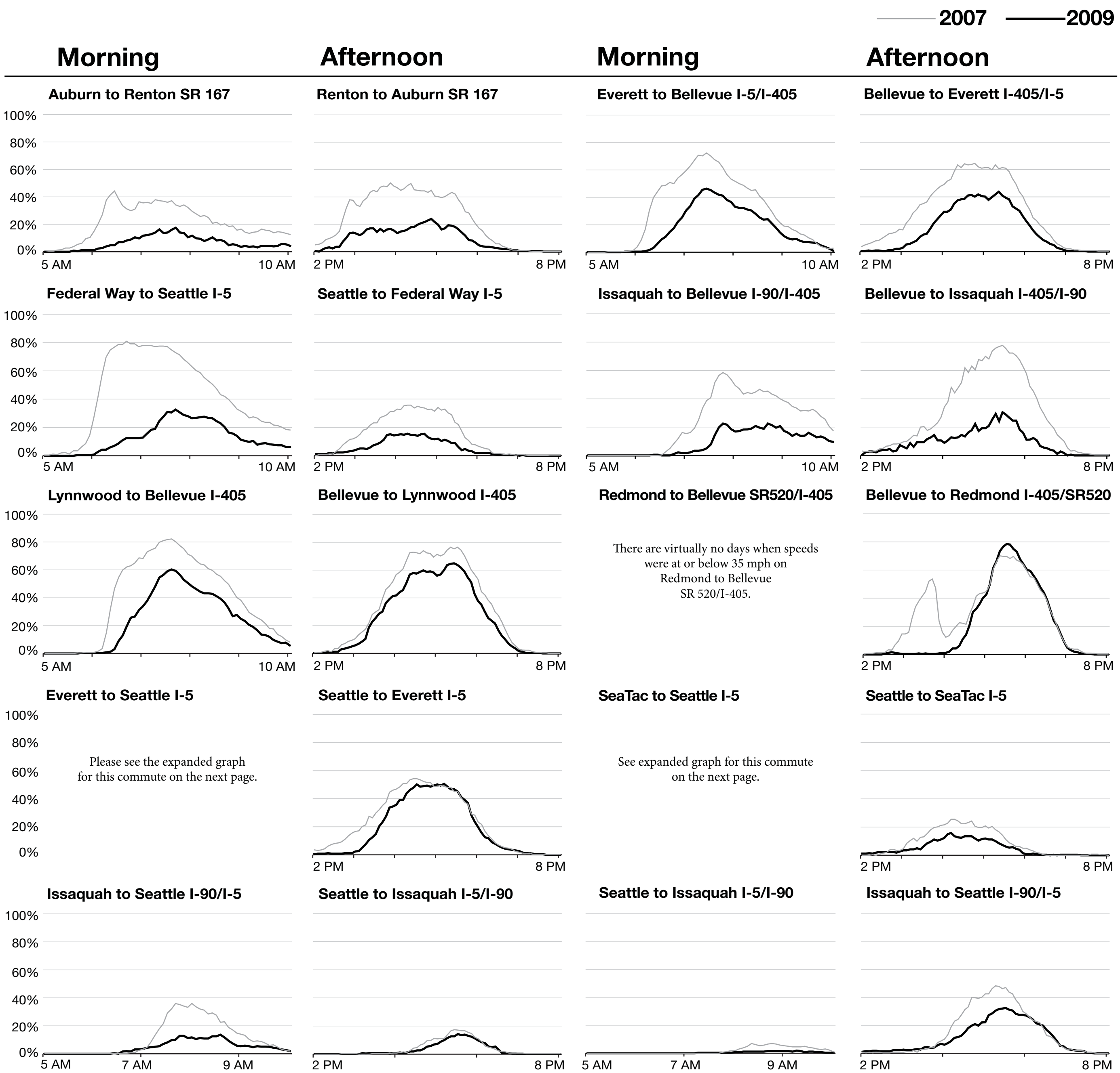
At 7:00 am in 2007, you had about a 78% chance that traffic would be moving at or below 35 mph. In 2009, the situation was better (black line below the gray line); your chance that traffic would be moving at or below 35 mph was about 13%.

Data source: WSDOT Traffic Office.

Weekday Average Speeds Shown in Stamp Graphs

Stamp graphs: Percentage of weekdays with average speeds of 35 mph or less

The following "stamp graphs" show how often severe congestion occurs on the 38 key central Puget Sound commute routes that are shown in the tables on pages 28 and 29. These graphs, comparing 2007 and 2009 data, show the percentage of days annually when average speeds were at or below 35 mph on these key commute routes. For more on how to read a stamp graph, please see the illustration on page 30.

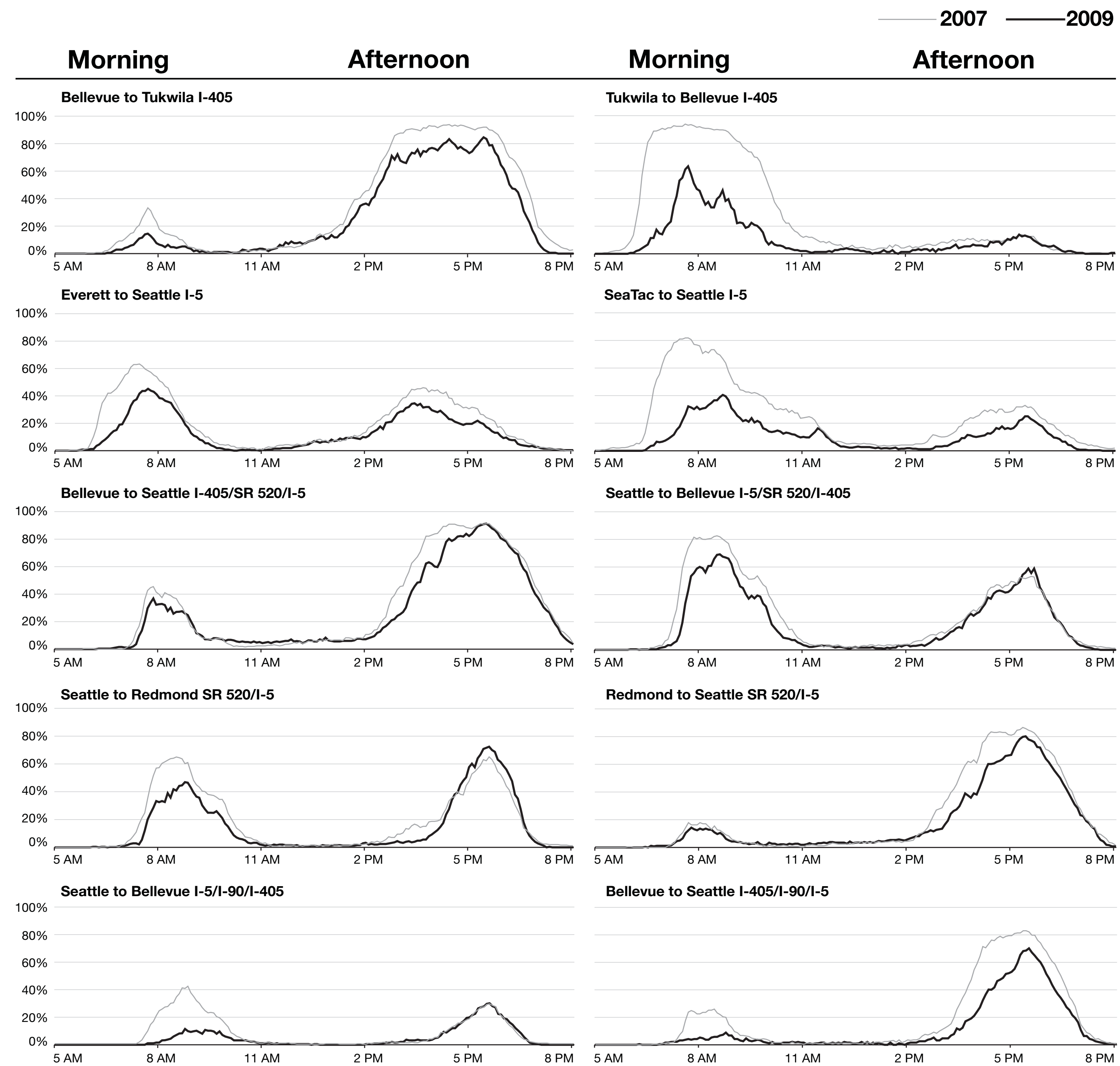


Data source: WSDOT Traffic Office.

Weekday Average Speeds Shown in Stamp Graphs, continued

Stamp graphs: Percentage of weekdays with average speeds of 35 mph or less

The following "stamp graphs" show how often severe congestion occurs on the 38 key central Puget Sound commute routes that are shown in the tables on pages 28 and 29. These graphs, comparing 2007 and 2009 data, show the percentage of days annually when average speeds were at or below 35 mph on these key commute routes. For more on how to read a stamp graph please see the illustration on page 30.



Data source: WSDOT Traffic Office.

Travel Time Analysis for 14 Additional Puget Sound Commute Routes

WSDOT tracks 14 additional routes that have the potential for future congestion

WSDOT tracks a total of 52 commuter routes annually, representing morning and evening commutes between major population and work centers. Thirty-eight of those routes regularly experience congestion (see pp. 27-32). The additional 14 routes, listed on this page, represent the relatively uncongested routes for which WSDOT tracks travel time and volume data. Twelve of the 14 routes do not regularly experience congestion.

The 95% reliable travel time is the only measure that indicates congestion for these twelve routes. Five routes show a slight decrease in reliability, and six others are slightly up or flat between 2007 and 2009. One route out of these twelve shows a larger decrease: Auburn to Renton evening commute is down five minutes between 2007 and 2009; the 2007 value of 21 minutes represents an unusual spike for this route, and 2009 represents a return to its normal 95% reliable travel time of 15-16 minutes. Because the 95% reliable travel time can be adversely affected by a few "very bad days," it is likely that overall conditions on the routes have not changed much, as shown by the flat average travel times.

In terms of volume (vehicle miles traveled, or VMT), all morning routes were slightly down and all evening routes were slightly up, ranging between one and four percent. This matches a similar pattern in the 38 congested routes, which saw a roughly even split in volumes up and down in the morning routes, and slight increases in the evening routes.

WSDOT monitors these commute routes to see if they are developing congested characteristics and should be moved to the list of congested routes. None of these routes have developed significant congestion problems in the past four years, so the list of 38 congested routes has remained unchanged.

Morning/Evening commutes: changes in travel time performance on 14 additional commute routes

2007 morning (5am-10am) and evening (2pm-8pm) peak vs. 2009 morning and evening peak of commuter rush (individual peak times vary) for an annual average weekday
Length of route in miles; all travel times in minutes; peak of commuter rush and duration of congestion expressed in hours and minutes

			Travel time on the route at		Average travel time at peak of rush			95th percentile			Maximum throughput travel time		VMT during peak period	Duration of congestion (how long the average speed is below 45mph)		
											MT³ Index					
Route	Length of route	Peak of commuter rush	Posted speed	Maximum throughput speed	2007	2009	Δ	2007	2009	Δ	2007	2009	%Δ in VMT	2007	2009	Δ
Morning (AM)																
I-5 Seattle to Everett	24	8:50	24	28	27	26	-1	32	30	-2	0.95	0.92	-1%	*	*	n/a
I-5 Seattle to SeaTac	13	7:45	13	16	14	15	1	16	17	1	0.90	0.97	-2%	*	*	n/a
I-405 Bellevue to Lynnwood	16	9:10	16	19	18	17	-1	19	18	-1	0.94	0.89	-1%	*	*	n/a
SR 167 Renton to Auburn	10	9:35	10	12	11	10	-1	12	11	-1	0.94	0.85	-4%	*	*	n/a
SR 520 Bellevue to Redmond	7	9:50	7	8	10	9	-1	13	14	1	1.23	1.11	-4%	1:15	*	-1:15
I-90 Bellevue to Issaquah	9	9:40	9	11	10	10	0	13	10	-3	0.90	0.90	-2%	*	*	n/a
I-5 Seattle to Federal Way	22	7:40	22	27	23	24	1	25	26	1	0.87	0.90	-1%	*	*	n/a
I-405 Bellevue to Everett	23	7:35	23	28	26	25	-1	27	26	-1	0.93	0.89	-2%	*	*	n/a
Evening (PM)																
I-405 Lynnwood to Bellevue	16	5:20	16	19	22	21	-1	31	31	0	1.15	1.10	3%	*	*	*
SR 167 Auburn to Renton	10	5:15	10	12	12	11	-1	21	16	-5	1.02	0.94	4%	*	*	*
SR 520 Redmond to Bellevue	7	5:25	7	9	16	12	-4	35	27	-8	1.87	1.40	3%	3:40	0:35	-3:05
I-90 Issaquah to Bellevue	10	5:20	9	11	12	13	1	16	18	2	1.06	1.15	1%	*	*	*
I-5 Federal Way to Seattle	22	5:15	22	26	30	29	-1	46	46	0	1.15	1.11	2%	*	*	*
I-5 Everett to Bellevue	24	5:15	23	28	30	30	0	39	41	2	1.07	1.07	3%	*	*	*

Data source: WSDOT Traffic Operations and the Washington State Transportation Center (TRAC) at the University of Washington.

Note: In 2010, the maximum throughput travel time speed for the MT³I was re-set at 50 mph, instead of 51 mph. The MT³I was recalculated for 2003-2008 data. In 2010, commute lengths have been rounded to integer values for publication purposes only. The duration of congestion is not limited to the peak periods if it extends beyond the peak period.

* Indicates that speed did not fall below 45 mph of posted speed on a route.

Travel Time Analysis: Spokane

Those living in Bellevue and working in Redmond experience some highway traffic congestion

The two exceptions are Bellevue to Redmond morning commute and the Redmond to Bellevue evening commute. The distance between the two cities is about seven miles. The evening commute experiences substantial travel time and reliability issues, but most of the problem on this route are caused by backups from the Redmond to Seattle evening commute. Since several local roads between Redmond and Bellevue offer non-highway alternatives to commuters, WSDOT does not track these two routes in its analysis of the 38 high-demand commute routes.

Spokane travel time analysis

Beyond the central Puget Sound region, WSDOT also tracks two commute routes in Spokane as part of the Congestion Report's travel time analysis. Spokane traffic volumes were reduced again in 2009, with a peak flow near Altamont Street of 109,000 vehicles per day. This is a decrease of 4.4% in 2009 compared to 2007 (114,000 vehicles a day). Similarly, VMT decreased by an average of 7% (both eastbound and westbound combined) in 2009 compared to 2007, during peak periods.

Incidents remain the major cause of delay in the corridor. The significant reduction in 95% reliable travel time can be attributed to longer-than-normal travel times documented in 2007 due to a major I-90 construction project. In 2009, a night time paving project significantly increased travel times during construction times. The impact of this construction project is reflected in the overall measured hours of congestion for the corridor but not in peak hours. The table below compares Spokane travel times from 2009 and 2007. The average travel time decreased slightly (2% or less), but 95% reliable travel times have dropped significantly – by 20% – along both commute routes during peak periods.

Morning/Evening commutes: changes in travel time performance on Spokane commute routes

2007 morning 6am-8am and evening 4pm-6pm peak vs. 2009 morning and evening peak of commuter rush (individual peak times vary) for an annual average weekday
Length of route in miles; all travel times in minutes:seconds; peak of commuter rush expressed in hours and minutes

				Travel time on the route at		Average travel time at peak of AM rush			95th percentile			Commute vehicle miles traveled
Route	Direction of travel	Length of route	Peak of commuter rush	Posted speed	Maximum throughput speed	2007	2009	%Δ	2007	2009	%Δ	%Δ
I-90: Argonne Rd. to Division St.	WB	8	8:00 AM	8	9	8:20	8:13	-1%	10:10	8:10	-20%	-10%
I-90: Division St. to Argonne Rd.	EB	8	5:20 PM	8	9	8:10	8:00	-2%	10:48	8:32	-20%	-4%

Data source: WSDOT Eastern Region Traffic Office.

Note: Commute lengths have been rounded to integer values for publication purposes only.

High Occupancy Vehicle Lanes Performance Analysis

HOV Lane Performance: Speed and Reliability

The freeway system in the central Puget Sound region includes a network of high occupancy vehicle (HOV) lanes that are reserved primarily for those who travel by carpool, vanpool, or bus. The HOV network is designed to provide a faster, more reliable travel option for these users, and contributes to the efficiency of the overall freeway system by helping move more travelers in fewer vehicles compared to adjacent general purpose (GP) lanes. About 225 lane miles of the planned 320-mile Puget Sound area freeway HOV system have been built. More information about the HOV lane system can be found at www.wsdot.wa.gov/hov/.

WSDOT monitors three aspects of HOV lane performance:

- Travel time performance for HOV lane users
- Travel performance and reliability on freeway HOV corridors
- The person-carrying performance of HOV lanes as compared to the adjacent GP lanes (See pp. 38-41 for a discussion of HOV travel time performance.)

The state performance standard is based on peak hour performance only; during off-peak hours, HOV lanes generally exceed the standard throughout the network. Even during periods when HOV lane performance is below the state standard, HOV lanes still generally continue to provide travel time benefits to users.

Speed and reliability of HOV lanes are monitored annually and the results are published at www.depts.washington.edu/hov/.

HOV lane performance: speed and reliability

WSDOT and the Puget Sound Regional Council (PSRC) adopted a performance and reliability standard for freeway HOV lanes stating that travelers in the HOV lane should be able to maintain an average speed of 45 mph or greater, 90% of the time, during the peak period. WSDOT annually evaluates the extent to which each freeway HOV corridor in the central Puget Sound region meets that standard.

Eight HOV corridors now meet the performance reliability standard

In 2009, eight of the 14 HOV corridors in the central Puget Sound region met the the required standard, and performance overall improved on ten corridors. Three of the ten corridors that now meet the standard but did not in 2007 have improved by between 18% and 66%. The morning I-5 northbound corridor from Federal Way to Seattle (discussed further on page 24-26) went from a reliability compliance of 33% to 92%, the morning I-405 northbound corridor from Tukwila to Bellevue (discussed further on page 23) went from 31% to 99%, and the morning I-405 southbound corridor from Lynnwood to Bellevue went from 76% to 94%.

That said, there continue to be segments that experience reduced performance during peak periods. Five of the seven HOV corridors fail to meet the standard during the primary evening peak hours, as does one of the seven morning peak routes. Of the corridors that still do not meet the standard, all but one have improved by between 12% and 40%. Only one, the I-5 Seattle to Everett evening route, has lost ground: its reliability compliance in 2007 was 51%, improved to 64% in 2008, but deteriorated to 49% in 2009.

HOV lane reliability performance on major central Puget Sound corridors

2007-2009; Goal is to maintain 45 mph for 90% of peak hour
Percentage of peak hours when the 45 mph goal is met (See notes, below)

Commute routes	Length (miles)	2007	2008	2009
Morning peak direction commutes				
I-5, Everett to Seattle SB	17[1]	35% **x**[2]	60% **x**	69% **x**
I-5, Federal Way to Seattle NB	19	33% **x**	67% **x**	92%
I-405, Lynnwood to Bellevue SB	16	76% **x**	92%	94%
I-405, Tukwila to Bellevue NB	14	31% **x**	49% **x**	99%
I-90, Issaquah to Seattle WB	12	99%	100%	96%
SR 520, Redmond to Bellevue WB	8	97%	99%	94%
SR 167, Auburn to Renton NB	9	96%	99%	99%
Evening peak direction commutes				
I-5, Seattle to Everett NB	16	51% **x**	64% **x**	49% **x**
I-5, Seattle to Federal Way SB	19	47% **x**	57% **x**	67% **x**
I-405, Bellevue to Lynnwood NB	16	53% **x**	58% **x**	71% **x**
I-405, Bellevue to Tukwila SB	13	30% **x**	35% **x**	70% **x**
I-90, Seattle to Issaquah EB	11	100%	100%	95%
SR 520, Redmond to Bellevue WB	8	59% **x**	68% **x**	71% **x**
SR 167, Renton to Auburn SB	8	91%	98%	99%

Data source: Washington State Transportation Center (TRAC).

Notes: HOV reliability performance standards are based on the peak hour, the one-hour period during each peak period when average travel time is slowest. To meet the standard, a speed of 45 mph must be maintained for 90% of the peak hour.

NB = Northbound; SB = Southbound; EB = Eastbound; WB = Westbound

1 TRAC analyzes performance data for all complete segments of HOV lanes that have a loop detector. In some cases, data is not analyzed for the very beginning and ends of the lanes because there are no detectors at the very beginnings and ends of the HOV lanes.

2 Numbers represent the percentage of the peak hour when speeds are above 45 mph. An **X** indicates the route did not meet the standard.

High Occupancy Vehicle Lanes Performance Analysis

Effectiveness of HOV Lanes

Nonetheless, HOV corridor network has become noticeably more reliable since 2007. The table on page 35 shows which corridors meet or fail the performance standard during the morning peak period and evening peak period.

HOV lane performance: Volumes and compliance of users

The WSDOT HOV lane monitoring program tracks vehicle volume patterns at 10 locations on the central Puget Sound's major freeway corridors. Volumes are measured at each of these locations during the peak periods, for both HOV and general purpose lanes.

From 2007 to 2009, the magnitude of the change in the number of vehicles in the HOV and GP lanes varied among the spot locations. Overall, the average peak direction HOV vehicle volume at each location decreased by about 9%, while peak direction GP vehicle volumes grew by an average of about 4%. The locations with the largest changes were on I-405 between Tukwila and Bellevue, a segment that benefited from several WSDOT construction projects that increased capacity for both GP and HOV travelers. This segment has seen faster travel times and higher volumes following that construction. Other location on this I-405 segment saw reductions in average volumes of about 7% less for the average peak direction HOV location, while for the average peak direction GP location gained 2%.

While the HOV lane showed lower vehicle volumes on average and the GP lanes showed slightly higher vehicle volumes from 2007 to 2009, when the GP and HOV peak direction volumes are combined, the change in total vehicle volume during the two-year period across all the spot locations was less than 1%.

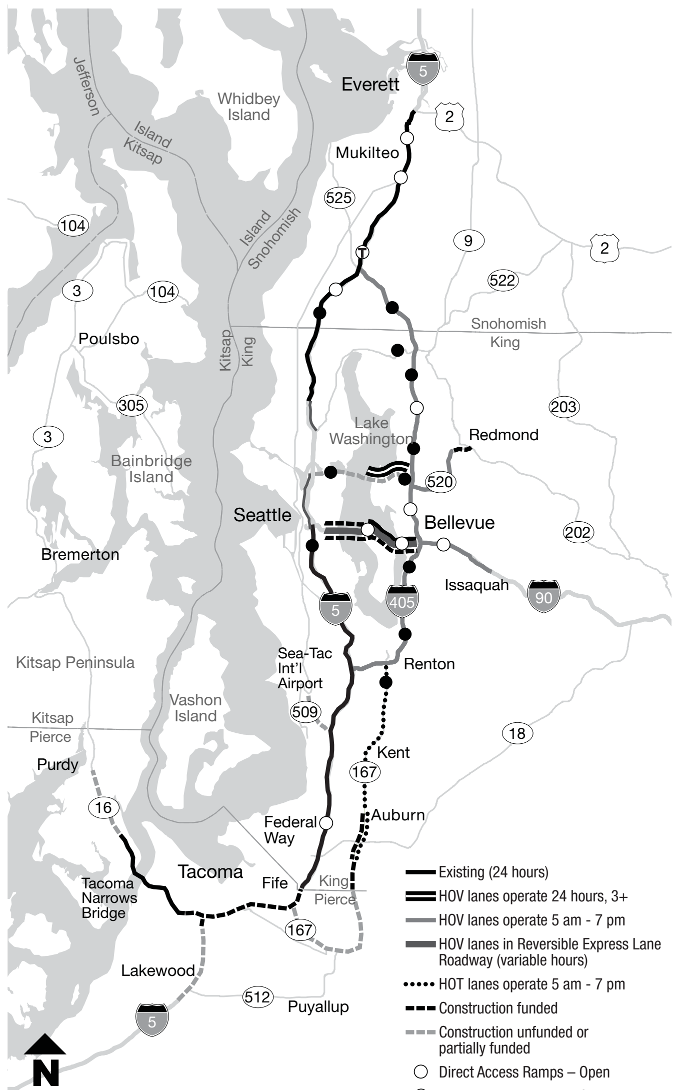
Note that these vehicle volumes are only for selected spot locations, in contrast to the travel time analysis (p. 18) which analyzes the aggregate changes in VMT based on a series of locations along commute routes.

Vehicle occupancy is also monitored at the spot locations. The percentage of vehicles observed using the HOV lane that did not meet the minimum occupancy requirement of at least two people (three people on westbound SR 520 west of I-405) is relatively low compared to other locations around the country. While HOV compliance varies from location to location in the system, the overall average observed violation rate across all HOV sampling locations (not including the SR 167 HOT lane location) during the AM and PM peak periods was slightly less than 4%.

HOV lanes are effective at moving people

The HOV lane monitoring program also estimates person volume patterns at the same spot locations in the region where vehicle volumes are monitored. Monitoring allows WSDOT to determine the extent to which the freeway HOV network contributes to a more efficient overall freeway network by allowing movement of more people in fewer vehicles.

Freeway HOV and HOT Lane System



Data Source: WSDOT Transit Office.
Note: HOV lanes require two or more people (2+) unless otherwise noted. Hours of operation are for all seven days of the week.

HOV Lane Usage: Variables and Transit

HOV lane usage variables

HOV lane usage varies by location throughout the region. The most successful examples of HOV lane performance are at locations that combine the travel time benefits of the HOV lane with strong transit service. I-5 at Northgate is an example of a location that offers these two features. In 2009, during the weekday AM peak period, the southbound HOV lane at this location carries an average of about 13,300 people, which is 43% of all southbound travelers on that corridor, in only 20% of the vehicles. The HOV lane at this location carries an average of 3.4 people in each vehicle, or about three times more than the average vehicle in GP. Overall, the Seattle-area network (generally one HOV lane in each direction) attracts a significant number of ridesharing travelers, carrying an average of 33% of the people counted at the monitoring locations during the AM and PM peak periods.

The overall trend from 2004 to 2007 across all monitoring locations was one of generally increasing HOV lane person volumes. In 2008, changes in overall HOV person volume depended on location, and the overall HOV person volume was down by about 3%. That change was influenced in part by lower vehicle volumes in the region during that year, even though bus transit ridership was up at nearly every monitoring location (in fact, for King County Metro Transit, 2008 was a record-setting year for ridership). In 2009, the trend of overall bus transit ridership was down from the previous year. As noted previously, vehicle volumes in the HOV lane were also lower in 2009 vs. 2007, at most of the monitoring locations.

The impact of transit on HOV lane usage

Transit agencies noted that several factors affected bus ridership changes during the past two years. One of the most significant factors was a major change in the condition of the economy from 2007 to 2009, and especially the change in employment levels and gas prices (see pp. 21-23). Fare increases also had a negative impact on transit ridership, as they were implemented in 2008 and 2009 by several bus transit agencies serving the Seattle area.

A third factor that accounts for some reduced bus ridership in 2009 was the opening of the Link light rail service in July 2009, connecting SeaTac and downtown Seattle, combined with associated cancellations or schedule changes for some bus routes paralleling the light rail corridor. Some riders moved from bus service to light rail service: in turn, some of the reduced bus ridership observed at monitoring locations reflects the shift of riders away from a public transportation mode that uses freeways, to a mode that uses other facilities.

The net effect of lower bus transit ridership and lower vehicle volumes was a lower HOV person volume in 2009 compared to 2007, at almost all monitoring locations. The accompanying graph shows the trend of HOV lane use on the major corridors during the peak periods.

Comparing HOV lane person throughput with GP lanes

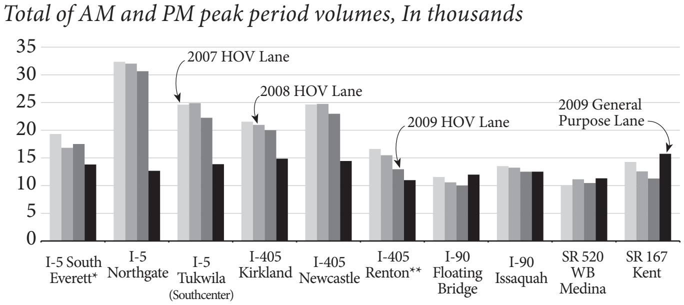
Another way to track HOV lane performance over time is to compare person throughput in the HOV lane with that of the adjacent GP lanes, on a per-lane basis. Recent annual *Gray Notebook* reports have shown that since 2005 there has been continued growth in the number of persons carried by the HOV lane, relative to the average adjacent GP lane. In 2007, eight of the ten monitoring locations showed HOV person throughput exceeding adjacent GP person throughput on a per-lane basis. In 2009, reduced person volumes in the HOV lane resulted in six of the ten monitoring locations showing HOV person throughput exceeding adjacent GP per-lane person throughput, while a seventh location (I-90 at Issaquah) had nearly equal GP and HOV per-lane person throughput. Of the other three locations, SR 520 westbound at Medina showed some growth in peak period person volumes since 2007, though person volumes were down from 2008 levels.

Conditions at the other two locations are somewhat unusual. At SR 167 in Kent, the HOV lane was converted to a HOT lane in mid-2008, while the monitoring location on the I-90 floating bridge has a two-lane center reversible roadway that does not have an HOV-only restriction, but is a continuation of an HOV lane segment.

The graph below compares HOV lane use to adjacent 2009 GP lane use (per-lane) on the major corridors during peak periods.

Comparison of HOV lane and general purpose lane person throughput

Total of AM and PM peak period volumes, In thousands



Data source: Washington State Transportation Center (TRAC).

Notes: Volumes are for peak period directions only. *In 2007 the monitoring location changed because of construction. **The monitoring location changed from I-405 Tukwila to I-405 Rention. (Cedar Ave.)

High Occupancy Vehicle Lanes Performance Analysis

HOV Lanes versus General Purpose Lane Travel Times

The HOV versus GP lane travel time tables on the following pages show travel times for the 48 HOV routes that run beside the 38 Puget Sound commute routes WSDOT tracks. Several routes on I-90 and I-5 have travel times for reversible express lanes. On the four westbound routes that use SR 520, travel times are provided for two-person and three-or-more (3+) HOV lanes, since part of the HOV system on that highway is open only to vehicles with three or more people.

Average travel times on the majority of HOV lanes improved between 2007 and 2009

Of the 48 HOV routes, 36 show improved average travel times from 2007 to 2009. Improvement on the routes ranged from one to nine minutes, usually corresponding with similar improvements seen in their GP counterparts (see table on page 19-20). The improvements that these HOV routes experienced between 2007 and 2009 are greater than those seen in the last Congestion Report, which covered 2006 and 2008. A reasonable explanation is that the HOV routes are affected by the same forces that are improving travel times in GP lanes: economic conditions and WSDOT's congestion relief projects.

HOV lanes provide substantial benefits in travel time

Generally speaking, the patterns that have emerged since WSDOT began publishing this data have held steady, with roughly the same difference between GP travel times and HOV travel times. Although historically, a few routes do not show any benefit (see the 2008 Congestion Report, page 35), 39 of the 48 provided a faster trip than in adjacent GP lanes .

Seattle to Redmond evening HOV travel times are four minutes longer in 2009

HOV travel times on the Seattle to Redmond evening route increased by four minutes from 2007 to 2009, a substantial increase in a period that saw most HOV routes' travel times decreasing. This is also the case with the 95% reliable travel time, which is up by six minutes.

The travel time change appears to be associated with SR 520/ West Lake Sammamish Parkway to SR 202 construction project to expand capacity in Redmond. Travel times began to go up after the project began in April 2009. Prior to the beginning of construction, both the average travel time and 95% reliable travel time were down by one minute, a pattern consistent with most other HOV routes in the region through the course of 2009. After the project began, the average travel time went up five minutes, while the 95% reliable travel time went up eight minutes. When looking across the full year, the net increases were only four and six minutes, respectively.

The slow segments are on a part of the route that does not have an HOV lane; the HOV lane ends prior to the construction zone. Both the HOV segment and its associated GP segment are equally affected by the slower speeds in 2009, so the relative benefit of the HOV trip compared to the associated GP trip is not affected.

HOV Lane Travel Times for Morning Commutes

Morning commutes: HOV lane travel time performance compared to general purpose lanes

			Travel times on the route at		Average travel time at peak of AM rush					95% Reliable travel times				
Route	Length of route	Peak of commuter AM rush	Posted speed	Maximum throughput speed	HOV lanes 2007	HOV lanes 2009	Δ	GP lanes 2009	2009: Difference HOV vs. GP	HOV lanes 2007	HOV lanes 2009	Δ	GP lanes 2009	2009: Difference HOV vs. GP
To Seattle														
I-5 Everett to Seattle														
Regular HOV lane[2]	22	7:30	22	27	41	33	-8	40	-7	65	52	-13	66	-14
Reversible lanes[2]	22	7:30	22	27	38	30	-8	40	-10	57	46	-11	66	-20
I-5 Federal Way to Seattle	22	7:35	22	26	34	25	-9	35	-10	47	31	-16	52	-21
I-90 Issaquah to Seattle														
HOV & GP lanes[1]	14	7:45	14	17	17	15	-2	18	-3	21	18	-3	26	-8
HOV & reversible lanes[1]	14	7:45	14	17	16	15	-1	18	-3	18	16	-2	26	-10
SR 520 Redmond to Seattle														
2 person	15	7:45	15	18	22	21	-1	21	0	31	30	-1	31	-1
3+ HOV	15	7:45	15	18	17	18	1	21	-3	20	22	2	31	-9
I-5 SeaTac to Seattle	13	8:40	13	16	21	15	-6	22	-7	27	20	-7	31	-11
I-90 Bellevue to Seattle														
HOV & GP lanes[1]	9	7:50	9	11	11	9	-2	8	1	15	11	-4	12	-1
HOV & reversible lanes[1]	9	7:50	9	11	9	9	0	8	1	10	9	-1	12	-3
SR 520 Bellevue to Seattle														
2 person	10	7:50	10	12	18	17	-1	17	0	23	26	3	26	0
3+ HOV	10	7:50	10	12	13	12	-1	17	-5	15	15	0	26	-11
To Bellevue														
I-405 Everett to Bellevue	23	7:25	23	28	30	27	-3	42	-15	41	33	-8	68	-35
I-405 Lynnwood to Bellevue	16	7:35	16	19	21	18	-3	33	-15	27	22	-5	54	-32
I-405 Tukwila to Bellevue	14	7:40	14	16	22	14	-8	26	-12	32	15	-17	37	-22
I-90 Seattle to Bellevue														
HOV & GP lanes[1]	9	8:50	9	11	14	11	-3	12	-1	21	16	-5	17	-1
SR 520 Seattle to Bellevue	10	8:45	10	12	23	20	-3	20	0	33	29	-4	29	0
I-90 Issaquah to Bellevue	9	8:40	9	11	12	12	0	15	-3	15	15	0	23	-8
SR 520 Redmond to Bellevue	7	7:50	7	9	9	9	0	9	0	10	11	1	10	1

Data source: WSDOT Traffic Operations and the Washington State Transportation Center (TRAC) at the University of Washington.

Note: HOV Trips with the same endpoints as GP lane trips, but differing lengths, do not require any adjustment, since the difference in lengths is the result of HOVs using different roadways than GPs (e.g., an HOV only interchange ramp). In 2010, commute lengths have been rounded to integer values for publication purposes only.

1 For each HOV trip to/from Seattle on I-90, comparisons are made with a modified GP trip that is 1.2 to 1.8 miles shorter (depending on trip type and direction) than the corresponding standard GP trip, to enable a direct apples-to-apples GP vs. HOV comparison. Therefore, travel times and time stamp for peak of commuter rush for these shortened GP trips will not match travel times and time stamp for peak of commuter rush in the tables on pages 19-20.

2 The I-5 HOV trips that use the express lanes between Everett and Seattle are 1.2 miles shorter than the same trips described in the 2009 Gray Notebook Congestion report, because of a lack of data at the downtown Seattle endpoint of those express lane trips. To enable a direct comparison, the corresponding GP trips have been shortened by the same amount; this means that travel times for these shortened GP trips will not match travel times in the tables on pages 19-20, and the 2007 values in this table will not match 2007 values reported in the 2008 congestion report.

High Occupancy Vehicle Lanes Performance Analysis

HOV Lane Travel Times for Evening Commutes

Evening commutes: HOV lane travel time performance compared to general purpose lanes

Route	Length of route	Peak of commuter PM rush	Travel times on the route at: Posted speed	Travel times on the route at: Maximum throughput speed	Average travel time at peak of AM rush: HOV lanes 2007	HOV lanes 2009	Δ	GP lanes 2009	2009: Difference HOV vs. GP	95% Reliable travel times: HOV lanes 2007	HOV lanes 2009	Δ	GP lanes 2009	2009: Difference HOV vs. GP
From Seattle														
I-5 Seattle to Everett														
Regular HOV lane[2]	22	4:50	22	27	38	36	-2	39	-3	58	50	-8	52	-2
Reversible lanes[2]	22	4:50	22	27	34	31	-3	39	-8	53	41	-12	52	-11
I-5 Seattle to Federal Way	21	4:05	21	25	32	27	-5	32	-5	48	38	-10	44	-6
I-5 Seattle to SeaTac	13	4:10	13	16	18	17	-1	19	-2	24	23	-1	27	-4
I-90 Seattle to Bellevue														
HOV & GP lanes[1]	9	5:30	9	11	14	12	-2	13	-1	22	20	-2	22	-2
HOV & reversible lanes[1]	9	5:30	9	11	10	10	0	13	-3	10	11	1	22	-11
SR 520 Seattle to Bellevue	10	5:30	10	12	19	20	1	20	0	29	33	4	33	0
SR 520 Seattle to Redmond	15	5:30	15	18	26	30	4	31	-1	37	43	6	46	-3
I-90 Seattle to Issaquah														
HOV & GP lanes[1]	14	5:35	14	17	19	17	-2	18	-1	27	25	-2	26	-1
HOV & reversable lanes[1]	14	5:35	14	17	15	14	-1	18	-4	16	15	-1	26	-11
From Bellevue														
I-405 Bellevue to Everett[2]	23	5:20	23	28	32	29	-3	39	-10	48	37	-11	55	-18
I-405 Bellevue to Lynnwood	16	5:20	16	19	23	21	-2	31	-10	33	29	-4	46	-17
I-405 Bellevue to Tukwila	13	4:25	13	16	21	17	-4	29	-12	29	23	-6	43	-20
I-90 Bellevue to Seattle														
HOV & GP lanes[1]	9	5:30	9	11	16	14	-2	20	-6	25	22	-3	34	-12
SR 520 Bellevue to Seattle														
2 person	10	5:25	10	12	26	25	-1	26	-1	37	34	-3	38	-4
3+ HOV	10	5:25	10	12	16	16	0	26	-10	21	24	3	38	-14
I-90 Bellevue to Issaquah	9	5:30	9	11	15	13	-2	14	-1	20	17	-3	19	-2
I-90 Bellevue to Redmond	7	5:30	7	8	13	15	2	16	-1	20	24	4	24	0

Data source: WSDOT Traffic Operations and the Washington State Transportation Center (TRAC) at the University of Washington.

Note: HOV Trips with the same endpoints as GP lane trips, but differing lengths, do not require any adjustment, since the difference in lengths is the result of HOVs using different roadways than GPs (e.g., an HOV only interchange ramp). In 2010, commute lengths have been rounded to integer values for publication purposes only.

1 For each HOV trip to/from Seattle on I-90, comparisons are made with a modified GP trip that is 1.2 to 1.8 miles shorter (depending on trip type and direction) than the corresponding standard GP trip, to enable a direct apples-to-apples GP vs. HOV comparison. Therefore, travel times and time stamp for peak of commuter rush for these shortened GP trips will not match travel times and time stamp for peak of commuter rush in the tables on pages 19-20.

2 The I-5 HOV trips that use the express lanes between Everett and Seattle are 1.2 miles shorter than the same trips described in the 2009 Gray Notebook Congestion report, because of a lack of data at the downtown Seattle endpoint of those express lane trips. To enable a direct comparison, the corresponding GP trips have been shortened by the same amount; this means that travel times for these shortened GP trips will not match travel times in the tables on pages 19-20, and the 2007 values in this table will not match 2007 values reported in the 2008 congestion report.

HOV Lane Travel Times for Other Location Commutes

Morning / Evening commutes: HOV lane travel time performance compared to general purpose lanes

			Travel times on the route at		Average travel time at peak of AM rush					95% Reliable travel times				
					HOV lanes			GP lanes	2009: Difference	HOV lanes			GP lanes	2009: Difference
Route	Length of route	Peak of commuter rush	Posted speed	Maximum throughput speed	2007	2009	Δ	2009	HOV vs. GP	2007	2009	Δ	2009	HOV vs. GP
To other locations – Morning (AM)														
I-405 Bellevue to Tukwila	13	7:40	13	16	14	14	0	20	-6	15	15	0	26	-11
SR 167 Auburn to Renton														
HOT lanes	10	7:40	10	12	11	10	-1	15	-5	14	10	-4	22	-12
SR 520 Seattle to Issaquah														
HOV & GP lanes[1]	14	8:45	14	17	18	15	-3	15	0	25	21	-4	21	0
I-90 Seattle to Redmond	15	8:45	15	18	27	25	-2	25	0	37	35	-2	34	1
From other locations – Evening (PM)														
I-5 Everett to Seattle														
Regular HOV lane[2]	22	3:35	22	27	37	33	-4	35	-2	51	43	-8	50	-7
I-90 Issaquah to Seattle														
HOV & GP lanes[1]	14	5:30	14	17	18	18	0	21	-3	25	27	2	41	-14
SR 520 Redmond to Seattle														
2 person	15	5:30	15	18	35	32	-3	33	-1	56	51	-5	53	-2
3+ HOV	15	5:30	15	18	23	22	-1	33	-11	40	37	-3	53	-16
I-5 SeaTac to Seattle	13	5:25	13	16	17	16	-1	20	-4	23	25	2	36	-11
SR 167 Renton to Auburn	10	3:45	10	12	13	11	-2	14	-3	19	13	-6	25	-12
I-405 Tukwila to Bellevue	14	5:20	14	16	15	15	0	20	-5	15	17	2	27	-10

Data source: WSDOT Traffic Operations and the Washington State Transportation Center (TRAC) at the University of Washington.

Note: HOV Trips with the same endpoints as GP lane trips, but differing lengths, do not require any adjustment, since the difference in lengths is the result of HOVs using different roadways than GPs (e.g., an HOV only interchange ramp). In 2010, commute lengths have been rounded to integer values for publication purposes only.

1 For each HOV trip to/from Seattle on I-90, comparisons are made with a modified GP trip that is 1.2 to 1.8 miles shorter (depending on trip type and direction) than the corresponding standard GP trip, to enable a direct apples-to-apples GP vs. HOV comparison. Therefore, travel times and time stamp for peak of commuter rush for these shortened GP trips will not match travel times and time stamp for peak of commuter rush in the tables on pages 19-20.

2 The I-5 HOV trips that use the express lanes between Everett and Seattle are 1.2 miles shorter than the same trips described in the 2009 Gray Notebook Congestion report, because of a lack of data at the downtown Seattle endpoint of those express lane trips. To enable a direct comparison, the corresponding GP trips have been shortened by the same amount; this means that travel times for these shortened GP trips will not match travel times in the tables on pages 19-20, and the 2007 values in this table will not match 2007 values reported in the 2008 congestion report.

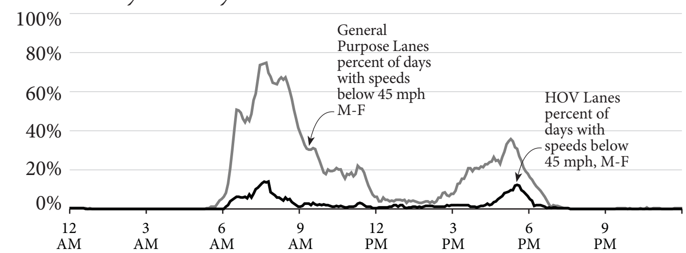
High Occupancy Vehicle Lanes Performance Analysis

Graphing HOV Lane vs. GP Lane Travel Times

Note: The graphs below show the existing HOV lane system's performance versus the performance of the adjacent general purpose (GP) lanes for selected Puget Sound commutes. The line graphs represent the percent of days when average vehicle speeds fell below 45 mph (the HOV lane reliability performance standard), throughout the course of the day. The dark line represents the HOV lanes, while the gray line represents the GP lanes.

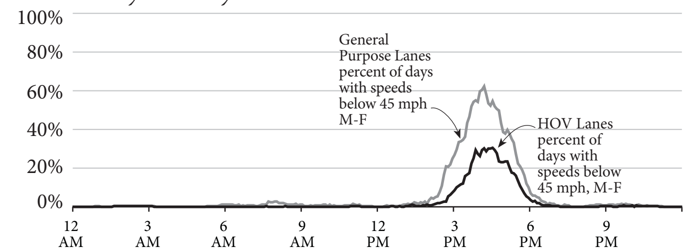
I-5 Federal Way to Seattle

2009 Weekday data only



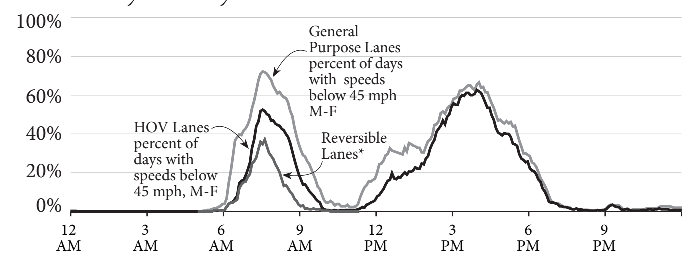
I-5 Seattle to Federal Way

2009 Weekday data only



I-5 Everett to Seattle

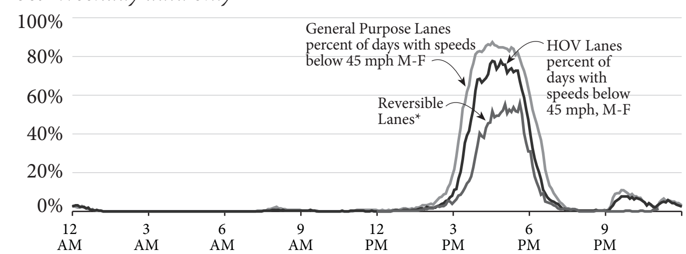
2009 Weekday data only



*Monday-Friday Hours of Operation: Southbound - 5 am o 11:15 am; Northbound - Noon to 11pm; Closed - 11 pm to 5am.

I-5 Seattle to Everett

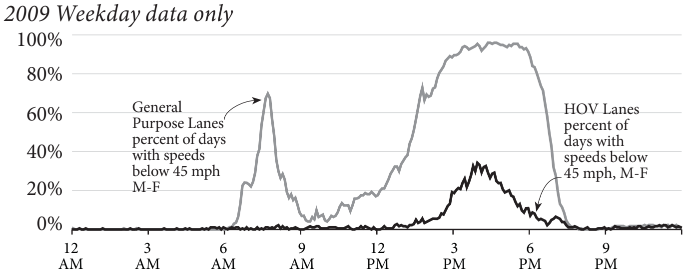
2009 Weekday data only



*Monday-Friday Hours of Operation: Southbound - 5 am o 11:15 am; Northbound - Noon to 11pm; Closed - 11 pm to 5am.

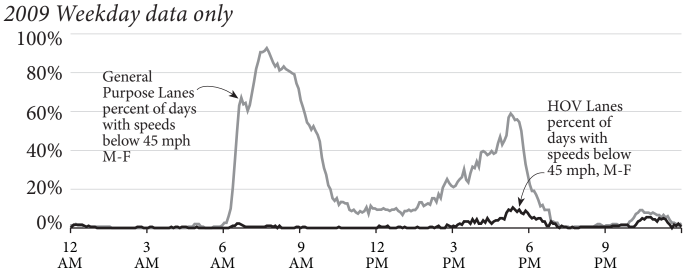
I-5 Bellevue to Tukwila

2009 Weekday data only



I-5 Tukwila to Bellevue

2009 Weekday data only



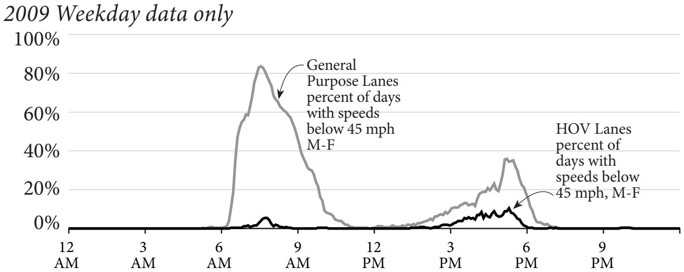
Data source: WSDOT Traffic Office.

Graphing HOV Lane vs. GP Lane Travel Times, continued

Note: The graphs below show the existing HOV lane system's performance versus the performance of the adjacent general purpose (GP) lanes for selected Puget Sound commutes. The line graphs represent the percent of days when average vehicle speeds fell below 45 mph (the HOV lane reliability performance standard), throughout the course of the day. The dark line represents the HOV lanes, while the gray line represents the GP lanes.

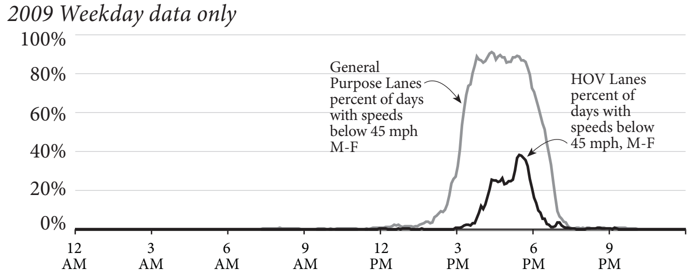
I-405 Lynnwood to Bellevue

2009 Weekday data only



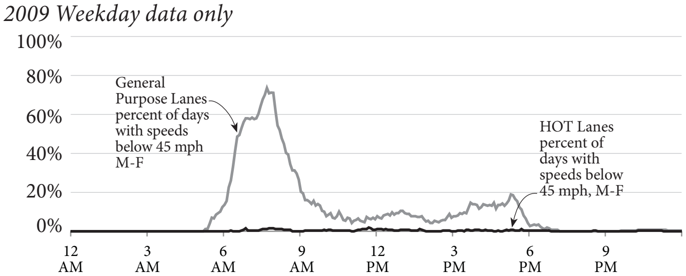
I-405 Bellevue to Lynnwood

2009 Weekday data only



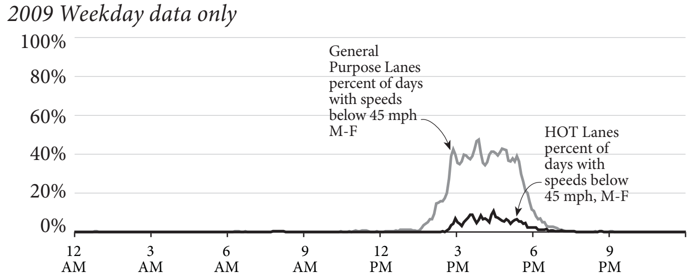
SR 167 Auburn to Renton

2009 Weekday data only



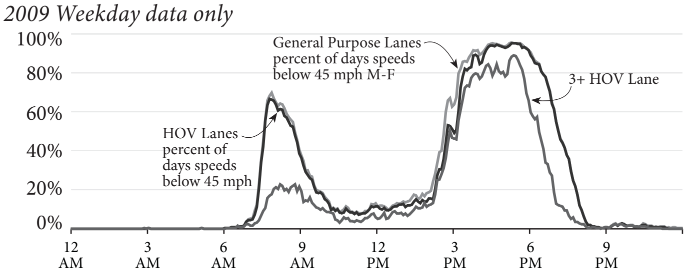
SR 167 Renton to Auburn

2009 Weekday data only



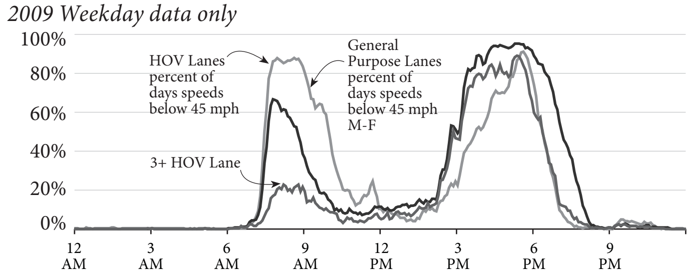
I-405/SR 520/I-5 Bellevue to Seattle

2009 Weekday data only



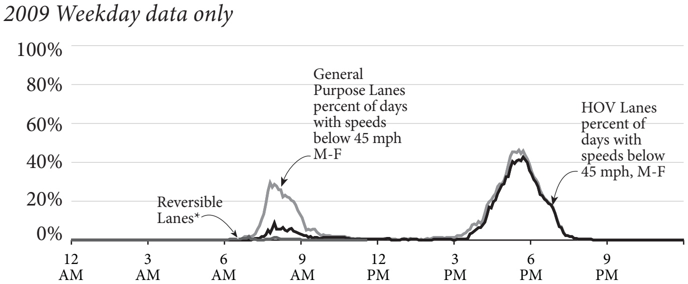
I-5/SR 520/I-405 Seattle to Bellevue

2009 Weekday data only



I-90/I-5 Issaquah to Seattle

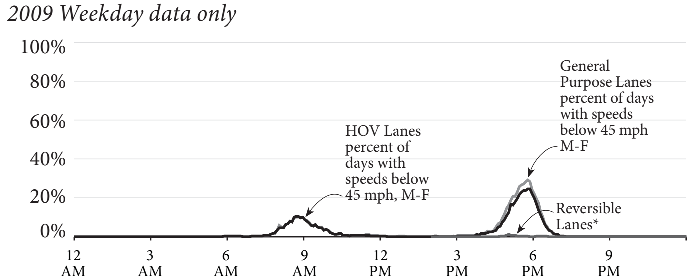
2009 Weekday data only



* Monday-Friday Hours of Operation: Westbound - 1 am o 12:30 pm; Eastbound - 2 pm to midnight.

I-5/I-90 Seattle to Issaquah

2009 Weekday data only



* Monday-Friday Hours of Operation: Westbound - 1 am o 12:30 pm; Eastbound - 2 pm to midnight.

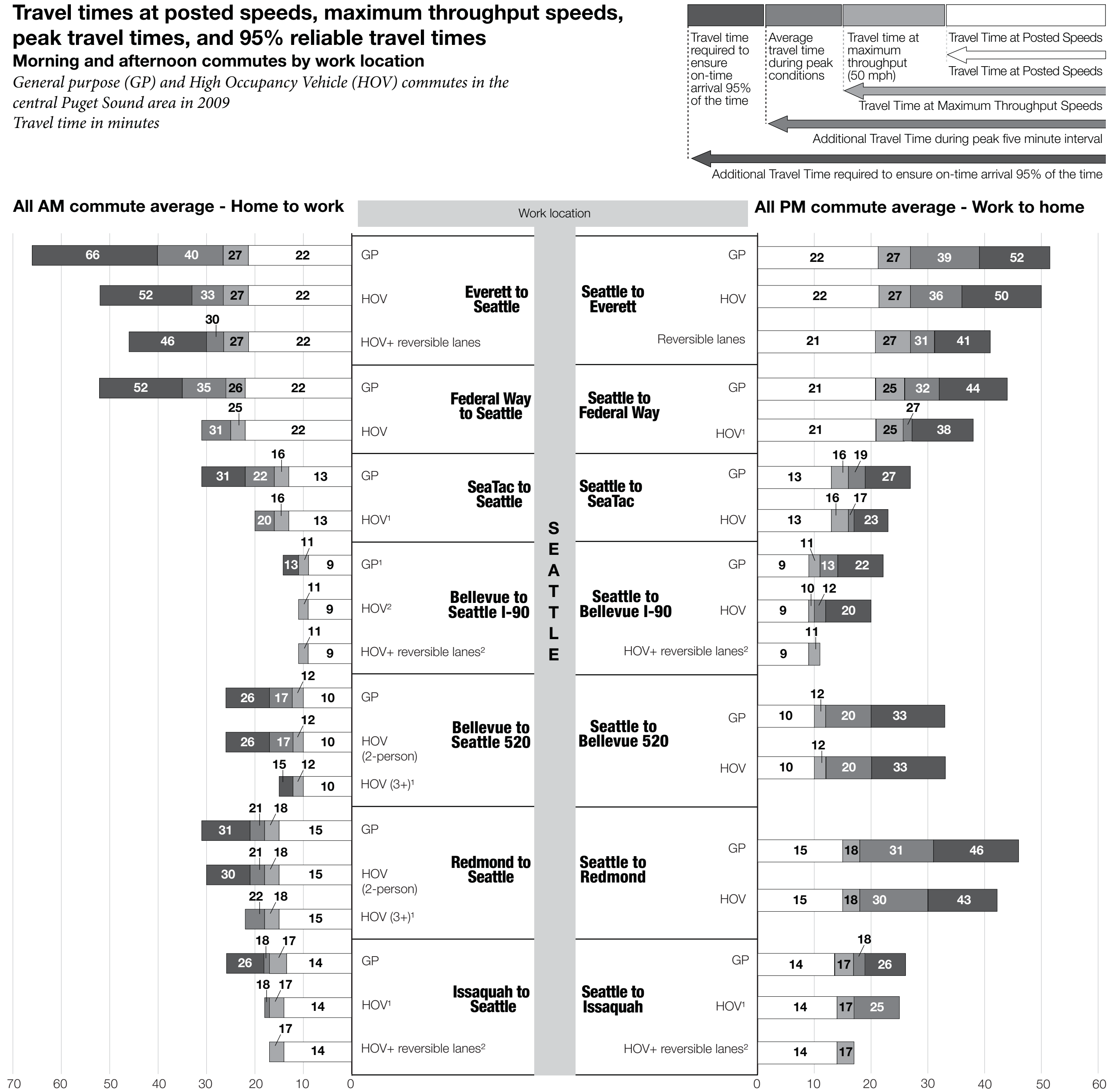
Data source: WSDOT Traffic Office.

HOV Lane Travel Times Compared to GP Lanes for Seattle Work Locations

Comparison of general purpose and HOV lane travel times in 2009-Seattle work locations

Below is a graphical representation of the tables from pp. 39-41, showing four of the travel times performance indicators.

Travel times at posted speeds, maximum throughput speeds, peak travel times, and 95% reliable travel times
Morning and afternoon commutes by work location
General purpose (GP) and High Occupancy Vehicle (HOV) commutes in the central Puget Sound area in 2009
Travel time in minutes



Data source: WSDOT Traffic Operations, TRAC.

Notes: 1 Average Travel Times were equal to or faster than maximum throughput travel times on this route.

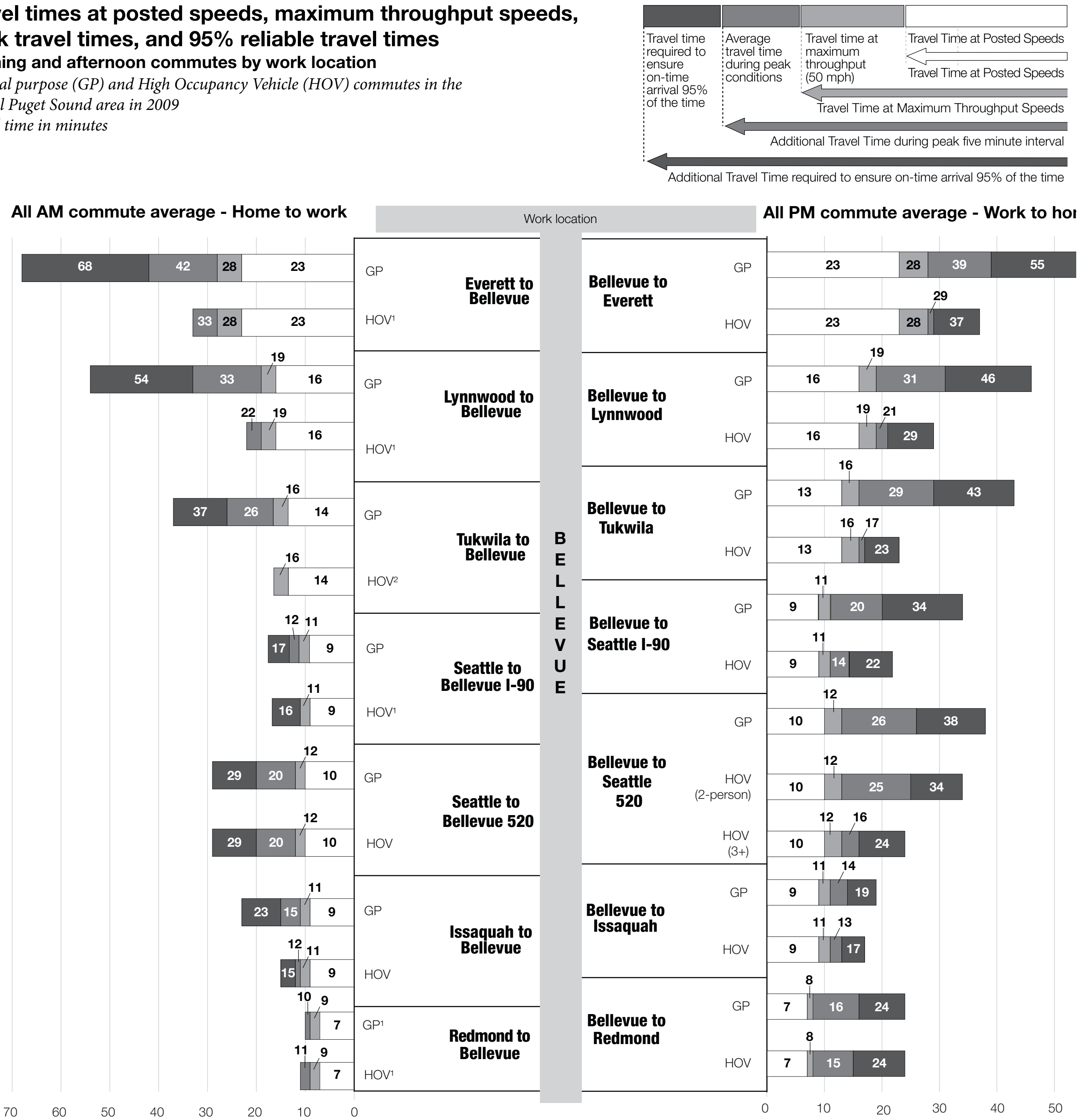
2 Average Travel Times and 95% Reliable Travel Times were equal to or faster than maximum throughput travel times on this route.

HOV Lane Travel Times Compared to GP Lanes for Bellevue Work Locations

Comparison of general purpose and HOV lane travel times in 2009-Bellevue work locations

Below is a graphical representation of the tables from pp. 39-41, showing four of the travel times performance indicators.

Travel times at posted speeds, maximum throughput speeds, peak travel times, and 95% reliable travel times
Morning and afternoon commutes by work location
General purpose (GP) and High Occupancy Vehicle (HOV) commutes in the central Puget Sound area in 2009
Travel time in minutes



Data source: WSDOT Traffic Operations, TRAC.

Notes: 1 Average Travel Times were equal to or faster than maximum throughput travel times on this route.
2 Average Travel Times and 95% Reliable Travel Times were equal to or faster than maximum throughput travel times on this route.

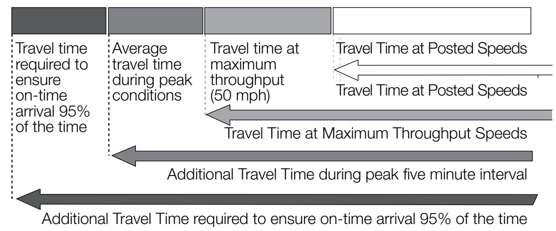
High Occupancy Vehicle Lanes Performance Analysis

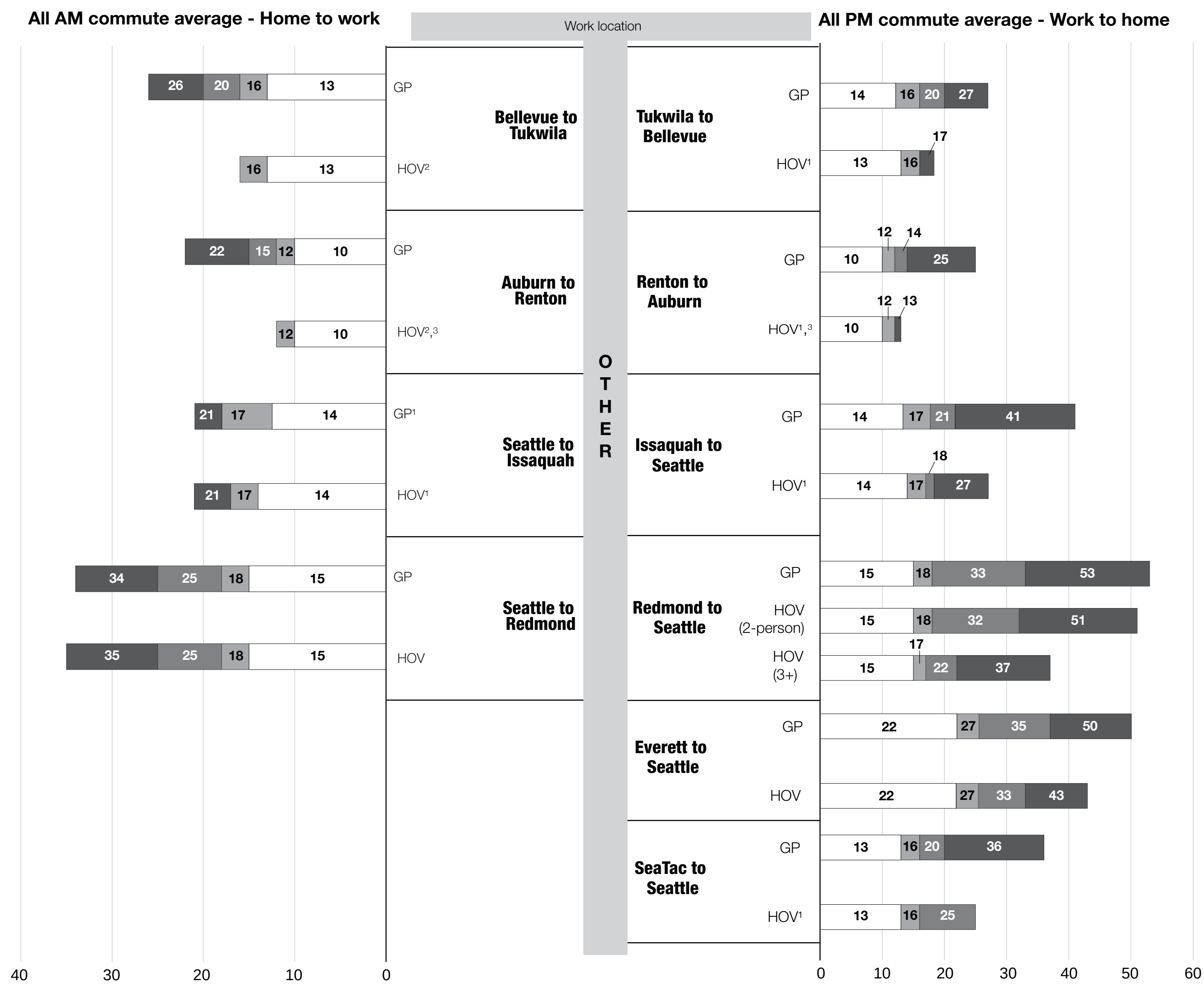
HOV Lane Travel Times Compared to GP Lanes for Other Work Locations

Comparison of general purpose and HOV lane travel times in 2009-Other work locations

Below is a graphical representation of the tables from pp. 39-41, showing four of the travel times performance indicators.

Travel times at posted speeds, maximum throughput speeds, peak travel times, and 95% reliable travel times
Morning and afternoon commutes by work location
General purpose (GP) and High Occupancy Vehicle (HOV) commutes in the central Puget Sound area in 2009
Travel time in minutes





Data source: WSDOT Traffic Operations, TRAC.

Notes: 1 Average Travel Times were equal to or faster than maximum throughput travel times on this route.
2 Average Travel Times and 95% Reliable Travel Times were equal to or faster than maximum throughput travel times on this route.
3 This route was operated in both directions as an HOV lane in 2007, an HOT lane in 2009.

Operate Efficiently: SR 167 High Occupancy Tolling

Operating efficiently means taking steps to smooth out traffic flow and avoid or reduce situations that constrict road capacity. Collisions account for at least 25% of traffic backups, so making roads safer will help ease congestion. Technology, such as driver information signs, enables WSDOT to react quickly to unforeseen traffic fluctuations. Among the tools that provide this efficiency are metered freeway on-ramps, incident response teams, variable speed-limit systems, variable tolling, integrated traffic signals, and Active Traffic Management.

SR 167 High Occupancy Tolling program

The first two years of the State Route 167 High Occupancy Toll (HOT) Lane project have yielded significant results, both for the drivers who access the HOT lanes and for general purpose (GP) lane users. Drivers who opt to use the HOT lanes save time and reduce the stress associated with their daily commute, while also reducing the volume of traffic in the GP lanes. The result: traffic moves at free-flow speeds more often and benefits all SR 167 users. HOT lanes are another example of how HOV lanes can operate efficiently to relieve congestion in vital corridors.

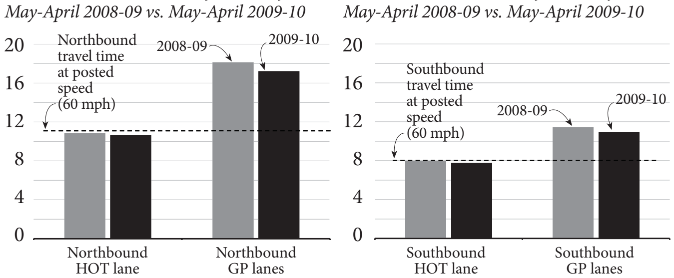
HOT lanes result in faster travel times, peak speeds

In 2009, the northbound HOT lane provided weekday (Tuesday through Thursday) drivers with an average time savings of eight minutes in the peak hour (7–8 am), with an average travel time of 11 minutes and an average toll of $1.25. The average peak travel time for the GP lanes was 19 minutes. The weekday southbound HOT lane provided drivers with an average savings of three minutes during the peak hour (4–5 pm), with an average travel time of eight minutes and an average toll of $1.25. Once again, the GP peak travel time average was longer at 11 minutes.

SR 167 travel times for HOT and GP lanes

Northbound travel times in minutes (corridor is 10 miles) Tuesday-Thursday, May-April 2008-09 vs. May-April 2009-10

Southbound travel times in minutes (corridor is 8 miles) Tuesday-Thursday, May-April 2008-09 vs. May-April 2009-10



Data source: WSDOT Northwest Region Traffic Office.

Note: Travel time is an average of morning (7-8 am) and evening (4-5 pm) peak periods.

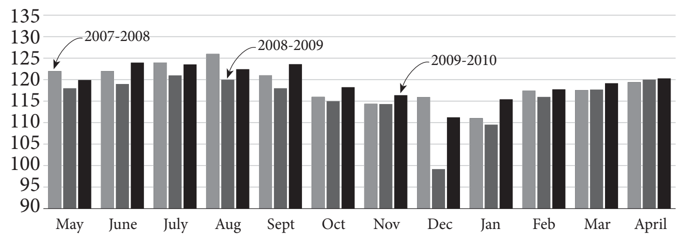
Southbound peak-hour speeds in the GP lane increased 19% compared to 2007; while northbound speeds increased 3%. Drivers in the HOT lanes attain maximum throughput speeds and usually travel at the posted speed limit of 60 mph.

Daily volumes rebound

During the second year of operations, the average daily traffic volumes in the GP lanes of SR 167 increased to the pre-opening volumes recorded in 2007. Daily volumes in the first year of HOT operations decreased slightly: this may have been in response to rising gas prices and the faltering economy, or to driver unfamiliarity with HOT lanes. On average, HOT lane volumes have increased by 12% while GP lane volumes increased 2%–3%.

SR 167 Average daily traffic volumes

Before and After opening of HOT lanes, 2007 - 2010
Volume in thousands



Data source: WSDOT Northwest Region Traffic Office.

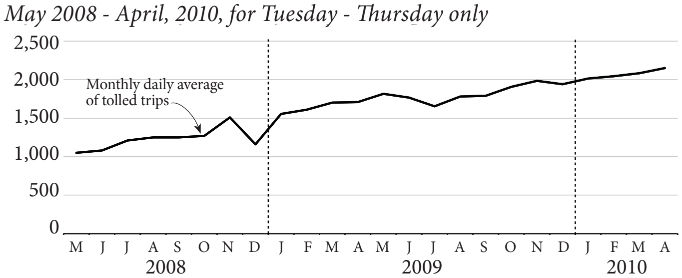
Note: The average recorded speeds for high occupancy lanes in 2007-2008 is represented by HOV speeds. HOT operations did not begin until May 2008.

The second year's operations reveal more user awareness of the HOT lanes and their benefits

The second year data indicates that the public understands the benefits of HOT lanes: the average daily number of tolled trips rose to 2,150 in April, 2010 compared to 1,710 in 2009. Monthly revenue continues to climb, and annual figures show a 33% increase to $420,400 in gross revenue by April 30, 2010. *Good To Go!* transponder sales increased to a monthly average of 4,800 in the second year of operation from 4,100 in the first year. Preliminary data suggests that since HOT operations began, the SR 167 corridor has seen 17% fewer collisions.

SR 167 HOT lanes average number of daily tolled trips

May 2008 - April, 2010, for Tuesday - Thursday only



Data source: WSDOT Northwest Region Traffic Office.

Active Traffic Management Systems: Smarter Highways

Intelligent Transportation Systems

Intelligent Transportation Systems (ITS) are technological interventions WSDOT uses to increase safety and help traffic flow move smoothly on the highway. These systems can be as small as a ramp meter, and as complex as active traffic management systems, which includes WSDOT's new Smarter Highways system. The table below shows the agency's ITS inventory as of September 30, 2010. WSDOT has added an ITS category for Smarter Highway gantries, the devices supporting automated traffic management operations on I-5, I-90, and SR 520.

Active Traffic Management: WSDOT's Smarter Highways

WSDOT activated the state's first Smarter Highways corridor on August 10, 2010. This technology, also known as Active Traffic Management, is located along a 7.5-mile section of I-5 northbound between Boeing Access Road and I-90 in Seattle. Fifteen sign bridges provide real-time traffic information to drivers every half mile.

When approaching a blocking incident, drivers are alerted by yellow merge arrows, red Xs over closed lanes, and green arrows over open lanes. The system also adjusts the speed limit to slow traffic before reaching congestion or a blocked lane. This advanced warning helps prevent panic breaking that can lead to collisions. There are also several side-mounted and overhead electronic message signs to convey additional real-time information to drivers. Warning drivers of incidents and congestion ahead is expected to reduce the number and severity of collisions.

One of the I-5 northbound Smarter Highway gantries south of downtown Seattle shortly after debuting in August 2010.

System performance

While nearly three months of operations is still too soon to evaluate the effect on collisions and congestion, the system performed well during the first months of operation. Based on collision data to date, there have been 35 collisions between August 10 and November 1 of 2010. This is lower when compared to 100 to 140 collisions recorded over a similar time frame during the past five years. This could mean a significant safety improvement. In addition, fewer collisions should result in better traffic flow and travel times.

Lane control

The lane control system was activated 51 times during the first month, with 23 activations for maintenance or construction activities, 16 for disabled vehicles, 11 for collisions, and one for a presidential motorcade.

WSDOT's Intelligent Transportation Systems inventory
Statewide inventory as of September 30, 2010

	Number of devices or sites each year				
Device type	**2007**	**2008**	**2009**	**2010**	**Approximate cost per device/site**
Closed circuit television cameras[1]	521	542	555	699	$15,000-$30,000
Variable message signs[1]	179	181	186	201	$100,000-$250,000
Highway advisory radio transmitters[2]	64	68	70	82	$50,000
Road/weather information systems	94	97	100	105	$25,000-$50,000
Metered ramps	137	137	143	154	$10,000-$100,000[3]
Traffic data stations	530	554	565	639	$10,000-$20,000
Smarter Highway gantries[4]	0	0	25	53	$650,000-$900,000

Data source: WSDOT Traffic Operations Office.

Notes: 1 Some local cities and counties pay WSDOT to maintain their closed circuit televisions and variable message signs; for 2007, figures included both WSDOT-owned and WSDOT-maintained elements, 2008-2010 figures include only WSDOT-owned elements.
2 Six highway advisory radio transmitters were miscategorized and included in the previous reports for 2007-2009. The figures above are correct.
3 This represents the cost of one ramp meter device; there may be multiple ramp meters on one ramp.
4 Gantries include electronic message and speed signs.

Active Traffic Management Systems: Smarter Highways, continued

Variable speed limits

Congestion on this corridor typically occurs during most weekday daylight hours and also midday on weekends. The electronic signs currently display speed limits between 40 mph and 60 mph; Speeds are determined by an algorithm using live traffic data from vehicle sensors on the roadway.

Driver compliance

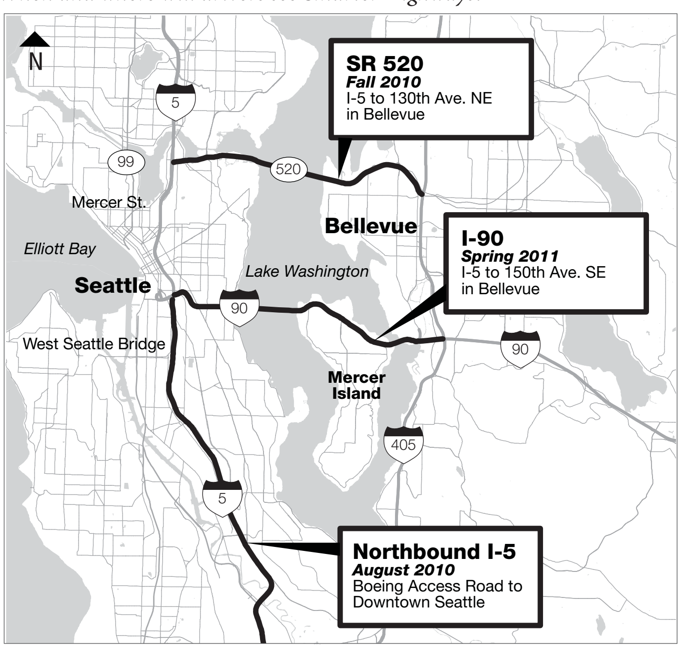
Drivers obeyed the lane control signs and merged out of closed lanes when directed by a yellow arrow or red X. Most questions from the public are related to the variable speed limits. The most common question is why the signs display 40 mph while traffic is stop-and-go, and if the speed limits are enforceable. The signs indicate the current speed limit for that section of roadway, or the speed of traffic. As with static speed limit signs, drivers may be ticketed if they exceed the speed of a variable speed limit sign.

What's next for Smarter Highways?

WSDOT is also constructing Smarter Highways on SR 520 and I-90 between Seattle and Bellevue. The signs will be activated on SR 520 later this fall and on I-90 in 2011.

Active traffic management projects near Seattle

When and where will drivers see Smarter Highways?



Data source: WSDOT Tolling Division.

I-90 variable speed limit signs

Another example of new technologies helping WSDOT to operate efficiently are the new electronic variable speed limit (VSL) signs installed on I-90 westbound between Bellevue and Seattle. This area typically sees heavy congestion for a brief afternoon peak.

The signs were activated on April 28, 2009, as part of the *I-90 Two-Way Transit & HOV Operations Stage 1* project. These signs are adjusted to display variable speed limits between 40 mph and 60 mph, based on current traffic conditions.

Variable speed limits are intended to increase safety by reducing the number of collisions that occur when drivers do not allow adequate braking time before reaching congestion. By alerting drivers to reduce their speed sooner, the likelihood of non-recurrent congestion conditions is lessened.

The table below shows the distribution of displayed speeds at each sign location during the afternoon peak period on weekdays in August 2010.

Frequency of displayed variable speed limits on I-90, westbound

PM peak period[1], Monday - Friday, August 2010

Location	Displayed speed limits (mph)				
	40	45	50	55	60
118th Avenue SE	4%	1%	4%	0%	91%
Bellevue Way	8%	1%	21%	0%	70%
East Channel	23%	7%	6%	1%	64%
North Mercer Way	27%	9%	11%	1%	52%
Shorewood Drive	31%	15%	7%	1%	46%
76th Avenue	34%	17%	5%	1%	44%
West Mercer Way	17%	16%	4%	7%	56%
West High Rise[2]	0%	4%	5%	5%	86%
Rainier[2]	0%	4%	70%	2%	24%

Data source: WSDOT Northwest Region Traffic Office.

Notes: Figures are rounded averages, and may not total to 100%.
1 The PM peak period for this corridor is between 3pm and 7pm.
2 The minimum speed limit is 40 mph for all locations except Rainier and West High Rise, which have a minimum speed limit of 45 mph.

WSDOT continues to analyze collision data

There does not appear to have been a significant change in collision trends in the year since the VSL signs were activated, but WSDOT will continue to monitor and evaluate collisions within this corridor. With only a few hours of congestion each day and a moderate pre-construction collision rate, more data is necessary to show that any change in collision rates was not due to the random nature of collisions.

Moving Washington: Operate Efficiently

Incident Response Program Annual Report

The mission of WSDOT's Incident Response (IR) program is the safe, quick clearance of traffic incidents on state highways. IR minimizes traffic congestion and restores traffic flow by removing dangerous traffic blockages that can lead to secondary collisions. IR roving units operate during peak traffic periods, offering a variety of motorist assistance services such as providing fuel and jump starts, changing flat tires, and moving disabled vehicles safely off the roadway reducing motorists' exposure to risk.

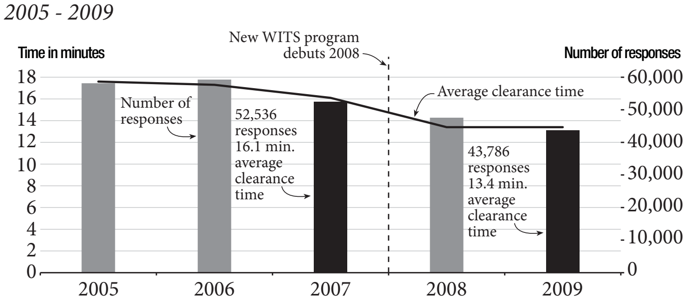
IR responders are trained and equipped to assist Washington State Patrol (WSP) troopers at collisions and other traffic emergencies. Available for call out 24/7, IR units assist WSP with traffic control, mobile communications, clean-up, and other incident clearance functions as needed during major incidents. More information on the IR program can be found at www.wsdot.wa.gov/Operations/IncidentResponse/.

Incidents cleared annually by WSDOT Incident Response Teams

The annual number of incidents statewide decreased by 16.7% in 2009 (43,786) compared to 2007 (52,536), including an 8% decrease from the 2008 total of 47,579 incidents.

The statewide average clearance time for incidents in 2009 was 13.4 minutes and in 2007 it was 16.1 minutes. These clearance times cannot be directly compared as definitional changes occurred in 2008 with the debut of the new WITS program. The number of incidents has decreased in 2008 and 2009, in part due to VMT on state highways declining by 3.8% and 1.6% respectively compared to 2007. WSDOT is investigating other potential factors for the decreasing number of incidents.

Number of responses and overall clearance time
2005 - 2009

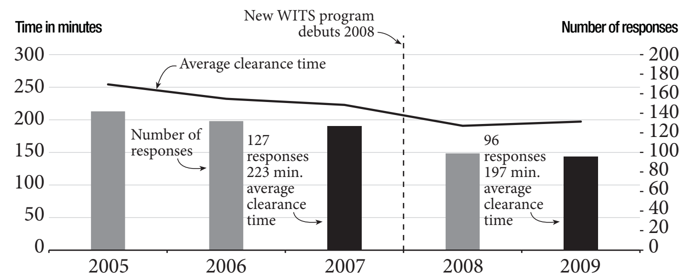


Data source: Washington Incident Tracking System, WSDOT Traffic Office.
Note: In Q1 2008, WSDOT's Incident Response Program moved to a new database system and began calculating average clearance time in a different way. This accounts for the apparent decrease in the average clearance time value.

Fatality incident responses decreased

The annual number of fatality incidents statewide decreased by 24.4% in 2009 (96) compared to 2007 (127). The fatality incident average clearance times in 2009 and 2007 were 197 minutes and 223 minutes respectively.

Number of responses and average clearance time of fatality collisions
2005-2009



Data source: Washington Incident Tracking System, WSDOT Traffic Office.
Note: In Q1 2008, WSDOT's Incident Response Program moved to a new database system and began calculating average clearance time in a different way. This accounts for the apparent decrease in the average clearance time value.

Traffic fatalities in 2009 are lowest since 1955

The downward trend in traffic fatalities on Washington's highways, city streets, county roads, and other public roadway continued in 2009. Washington experienced a decrease in fatalities from 2003 to 2004, and again from 2006 to 2008 after a spike in 2005 of 649 highway fatalities (see table below). The year 2009 brought the lowest number of traffic fatalities recorded (491) since 1955 (461).

Washington annual traffic fatalities
2003-2009

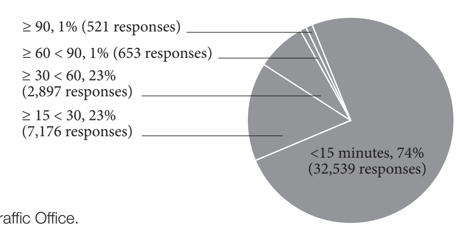
2003	2004	2005	2006	2007	2008	2009
600	567	649	633	571	522	491

Data source: Fatal Accident Reporting System (FARS).
Data analysis: WSDOT-Statewide Travel & Collision Data Office.

Number and percentage of responses by incident duration

In 2009, WSDOT IRT responded to 43,786 incidents statewide. The incident data is categorized into five categories, based on the duration of incident. The over-90 minute incidents made up 1% of all incidents in 2009.

Number and percentage of responses by category
2009



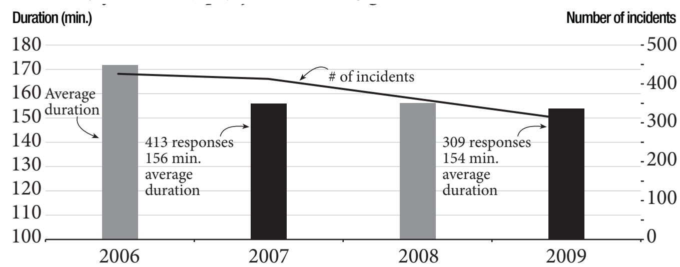
Data source: WITS, WSDOT Traffic Office.

Incident Response Program Annual Report, continued

WSDOT and WSP achieve annual GMAP target

In 2008, Governor Gregoire challenged WSP and WSDOT to repeat the successful performance achieved in 2007, reducing the duration of serious blocking incidents on nine key congested corridors. For 2009, the two agencies met the GMAP goal of 155 minutes, with the average annual duration for GMAP incidents coming in at 154 minutes. The annual average clearance time in 2007 was 156 minutes. This number has been incorrectly reported as 161 minutes in the previous GNB editions. In 2007, and 2008, the target was missed by one minute (156 minutes).

Progress toward the goal for reducing average clearance times for over-90-minute incidents on the nine key western Washington highway segments
2006 - 2009
Number of incidents per year vs. average duration in minutes



Data source: Washington State Patrol and WSDOT Traffic Office.

Major Incident Tow Pilot Project

The Major Incident Tow (MIT) Program is an incentive tow program. Its purpose is to reduce clearance times associated with incidents involving heavy trucks or vehicles (over 26,000 GVW). By quickly clearing heavy vehicle blockages, MIT reduces traveler delay and eliminates the likelihood of secondary collisions which often occur in the long queues that form behind lengthy incidents.

WSDOT and WSP jointly implemented the MIT as a pilot program for the 2007-09 Biennium, after studying a successful model - the Rapid Incident Scene Clearance Program (RISC) in Florida. MIT initially covered major freight corridors in King, Pierce, and Snohomish counties, and the funding provided for about 40 activations a year.

During the 2007-09 biennium, there were 34 activations, one cancellation, and three activations that received no payment because the tow company was not able to clear the blockage in less than 90 minutes. If the call was cancelled en route, a cancellation fee of $600 was paid to the tow company. In all, WSDOT paid out $79,581 to qualified MIT towing contractors.

Although there is only a small amount of, it appears that the program improved clearance times. Before MIT, comparable incidents (that would have qualified for MIT) showed an average road blockage time of 181 minutes; after MIT was deployed average blockage times dropped to 170 minutes for successful activations.

WSDOT refines its definitions of incidents

WSDOT and the Washington State Patrol, together with many other public safety and private sector professionals, have worked cooperatively to safely and efficiently clear traffic incidents and incident-related debris from the state highway system. This reduces congestion, improves safety, and increases traffic operations efficiency.

Traffic incidents have been identified as a major contributor to non-recurring traffic congestion. Traffic incidents account for 46% of all non-recurring congestion. For each of the different causes, whether recurring or non-recurring, there are strategies to reduce congestion.

Incident Response and performance measurements

The WSDOT Incident Response (IR) Program is a congestion reducing strategy that targets the largest contributor to non-recurring traffic congestion – traffic incidents. The motto of the IR program is "Clearing Roads. Helping Drivers." By reducing the number of traffic incidents and the time associated with clearing those incidents, the IR program has a significant impact on traffic congestion, as well as improving the safety of the traveling public. Nationally recognized traffic incident management performance measures include:

- **Roadway clearance time** This interval is defined as the time between the first recordable awareness of an incident (detection, notification, or verification) by a responding agency and first confirmation that all lanes are available for traffic flow.
- **Incident clearance time** This interval is defined as the time between the first recordable awareness of the incident and the time at which the last responder has left the scene.

These are important measures in tracking incident response performance, and WSDOT will be using both to report its performance on incident response in future *Gray Notebooks*.

The difficulty with incident response performance measurement is the definition of an incident is broad. It is easy to identify those capacity-reducing, lane-blocking incidents such as vehicle crashes, stalled vehicles, and roadway debris, but

Incident Response Program Annual Report, continued

equally important are the abandoned or disabled vehicles on the shoulder causing a distraction and potentially being involved in a struck-by incident. In an attempt to capture the complexity of the work of the IR program WSDOT has identified two general types of incidents – Emergency/Blocking and Non-blocking.

Emergency/Blocking incidents may be traffic related (such as a blocking collision, stalled or disabled vehicle, or debris in the travel portion of a roadway) or unrelated to traffic (such as natural disasters, severe weather conditions affecting traffic operations, etc.). These incidents involve life safety, whether due to the nature of the incident or because a travel lane is blocked and creates the risk of a secondary collision.

Non-blocking incidents are any incidents that do not block a travel lane but may constitute a hazard or be a distraction to other motorists. Non-blocking incidents can either be unplanned events (such as a disabled vehicle on shoulder, or a motorist parked on the shoulder using a cell phone), or planned events (such as parades or funeral processions). While not an immediate danger, these incidents are distractions and create a degree of risk for the individuals involved and for passing motorists, and require immediate attention.

Emergency/Blocking & Non-blocking incidents 2009 IR Program review

WSDOT plans to enhance its reporting by identifying incident types as either Emergency/Blocking (clearing roads) or Non-blocking (helping drivers). In 2009, there were 10,257 (23.4%) Emergency/Blocking responses and 33,529 (76.6%) Non-blocking responses, totaling 43,786 incidents.

Of the 10,257 Emergency/Blocking ("clearing roads") responses, 10,190 (99.3%) were traffic-related incidents, leaving 67 (0.7%) as non-traffic incidents. Emergency/Blocking traffic-related incidents tend to have one or more travel lanes blocked and usually involve critical life safety issues. Emergency non-traffic-related incidents include such events as pedestrians on the highway, search and rescue operations, brush fires, or other natural disasters.

For the "helping drivers" non-blocking incidents in 2009, 31,898 (95.1%) were unplanned events (such as abandoned and disabled vehicles or contacts with motorists who appeared to need assistance, but were on the phone or resting). Non-injury collisions that do not block the road also fall into this category. Planned events often involve traffic control responsibilities at such events as funerals processions, parades, or other civic events. There were 1,631 planned events in 2009, 4.9% of all non-blocking responses.

In 2009 the average incident clearance time for all 43,786 incidents was 13.4 minutes, and the average roadway clearance time when roads were blocked was 19.6 minutes.

New research addresses congestion caused by incidents

The Washington State Transportation Center (TRAC) at the University of Washington conducted research for WSDOT to determine the amount of delay caused by incidents, and the benefits that are obtained from WSDOT's IR activities. The study area included I-5 from SR 526 in the north to S. 320th in Federal Way in the south; all of I-90 west of milepost 19.5 (east of Front Street in Issaquah); all of I-405; SR 167 from I-405 to SR 18; and all of SR 520. The analysis was based on 2006 data, and developed the following conclusions.

The significance of crash- and incident-induced traffic delay

For the 2006 study year, a conservative estimate is that crashes and other traffic incidents (including disabled vehicles, debris, and other events requiring IR intervention to remove hazards) caused travelers to experience 5.3 million vehicle-hours of delay in addition to the delays caused by too many vehicles on the Puget Sound region's freeway system. This delay represents roughly 30% of the total delay from all causes that occurred on these roadways. About 11% of the total delay (1.95 million vehicle-hours) was the result of reported vehicle crashes.

Roadway conditions present when incidents create congestion

Congestion is caused by a combination of factors involving traffic volume (demand), driver behavior, and roadway characteristics (as measured in terms of functional roadway capacity). Recent research has shown that driver behavior, especially in combination with roadway configuration changes (uphill grades, sharp curves), can produce congestion under volume conditions lower than conventional traffic flow theory would suggest. The presence of driver distractions is also thought to be a major cause of these slowdowns. Incidents – both those that close lanes and those that simply create visual interest – are a key source of distractions. Larger, lane-blocking incidents are also a direct cause of lost roadway capacity. The longer capacity is reduced, the higher the probability congestion will occur, and the larger the vehicle queue that forms will be.

The effect of volume on congestion duration and delay after incidents

Incidents, including crashes, do not, in and of themselves, cause measurable delay. They cause delay only when the disruption they

Incident Response Program Annual Report, continued

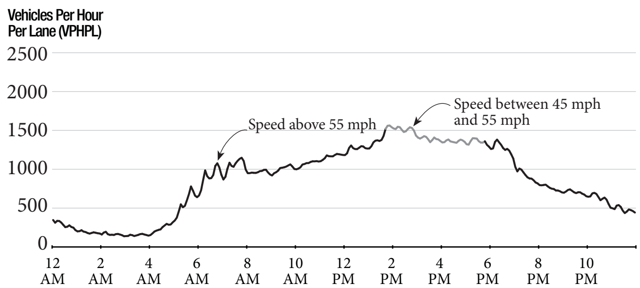
Percentage of capacity reduction by type of incident and size of roadway

Location of the incident	2-lane roadway (1 direction)	3-lane roadway	4-lane roadway
On the shoulder	25%	16%	11%
Blocking one lane	68%	47%	44%
Blocking two lanes	100%	78%	66%

Data source: Washington State Transportation Center (TRAC).

create causes functional roadway capacity to fall below actual demand. Therefore, the amount of delay caused by any given incident or type of incident is not constant but is a function of where it occurs, when it occurs, and the traffic demand relative to functional roadway capacity at the time it occurs.

Annual average weekday volume and speed with high midday volume pattern
SR 167 S 277th St., GP SB; 2009



Data source: Washington State Transportation Center (TRAC).

At low volumes, even modestly large incidents may create no measurable delay (except for the very brief "rubbernecking slow down" as vehicles pass the scene). At moderate volumes (relative to roadway capacity), small incidents still cause no congestion, but larger incidents lower the functional roadway capacity to the point at which queues form, creating significant measurable congestion. Under moderate volume conditions, large queues can dissipate quickly once the incident has been cleared.

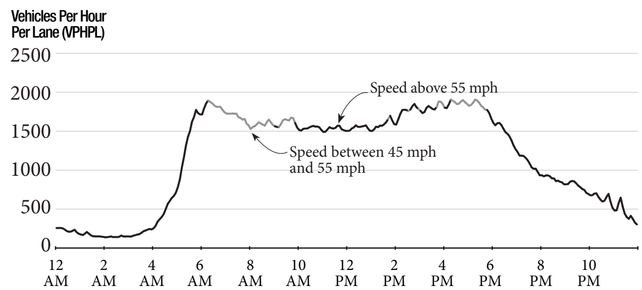
As volumes begin to approach the functional capacity, small incidents can create queuing and a dramatic increase in congestion. However, if volumes have already grown to the point where congestion has already formed before an incident occurs (such as in the top peak commute period), minor incidents create only a minor increase in the existing congestion. In addition, under both of these conditions, once congestion forms at an incident scene, congestion may remain until after the peak period traffic volumes subside, even if that incident is quickly cleared.

These factors mean that the congestion effects of incidents are different in the AM and PM peak periods, simply because the underlying traffic patterns are different. The example time-of-day volume graphs shown in the at the top of the page will be used to examine these differences.

In the graph above showing high volume, peak direction traffic volumes increase very sharply at the beginning of the morning peak period. While volumes decline at the end of the morning commute, midday traffic volumes often remain fairly high. Conversely, the PM peak starts with fairly high midday volumes and ends with a fairly steep drop-off of volumes.

In the graph showing low volume, morning traffic volumes are never near capacity. Volumes at this site grow steadily throughout the afternoon, where routine PM peak congestion leads to a slight decrease in vehicle volume throughput until the commute period ends, at which point volumes drop dramatically.

Annual average weekday volume and speed with modest midday volume pattern
I-5 156th St. SW, GP SB; 2009



Data source: Washington State Transportation Center (TRAC).

At high volume locations, early morning incidents that are cleared quickly before volumes peak cause little congestion; if congestion forms as the volume nears its peak, that congestion can last well after the end of morning commute hours, whether the incident is cleared quickly or not. Congestion remains, because volumes remain high relative to roadway capacity: at 9:30 AM, there is little spare capacity available for clearing the remaining queues.

Low volume morning conditions mean that only larger incidents (crashes) will cause congestion, and because there is considerable extra capacity available, queues that do form at a crash site will dissipate quickly once that crash has been removed.

Conversely, in both graphics, midday volumes are reasonably high. As a result, incidents that occur an hour or two before the start of the evening commute will cause queuing. If they can be cleared very quickly, only small queues will form, and those will dissipate before the commute begins. If they are not quickly cleared, the incident queue itself, combined with the rising PM

Incident Response Program Annual Report, continued

commute volume, will cause large back ups. Because volume already outstrips road capacity, the result is that the evening commute period is congested from start to finish. However, unlike in the AM peak, congestion rarely lasts long after the end of PM peak hours if incidents have been cleared, simply because fewer and fewer cars enter the freeway, allowing even large queues to clear fairly quickly. This can be seen in both graphs on page 53, as volumes drop dramatically at the end of the PM peak.

The value of delay caused by incidents

Because of the complex interaction between incident size, incident duration, traffic volume, and roadway capacity, there is no simple relationship that defines the amount of delay caused by an incident of any specific length. However, for planning and programming purposes, such a value is important. This research project determined that, once congestion forms, growth in delay is roughly linear to the duration of an incident. Therefore, by dividing the total incident caused delay by the total duration of those incidents, it is possible to determine the average vehicle-delay caused per minute of incident. Using this method, our study indicates that,

- the average incident that does not involve a lane closure results in about 576 vehicle-minutes of delay per minute that the incident is present,
- if the incident closes a lane, the effect of that lane closure results in 814 vehicle-minutes of delay per minute of closure.

Because these are average figures, they will significantly under-estimate the delay created by an incident in heavier volume conditions (relative to roadway capacity) and significantly overes-timate the delay in lower volume conditions. This can be seen in the two tables to the right, which illustrate freeway segments on which vehicle delay is especially high or low per minute of incident.

By using commonly accepted values of time for passenger and commercial vehicles (see note, below), along with an assumption that the traffic stream is made up of 10% commercial vehicles, the average delay values can be converted to an average dollar cost that represents the average cost of time and fuel lost to con-gestion for every minute of incident for three categories of traffic disruptions. These cost values are:

- Incident = $244 / minute of incident
- Closure = $345 / minute of lane closure
- Crash = $286 / minute of crash scene duration

Note: Dollar values per vehicle-minute of delay were based on values of time previously developed by WSDOT: $21.90 an hour for passenger cars and $57.40 for trucks (comprising a mix of heavy and medium duty vehicles).

Vehicle minutes of delay due to incidents on high delay segments

Corridor	Vehicle minutes of delay per minutes of incident time	Vehicle minutes of delay per minutes of lane closure
I-405 Bellevue SB	2089	1915
I-5 North Seattle SB	1975	2106
SR 167 Renton NB	1652	591
I-5 South (Fed. Way) SB	1144	1493
I-405 Kennydale SB	907	1235

Data source: Washington State Transportation Center (TRAC)..

Vehicle minutes of delay due to incidents on low delay segments

Corridor	Vehicle minutes of delay per minutes of incident time	Vehicle minutes of delay per minutes of lane closure
I-90 Issaquah EB	10	<1
I-90 Bellevue EB	15	39
I-5 Everett SB	63	61
I-90 Issaquah WB	85	53
I-405 North NB	95	268

Data source: Washington State Transportation Center (TRAC)..

If trucks make up a greater proportion of the traffic stream, the value associated with delay increases substantially, and like the delay per minute incident statistics upon which these values were based, these figures are simple averages. For times and locations where delays are longer than average, these values will underes-timate the value of incident clearance. For times and locations where lower volumes result in lower delays per minute of incident, these values will overestimate incident response benefits. Simi-larly, truck percentage and make-up also vary by time of day and from corridor to corridor. Corridors with higher truck volumes will benefit from more per minute of incident response savings than corridors that serve almost exclusively passenger cars.

Manage Demand: WSDOT's Demand Management Tools

Reducing trips on our highway system by encouraging the use of higher occupancy modes of transportation, and by shifting some travel to non-peak hours are some of the strategies WSDOT uses to manage the demand for capacity on Washington's highways. These strategies also support other important WSDOT goals, including reducing greenhouse gas emissions and energy consumption. WSDOT builds on a foundation of strong partnerships throughout the region to successfully reduce the demand for vehicle travel throughout the state.

Commute Trip Reduction reduces freeway and arterial delay and saves money

Since 1993 some worksites throughout the state have been participated in the Commute Trip Reduction (CTR) program. WSDOT worked with the Puget Sound Regional Council (PSRC) to estimate the impact on regional delay if worksites participating in the CTR program returned to the drive alone rates they had upon first entering the CTR program. For this analysis, PSRC modified their base year travel demand model by measuring the changes in system delay with the drive alone trips added back into the model.

According to the modeled calculations, the central Puget Sound freeway and arterial system would need to accommodate 22,500 additional daily drive-alone vehicle trips during the morning peak. As shown in the table below, these additional vehicle trips would increase daily freeway and arterial system delay in the morning peak by about 12,900 hours (about 3.2 million hours annually), an increase of about 7.6%. This additional daily AM peak period delay equals about 3.2 million hours annually, equating to nearly $99 million in annual congestion costs in the region due to lost time and operational costs.

CTR program reduces to freeway and arterial delay
Puget Sound Regional Council travel demand model analysis

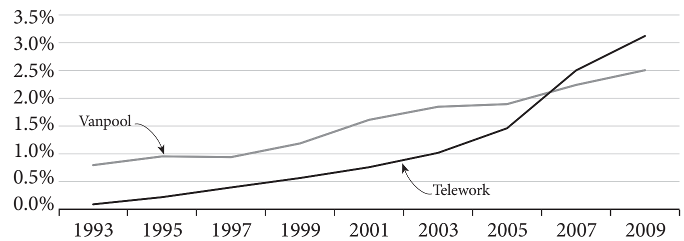
Type of roadway	2006 base model	2006 base model without CTR	Percent change in delay without CTR
Arterial	104,074	110,456	+6.1%
Freeway	66,096	72,653	+9.9%
Total	170,170	183,109	+7.6%

Data source: WSDOT Public Transportation Division.

CTR program drive-alone trips and VMT reductions

Both statewide and county-level surveys show that from 2007 to 2009, worksites in the CTR program reduced drive-alone trips by 5.4%, and VMT per employee by 6%. The number of CTR program participants using alternatives to driving alone (such as riding the bus and bicycling) increased between 2007 and 2009. The number of people teleworking and vanpooling also grew steadily between 1993 and 2009.

Steady increase in teleworking and vanpooling
Percent of workers vanpooling and teleworking; 1993-2009



Data source: WSDOT Public Transportation Division.

GTEC partnerships help manage demand

Through CTR and the Growth and Transportation Efficiency Center (GTEC) program, WSDOT continues to build long-term relationships with jurisdictions, non-governmental organizations, and employers. These relationships and programs are the foundation of the demand management infrastructure, which will be critical to ensure that demand management becomes an even more important strategy for addressing transportation challenges in the state through the coming decades. These partnerships include:

- WSDOT partners with nine counties across the state, that in turn partner with about 1,200 worksites
- Downtown Seattle GTEC resulted in 350 new employer partnerships
- King County is developing and supporting 17 GTECs

Employers in GTECs across the state are voluntarily implementing strategies that reduce VMT and greenhouse gas emissions by providing their employees with transportation options. In addition to providing a tailored set of options to employees, GTECs often work toward making changes in land use policies.

For a full discussion on how commute options help WSDOT manage demand, please see the Commute Options Annual Report on pp. 28-32 in the June 2010 *Gray Notebook 38*.

Moving Washington
Add Capacity Strategically

WSDOT Capacity Expansion Projects: I-405 corridor

As the state continues to grow, it is necessary to develop additional traffic capacity. However, budgetary constraints and other factors mean we cannot simply build our way out of congestion. WSDOT plans projects wisely by targeting the worst traffic-flow bottlenecks and chokepoints in the transportation system. The 2003 and 2005 transportation funding packages include 116 mobility projects that add capacity where it makes the most sense statewide. Washington continues to invest in improvements to I-5, I-405, and SR 520 in the central Puget Sound and US 395 through Spokane, among others around the state.

I-405 corridor expansion program update

Since its adoption in 2002, the I-405 Master Plan and its capacity addition projects have helped relieve congestion along the corridor. The master plan includes adding up to two lanes in each direction, a corridor-wide, bus rapid transit line, and increased local transit service.

Several major highway projects from the plan are now complete, including the I-405 Kirkland Nickel Stage 1 (September 2007), the I-405 - I-5 to SR 169 Stage 1 widening (June 2009), the I-405 South Bellevue widening (November 2009), and NE 195th Street to SR 527 northbound auxiliary lane (June 2010). The I-405 I-5 to SR 169 Stage 2 widening will be complete in 2011, and the I-405 NE 8th Street to SR 520 Braided Ramps will be complete in 2012. These projects increase I-405's capacity, alleviating congestion.

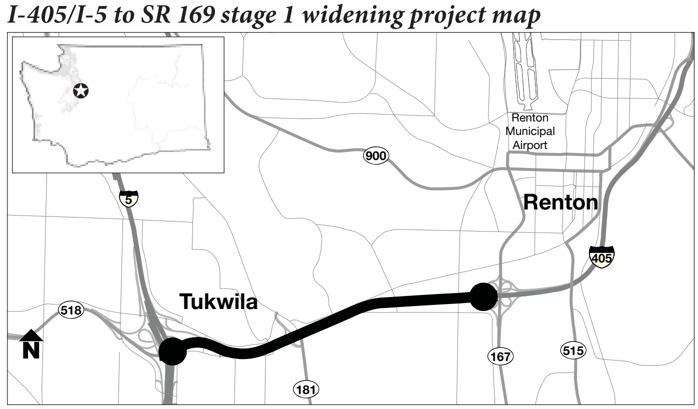
I-405 capacity additions south of Lake Washington are already delivering results

The I-405 I-5 to SR 169 Stage 1 widening project added one lane in each direction between I-5 and SR 167, and one lane on southbound SR 167 from I-405 to SW 41st Street. The project also featured improved merging patterns at the SR 167/I-405 and the I-405/SR 181 interchanges, widening a bridge over BNSF tracks, and building a new bridge on I-405 over Oakesdale Avenue SW. The new lanes opened to traffic on December 11, 2009, and have helped reduce congestion by accommodating more vehicles through the corridor during both peak travel periods.

Stage 1 capacity additions through Tukwila handle more volume while reducing congestion

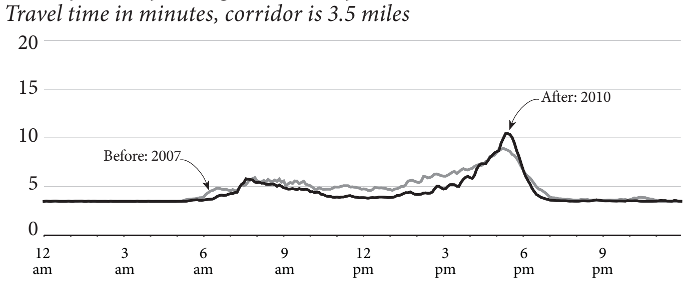
After the project's completion, congestion between I-5 and SR 167 on northbound I-405 greatly decreased: congestion does not begin until after 4:00 pm now. Before construction, the northbound general purpose (GP) lanes were congested on average midweek days for most of the day. Added capacity has decreased congestion, allowing an additional 800 vehicles an hour to get through during peak periods, postponing congested conditions until later in the day.

I-405/I-5 to SR 169 stage 1 widening project map



This expansion has helped accommodate the 15% growth in volume recorded between 2007 and 2010. During the afternoon peak from 2:00 pm to 6:00 pm, 2,800 more vehicles pass through the segment compared to 2007.

Before and After travel times from capacity additions at I-405 northbound from I-5 to SR 169
Monday - Friday during March - May, 2007 & 2010
Travel time in minutes, corridor is 3.5 miles



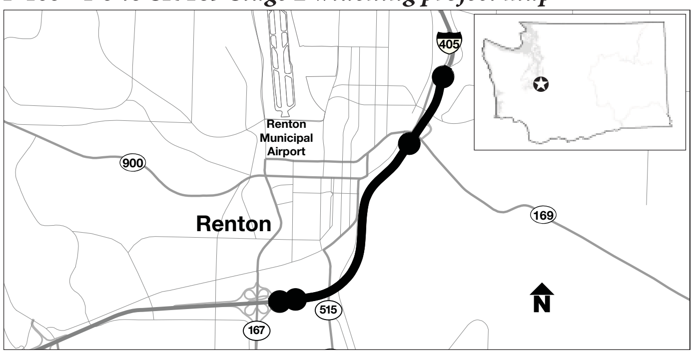
Data source: WSDOT Northwest Region Traffic Office.

WSDOT Capacity Expansion Projects: I-405 corridor, continued

Stage 2 will build upon Stage 1's measurable progress

While the completion of Stage 1 resulted in measurable decreases in the duration of peak periods, congestion north of the SR 167 interchange has not improved as much. Stage 2 construction began during summer 2009, with completion due in 2011.

I-405 - I-5 to SR 169 Stage 2 widening project map

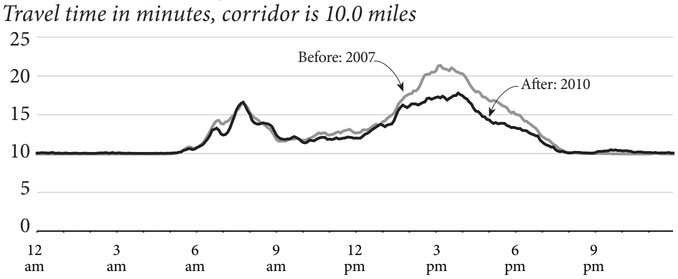


When Stage 2 is complete, drivers should expect faster travel times through this section. At the SR 167 southbound interchange, the new GP lane has provided more throughput capacity (see p. 55.) Up to 400 additional vehicles an hour pass through the segment due to the new lane, an increase in volume of almost 10%. During the morning peak from 6:00 am to 10:00 am, more than 1,200 additional vehicles are able to travel through the area.

Despite the traffic impacts from the construction of Stage 2, congestion was still significantly reduced. The project has eliminated congestion on I-405 southbound between SR 167 and I-5, and reduced traffic backups as far north as Coal Creek Parkway in Newcastle. The graph below shows the average weekday travel time on the ten-mile corridor between Coal Creek Parkway and I-5 from March through May in 2007 and 2010. The peak travel time was reduced from 21 to 17 minutes. The maximum throughput travel time index (MT³I) improved from 1.75 in 2007 to 1.44 in 2010.

Before and After travel times from capacity additions on I-405 southbound from Coal Creek Parkway to I-5

Monday - Friday during March - May, 2007 & 2010
Travel time in minutes, corridor is 10.0 miles

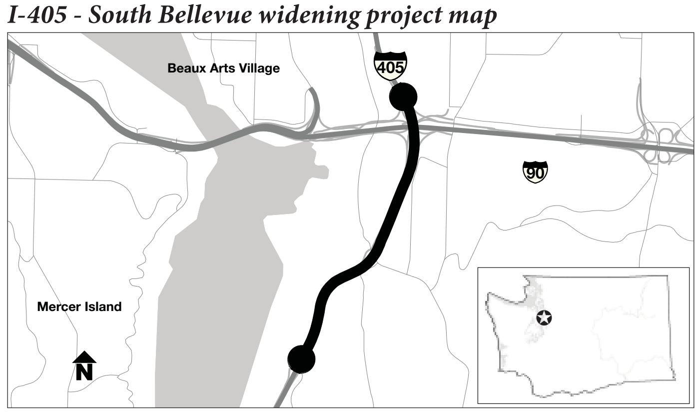


Data source: WSDOT Northwest Region Traffic Office.

I-405 South Bellevue Widening

The I-405 South Bellevue widening project helps relieve congestion for drivers coming to and leaving from Bellevue – one of the worst I-405 bottlenecks. The project added a GP lane northbound from 112th Avenue SE to SE 8th Street, and southbound from NE 4th Street to I-90; it also added a southbound HOV lane from SE 8th Street to I-90. Widening the roadway required many construction phases, including removing the Wilburton Tunnel, widening the bridges over Coal Creek Parkway and SE 8th Street, and building a new bridge for southbound traffic over I-90. Construction began in July 2007, and all lanes were open by September 2009. The new northbound GP lane from 112th Avenue SE to I-90 opened in January 2009; the section from I-90 to SE 8th Street opened in August 2009.

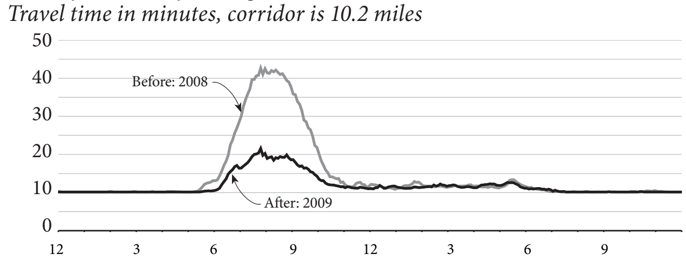
I-405 - South Bellevue widening project map



The additional capacity has helped to reduce travel time and congestion conditions along this section of the I-405 corridor. One of the high-demand commute routes along this corridor, the I-405 between Tukwila and Bellevue, has seen a 16-minute improvement in travel time following the completion of this project, while having a 16% increase in VMT in 2009 compared to 2007. (See page 19 for a comparison of travel time performance.)

Before and After travel times from capacity additions on I-405 northbound from SR 167 to NE 12th Street

Tuesday - Thursday during October, 2008 & 2009
Travel time in minutes, corridor is 10.2 miles



Data source: WSDOT Northwest Region Traffic Office.

WSDOT Capacity Expansion Projects: I-405 corridor, continued

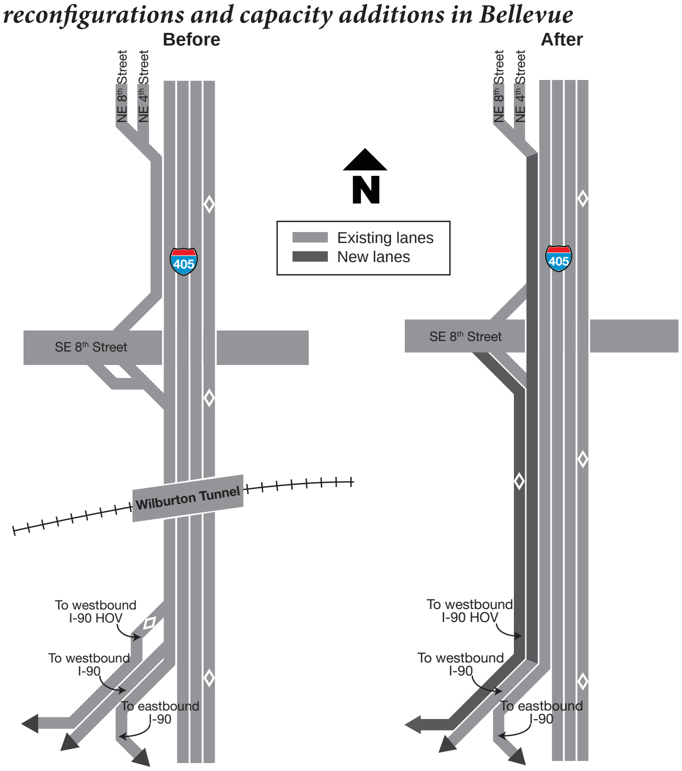
Before and After results of SR 169 to NE 8th Street show travel time improvements

This 10.2 mile section of I-405 has a travel time of about 10 minutes at the posted speed of 60 mph, but it was often congested due to the high volume of drivers merging onto I-90 within the short distance between the Coal Creek Parkway on-ramp and the I-90 off-ramp. The new lane provides more room for the weaving movement at these two interchanges. Since opening in October 2009, the maximum travel time during the morning peak went from 43 minutes in 2008 to 22 minutes in 2009 – a 48% reduction. The MT³I shrank from 3.42 in 2008 to 1.62 in 2009. The additional capacity in both directions of this section of I-405 can now better handle the 70,000-plus vehicles daily.

Added capacity accommodates more volume, delaying the onset of congested conditions

In 2008, the northbound volume in the GP lanes topped 3,500 vehicles per hour (vph) in the morning, but dropped sharply by 6:45am as the morning peak began. Morning congestion caused the volume to drop to below 2,500 vehicles, not increasing again until after 9:00am. With the new northbound lane, volumes now remain above 3,500 vph during the entire AM peak travel period.

Before & After: southbound I-405 interchange reconfigurations and capacity additions in Bellevue



Source: WSDOT Northwest Region Design Office.
Note: Not drawn to scale.

As the corridor accommodates more volume, there is less congestion with faster speeds through the corridor.

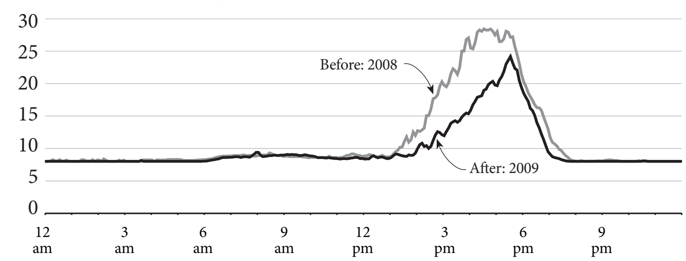
Improved interchange configurations and added lanes shorten southbound travel times

The South Bellevue widening project also added a new southbound GP lane from the NE 8th Street/NE 4th Street on-ramp to I-90, in addition to a new, outside HOV lane from SE 8th Street to I-90, as shown by the diagram at the bottom of this page.

This eight-mile-long corridor has a travel time of eight minutes at the posted speed of 60 mph. The new GP lane offers drivers more time to merge onto I-405 from NE 4th Street or SE 8th Street, helping to keep traffic moving through this busy section of I-405. While traffic north of I-90 moves much faster now during the afternoon peak, congestion still occurs south of I-90 where no new capacity was added. However, congestion is accumulating at a slower rate and later in the PM peak period. With all of the capacity additions, the maximum travel time dropped to 24 minutes in 2009 from 28 in 2008, a 14% reduction in travel time. The MT³I shrank from 2.95 to 2.51 in the same period, a reduction of 15%.

Before & After travel time results from capacity additions on I-405 southbound from NE 70th Place to 112th Avenue SE

Tuesday - Thursday during October, 2008 & 2009
Travel times in minutes, corridor is 8.0 miles



Data source: WSDOT Northwest Region Traffic Office.

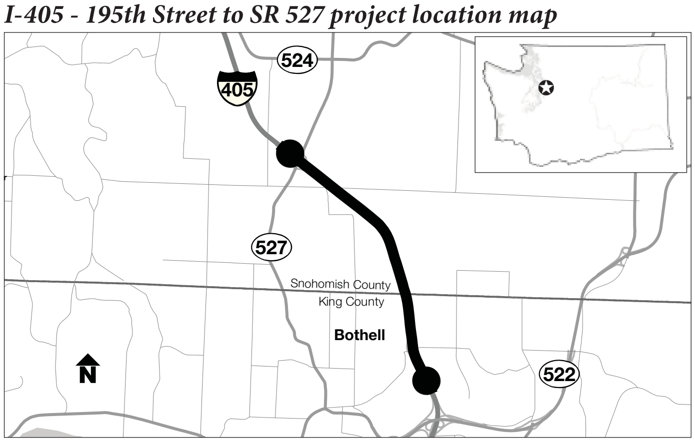
Before the new lanes were opened, southbound traffic volume built through the morning and midday, reaching 3,500 vehicles an hour by about 2:00 pm, when congestion began to increase. Then volume continuously dropped until reaching about 3,000 vph, between 6:00 and 7:00 pm, showing reduced congestion, but remaining high demand. After the new GP lanes were opened in October 2009, volume at NE 4th Street during the PM peak period continued to increase, and now exceeds 4,000 vph around 4:00 pm. Volume decreases to 3,000 vph around 5:30 pm, before beginning to increase again. This increase in throughput reflects that it is taking longer for congestion to build up and its duration is shorter.

WSDOT Capacity Expansion Projects: I-405 corridor, continued

I-405 – NE 195th Street to SR 527 (Bothell vicinity)

This project added an auxiliary lane on northbound I-405 in Bothell between NE 195th Street and SR 527 in June, 2010. This capacity addition was made possible by funding from the 2009 American Recovery and Reinvestment Act (see p. 52 of *Gray Notebook 38*), which expedited the project's schedule by two full years, providing immediate congestion relief along a major I-405 bottleneck.

I-405 - 195th Street to SR 527 project location map

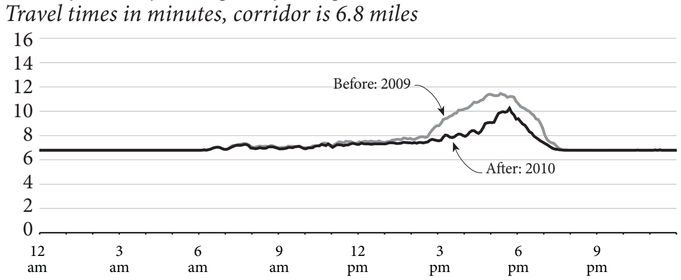


New northbound auxiliary lane eliminates bottleneck

The new lane has completely eliminated northbound congestion between NE 195th St and SR 527, where a bottleneck created three-hour back-ups each weekday. During the PM peak, volume on I-405 northbound south of SR 527 reached 5,000 vph increasing to 5,500 vph after the new lane was opened, a 10% increase. The northbound HOV lane has seen a decrease of about 300 vph during the PM peak – a drop of almost 25%. Before construction, the two GP lanes here reached a peak of 4,000 vph before speeds began to slow and volume decreased, averaging about 3,800 vph for the rest of the PM peak period. After construction, the three GP lanes are able to accommodate a peak volume of more than 4,500 vph.

The route used for travel time was longer than the project limits extending from south of the project limits to north of the project limits all the way to I-5. The before and after peak hour travel times through this 6.8-mile corridor were 11.3 minutes in 2009 and 9.7 minutes in 2010. The MT³I went from 1.39 to 1.19, a 14% decrease. The most significant change is faster travel time throughout the PM peak: the duration of congestion went from 3 hours 40 minutes in 2009 to 1 hour 10 minutes in 2010.

Before & After travel times from capacity additions on I-405 northbound from NE 160th Street to SR 524
Monday - Friday average, July - August 2009 & 2010
Travel times in minutes, corridor is 6.8 miles



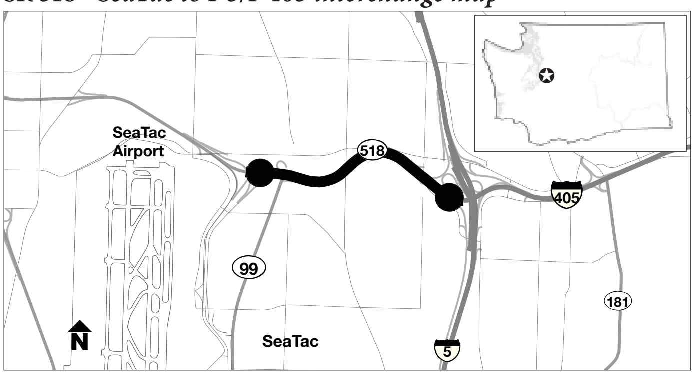
Data source: WSDOT Northwest Region Traffic Office.

WSDOT Capacity Expansion Projects: SR 518 corridor

SR 518 – SeaTac International Airport to I-5/I-405 interchange

SR 518 is essentially an extension of I-405 that runs west of I-5 to SeaTac International Airport. This project added a third lane on eastbound SR 518 between the North Airport Expressway and I-5, improved the eastbound connection from SR 99, widened the bridge over 42nd Avenue, and made safety improvements to the 51st Avenue off-ramp. All lanes were open to traffic in June 2009.

SR 518 - SeaTac to I-5/I-405 interchange map

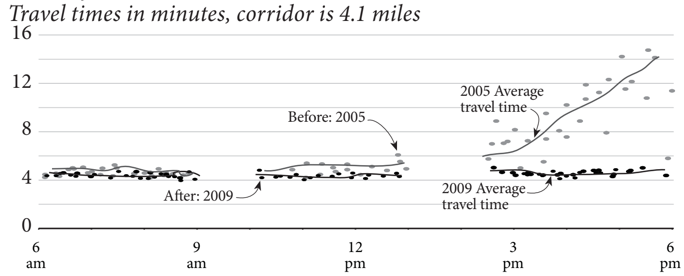


Travel times were measured by test vehicle in December, both before the project began in 2005 and after completion in 2009, in order to capture holiday peak traffic to and from the airport. Travel times were recorded throughout the day for several days between SR 509 and SR 181, a distance of 4.1 miles.

In 2005, the duration of SR 518 eastbound congestion typically started around 1pm and ended after 6pm After the project was completed, congestion was reduced when free flow speeds occurred during the same time period. The graph below shows the eastbound travel times in 2005 and 2009: the peak travel time was reduced from 15 minutes before construction to five minutes after the added capacity was opened.

Before & After travel time results from capacity additions on SR 518 eastbound from SR 509 to SR 181

Weekdays in December, 2005 & 2009
Travel times in minutes, corridor is 4.1 miles



Data source: WSDOT Northwest Region Traffic Office.

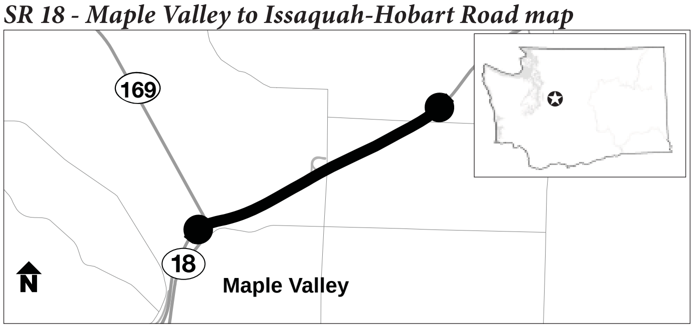
Data note: Travel times recorded by test vehicle shown for 6am-9am, 11am-1pm, and 2pm-6pm peak periods only.

WSDOT Capacity Expansion Projects: SR 18 corridor

SR 18 capacity additions complete, enhancing a key corridor between I-5 and I-90

The SR 18 Maple Valley to Issaquah-Hobart Road project transformed SR 18 from an undivided, two-lane road with signals and intersections into a four-lane, divided highway between Maple Valley and Issaquah. The new features helped to bring SR 18 up to current highway standards with wider shoulders, guardrail, and a median to divide traffic. A new overpass was constructed at SE 200th Street, while a new interchange at 244th Ave SE and SE 200th Street was built to replace the existing signalized intersection.

SR 18 - Maple Valley to Issaquah-Hobart Road map



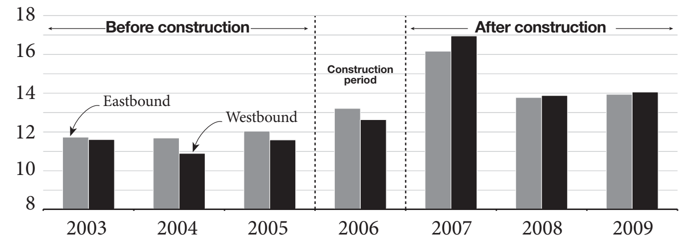
Construction took place in 2006. In August, the new eastbound roadway was opened to traffic and other features were in operation. The second lane of traffic in both directions was open to drivers by late October 2006.

Travel times improved as capacity was doubled

These improvements have provided significant travel time and safety benefits to drivers in the area. Before completion, SR 18 just west of Issaquah-Hobart Road served about 24,000 vehicles each weekday in September 2005. After, about 28,000 vehicles travel through this location on SR 18 daily as of September 2009. The improvements more than doubled the highway's capacity, increasing its reliability and efficiency, eliminating backups through the corridor.

Eastbound and westbound traffic volumes on SR 18, west of Issaquah-Hobart Road

Average number of vehicles Monday - Friday
September 2005 & 2009, numbers in thousands



Data source: WSDOT Northwest Region Traffic Office.

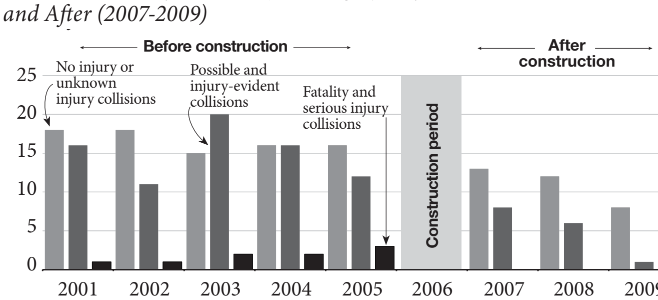
The travel time study showed a 15-to 20-minute reduction in travel time westbound during the pm peak and a six- to ten-minute travel time benefit eastbound during the am peak.

Greater capacity offers more improved safety

The widening of SR 18 has resulted in substantial safety benefits. Collision data for this project was collected between mileposts 16.0 and 20.0. The number of collisions per mile per year was reduced by more than half, from a rate of 8.4 to 4.0. The severity of injuries has also been reduced since project completion, with no serious injuries or fatalities in the project area since February 2006. The graph shows the number of collisions annually by injury type.

Safety benefits of adding capacity to SR 18: Before & After results of collisions between MP 16.0-18.0

Annual number of collisions per category, Before construction (2001-2005) and After (2007-2009)



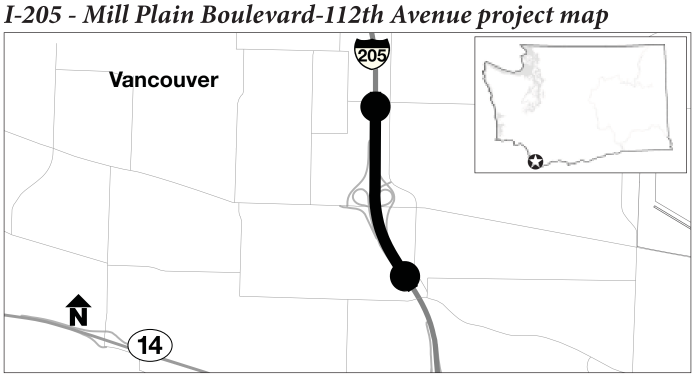
Data source: WSDOT Northwest Region Traffic Office.

WSDOT Capacity Expansion Projects: I-205 in Vancouver

I-205 - Mill Plain Exit - 112th connector project reduces congestion in Vancouver

The I-205 – Mill Plain Exit – 112th connector project was a complex effort to add capacity to a congested bottleneck in Vancouver, in addition to addressing safety issues created by the bottleneck and adjacent safety issues on supporting arterials like 112th Avenue (see pp. 5-6 of *Gray Notebook 37* for more information). The project created a direct connection to NE 112th Avenue from the northbound I-205 off-ramp to Mill Plain Boulevard. The close proximity of existing traffic signals and the high traffic volumes on Mill Plain Boulevard often resulted in long delays and traffic back-ups at the intersection of Mill Plain Boulevard and NE Chkalov Drive/NE112th Avenue. High volumes of traffic leaving northbound I-205 onto Mill Plain during peak travel times resulted in traffic back-ups on I-205's off-ramps, impeding traffic flow on northbound I-205 and westbound SR 14.

I-205 - Mill Plain Boulevard-112th Avenue project map



WSDOT evaluated the project's performance on congestion using measures such as traffic volume, speed, and travel time. The traffic data was collected during the morning (6:30-9:30 am) and afternoon peaks (3:00-6:00 pm) in June 2008, before project construction, and again in June 2010, after project construction.

Travel time, reliability improved on I-205 to northbound NE 112th Avenue

Traffic volume just north of the new off-ramp connecting I-205 to NE 112th Avenue did not change during the morning, but did increase by 18% in the afternoon, which was about 450 more vehicles during the pm peak period. The average travel time during the morning commute was reduced by about one minute after construction (from three minutes before to 1.9 minutes). In the pm peak period, travel time dropped by about two minutes, from 3.8 minutes to 1.9 minutes after, even with the 18% increase in traffic volume.

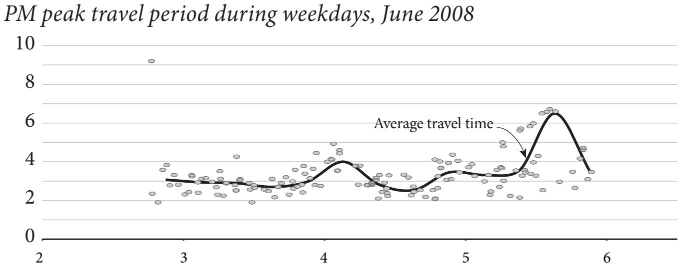
Travel time savings have also resulted in improved travel time reliability. Before construction, the differences between slow and faster arriving cars (10th & 90th percentiles) in both the am and pm peak periods were erratic. After construction, the visible peaks were gone, reducing travel time variance to within 30 seconds below or above the average travel time both during am and pm commutes (for example: dots in the after period stay close to the average travel time line).

Improvements to eastbound Mill Plain Boulevard provide better afternoon commute experience

Here, analysis showed that traffic volume remained at 1,800 vph at this location before and after construction. Although travel times and travel speeds during both am and pm peak periods did not change as much (about two minutes in the am and three minutes in the pm), the overall commute experience through this route has improved significantly after the construction, especially during pm peak period. Before construction, the location featured waves of extreme peak traffic with travel times reaching over four minutes at 4 pm and 6.5 minutes by 5:30 pm. After the project completion, there are no measurable signs of congestion (no spikes), and the travel time difference between commuters at various times during the pm peak period had become nearly constant by one minute. The one minute variance is partly attributable to vehicle arrival times at the signals. Reliable travel times have become much more reliable throughout the pm peak period.

Before: travel times of I-205 on-ramp from SE Mill Plain Boulevard in Vancouver

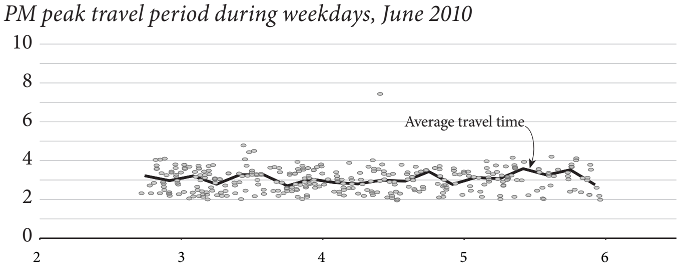
PM peak travel period during weekdays, June 2008



Data source: WSDOT Statewide Traffic and Collision Data Office.

After: travel times of I-205 on-ramp from SE Mill Plain Boulevard in Vancouver

PM peak travel period during weekdays, June 2010



Data source: WSDOT Statewide Traffic and Collision Data Office.

How WSDOT Fights Congestion

Washington depends on mobility

Effective transportation is critical to maintaining our economy, environment, and quality of life. Moving Washington is the WSDOT's vision of investments and priorities for the next 10 years. It integrates new capacity, efficiencies, and commute options to address congestion head-on and improve the performance of our state's transportation system. The program's primary objective is mobility, one of the state Legislature's six transportation priorities along with preserving our transportation infrastructure, making the system safe for all, protecting the environment, striving for economic vitality, and practicing sound stewardship.

The transportation improvements outlined here are necessary for us to continue to enjoy all that our state has to offer. From the coastal rain forests of the Olympic Peninsula to the river gorges in the south and east, Washington State is rich with landscapes and a diverse economy. We depend on a reliable trip to work, and we want to spend time with our families when our work is done. Businesses from agriculture and manufacturing to retail and tourism rely on our transportation system. More information on Moving Washington can be found at: www.wsdot.wa.gov/movingwashington/

Washington drivers are already seeing benefits

The Moving Washington 10-year transportation program will improve current traffic conditions and prepare our system for heightened demands in the future. The program includes specific actions that can achieve tangible early results. WSDOT has already started to realize results from the program's strategies with the completion of numerous highway construction projects. Examples of the benefits that these projects are having can be found on pages 47-61.

The Program

There is no single solution for traffic congestion, which is why WSDOT reduces congestion by focusing on three key balanced strategies – the basis for the Moving Washington program.

Add Capacity Strategically

As our state continues to grow, it is necessary to develop additional traffic capacity. However, budgetary constraints and other factors mean we cannot simply build our way out of congestion. WSDOT plans projects wisely by targeting the worst traffic-flow bottlenecks and chokepoints in the transportation system. The 2003 and 2005 transportation funding packages include 70 mobility projects that add capacity where it makes the most sense statewide. Washington continues to invest in improvements to I-5, I-405, and SR 520 in the central Puget Sound and US 395 through Spokane, among others around the state.

How WSDOT is fighting congestion

Using intelligent transportation systems to operate the system more efficiently:

- Active Traffic Management
- Traffic cameras
- Traffic management centers
- Variable message signs
- Integrated traffic signals
- Ramp meters
- Traffic data collectors

Providing commute choices to manage demand:

- Vanpools
- Park & rides
- Transit partnerships
- Telecommuting programs
- Commute trip reduction
- HOV/carpooling

Building additional highway capacity

- The 421 construction projects of the 2003 and 2005 transportation funding packages include more than 126 mobility projects to fight congestion, of which 70 have been completed.

Operate Efficiently

Efficiency means taking steps to smooth traffic flow and avoid or reduce situations that constrict road capacity. Collisions account for roughly 25% of traffic backups, so making our roads safer will go a long way toward easing congestion. Technology, such as driver information signs, enables WSDOT and the traveling public to react quickly to unforeseen traffic fluctuations. Among the tools WSDOT employs to provide this efficiency are active traffic management (smarter highways), metered freeway on-ramps, incident response teams, variable speed-limit systems, variable tolling, and integrated traffic signals.

Manage Demand

WSDOT seeks to make the best use of highway capacity by better distributing the demand placed on our most congested bridges and highways. That means offering commuters more choices, such as convenient bus service, incentives to carpool or vanpool, and promoting workplace environments more conducive to telecommuting. WSDOT continues to expand its programs to encourage drivers to use less congested routes and times to travel by displaying real-time traffic information through various means including via the Internet and variable message signs.

Moving Washington
Balanced Strategies

Corridor Performance Updates

Moving Washington: Corridor Performance

The Moving Washington program targets congestion on Washington State's busiest corridors. For each corridor, WSDOT utilizes the three strategies to fight congestion: add capacity strategically, operate efficiently, and manage demand. Projects listed are not comprehensive, but are only selected projects for the corridors.

For more information on the Moving Washington program and the strategic corridors, please see: www.wsdot.wa.gov/movingwashington.

Westside Corridor: I-5 between Arlington and Tumwater, SR 99, US 2

Selected congestion relief projects programmed to improve corridor performance:

Corridor performance highlights

Average travel times in minutes	2007	2009	%Δ
I-5 Everett-Seattle (AM)	47	41	-13%
I-5 Seattle-Everett (PM)	43	41	-5%
I-5 Federal Way-Seattle (AM)	47	35	-26%
I-5 Seattle-Federal Way (PM)	37	32	-14%
Delay on* I-5	10,568	6,982	-34%

Before & After case study: I-5 to US 2 hard shoulder running and ramp metering project helped reduce travel times by 6 minutes during evening peak (*2009 Congestion Report*, p. 44-45).

*Daily hours of delay relative to maximum throughput speeds.

Add capacity strategically

- SR 99 Alaskan Way Viaduct Replacement.
- SR 512 westbound to southbound flyover ramp.
- I-5 HOV lanes Lakewood to Fife.
- I-5/SR 18 westbound to southbound flyover ramp.
- SR 509 connection to Sea-Tac Airport.
- Complete business, access and transit lanes on SR 99 in Shoreline.
- SR 518 third lane from I-5 to Sea-Tac Airport.
- New HOV lanes on SR 99.
- Interchange reconstruction at SR 531.

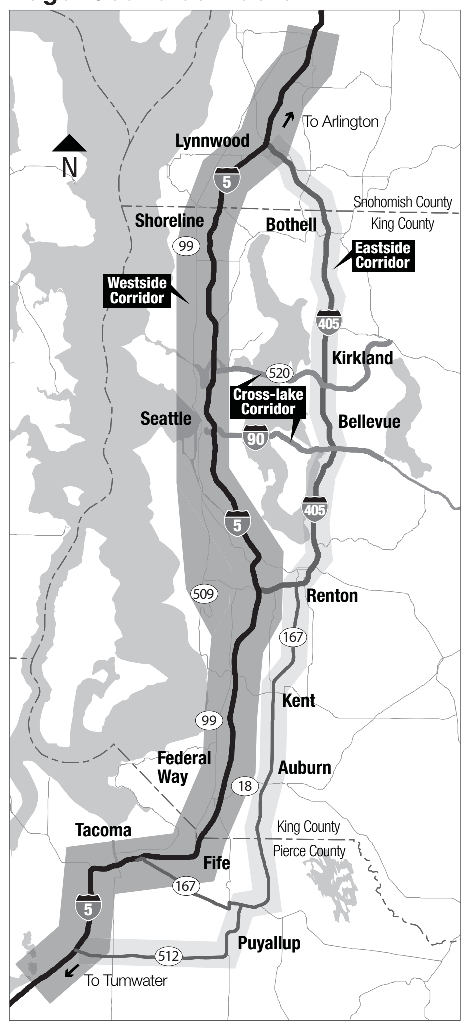
Operate efficiently

- I-5 Active Traffic Management.
- Install additional ramp meters.
- Automate operation of reversible lanes.
- Integrate ramp arterial signals.

Manage demand

- WSDOT provides rights of way and works with transit agencies to improve access and performance.
- Transit uses shoulder during peak periods from Olive Way to SR 520.
- Construct an Industrial Way HOV direct access ramp.
- Further expand the vanpool program in the Central Puget Sound region.
- Expand Park & Ride lot capacity.
- Support established growth and transportation efficiency centers (GTECs).

Moving Washington: Puget Sound corridors



Cross-Lake Corridor: I-90 and SR 520 between Seattle and Bellevue

Selected congestion relief projects programmed to improve corridor performance:

Corridor performance highlights

Average travel times in minutes	2007	2009	%Δ
I-90 Issaquah-Bellevue (AM)	17	15	-12%
I-90 Seattle-Bellevue (PM)	17	15	-12%
SR-520 Bellevue-Seattle (AM)	18	17	-6%
SR-520 Seattle-Bellevue (PM)	19	20	5%
Delay on* SR 520	2,180	1,689	-2%

Before and After case study: Construction mitigation efforts during the I-90 Homer Hadley Bridge Repair project in July 2009 helped divert 40% to 60% of traffic every weekday during the construction (*2009 Congetion Report*, p. 51-52).

*Daily hours of delay relative to maximum throughput speeds.

Add capacity strategically

- SR 520 HOV and Bridge Reconstruction.
- Extend the I-90 HOV Lane in Issaquah
- Widen SR 900 in Issaquah by one lane in each direction with HOV lanes.
- Phase 2 of the SR 519 South Seattle Intermodal Access to Port of Seattle.
- New interchange between SR 520 and SR 202.

Operate efficiently

- I-90 and SR 520 Active Traffic Management.
- Automate operation of the I-90 reversible lanes.
- Direct ramp connection between the new SR 520 HOV Lane and the I-5 reversible lanes.
- Move HOV lanes to the inside on SR 520 east of I-405.

Manage demand

- Begin variable time-of-day tolling on SR 520 in spring 2011.
- Support the implementation of Bus Rapid Transit service on SR 520.
- Increase capacity of Park & Ride lots.

Corridor Performance Updates

Puget Sound Eastside Corridor: I-405, SR 167, and SR 512

Selected congestion relief projects programmed to improve corridor performance (See map on page 62)

Corridor performance highlights

Average travel times in minutes	2007	2009	%Δ
I-405 Tukwila-Bellevue (AM)	42	26	-38%
I-405 Bellevue-Tukwila (PM)	34	29	-15%
SR-167 Auburn-Renton (AM)	18	15	-17%
SR-167 Renton-Auburn (PM)	19	14	-26%
Delay on* I-405	7,654	4,546	-41%
Delay on* SR 167	1,138	360	-68%

Before & After case study: Following completion of the I-405 South Bellevue widening project the peak morning commute was reduced to 22 min. in 2009 as compared to 43 min. before construction (p. 57).

*Daily hours of delay relative to maximum throughput speeds.

Add capacity strategically

- Improve ramp connections on SR 512 at SR 7 and at Canyon Road.
- Extend the SR 167 HOV/HOT Lanes.
- I-405 Corridor Express Lanes.
- Additional Lanes on I-405 in Renton and Bellevue vicinities.
- Build a new freeway connection from the Port of Tacoma to Puyallup.
- New bridge over NE 10th Street in downtown Bellevue.

Operate efficiently

- Use SR 512 shoulders during peak commuting periods as additional lanes.
- I-405/SR 167 HOT Lanes/Express Toll Lanes.
- Construct an HOV Bypass and signal improvements on SR 169 at I-405.

Manage demand

- Support the implementation of bus rapid transit service on the I-405 corridor.
- Help identify new GTECs along the SR 167 and I-405 corridors.
- Expand Park and Ride lot capacity.
- Better manage existing Park and Ride lot space.

Spokane: I-90 and North Spokane Corridors

Selected congestion relief projects programmed to improve corridor performance:

Corridor performance highlights

Average travel times in minutes : seconds	2007	2009	%Δ
I-90 Argonne-Division (AM)	8:20	8:13	-1%
I-90 Division-Argonne (PM)	8:10	8:00	-2%

Before & After case study: Spokane's Growth and Transportation Efficiency Center (GTEC) has helped reduce drive alone rates by 12.2% and VMT by 10.6% (*2009 Congestion Report*, p. 52).

Add capacity strategically

- US 395 North-South Freeway
- I-90/US 2 interchange eastbound off-ramp and terminal improvements

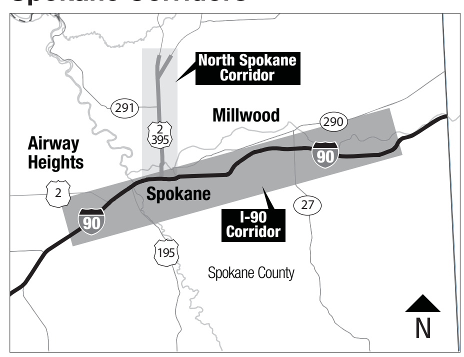
Operate efficiently

- Intelligent transportation systems upgrades.
- TMC expansion and security enhancements
- I-90 Sullivan interchange to Idaho state line-enhanced incident response.
- I-90 / Spokane port of entry weigh station relocation.

Manage demand

- US 195 Hatch Road to I-90 – park and ride facilities.

Moving Washington: Spokane Corridors



- North Spokane Corridor–new Park & Ride and pedestrian/bike paths.

Other Moving Washington corridors: selected congestion relief projects to improve performance

Vancouver Corridors: I-5/I-205 North-South, SR 500, and SR 14

Add Capacity Strategically
- Columbia River Crossing.
- SR 500/St. Johns Blvd. – Interchange.

Operate Efficiently
- Clark Co. and Vancouver signal optimization.

Manage demand
- Advanced Traffic Information System infill.

Cross-State Corridors: I-90, US 2, and SR 97

Add Capacity Strategically
- I-90 Snoqualmie Pass East Project.
- US 2/US 97 Peshastin East Interchange.
- US 97 Blewett Pass add passing lanes.

Operate Efficiently
- TMC improvements for Yakima and Wenatchee.
- I-90 IRT from North Bend to Spokane.
- US 2 Stevens Pass VSL System.

Manage demand
- Traveler information including flow maps, VMS, and web messaging on I-90 and US 2.
- I-90/SR 17 Park & Ride.

Connecting Communities Program

Add Capacity Strategically
- I-82/Valley Mall Blvd - interchange.
- SR 240 Columbia Ctr Blvd to US 395 – Construct interchange.
- Additional lanes on SR 28 at Sunset Highway.

Operate Efficiently
- SR 17 signal retiming.
- I-5 Lewis County ITS Infill.
- Add Tri-Cities Incident Response Teams.
- SR 21 Ferry Boat replacement.

Manage demand
- Chuckanut Park & Ride.
- Tri-Cities traveller information enhancements.
- New Park & Ride lots for US 97/SR 970, Alger, Conway.

Table of Tables & Graphs

Table of Tables & Graphs

Publication Information

Americans with Disabilities Act (ADA) Information

Persons with disabilities may request this information be prepared and supplied in alternative formats (large print, Braille, cassette tape, or on computer disk) by calling the Washington State Department of Transportation Office of Equal Opportunity (OEO) at (360) 705-7097. Persons who are deaf or hard of hearing may may contact OEO through the Washington Relay Service at 7-1-1.

Civil Rights Act of 1964, Title VI Statement to Public

WSDOT ensures full compliance with Title VI of the Civil Rights Act of 1964 by prohibiting discrimination against any person on the basis of race, color, national origin or sex in the provision of benefits and services resulting from its federally assisted programs and activities. For questions regarding WSDOT's Title VI Program, you may contact the Department's Title VI Coordinator at (360) 705-7098 or (509) 324-6018.

Other WSDOT Information Available

The Washington State Department of Transportation has a vast amount of traveler information available. Current traffic and weather information is available by dialing 5-1-1 from most phones. This automated telephone system provides information on:

- Puget Sound traffic conditions and travel times
- Statewide construction impacts
- Statewide incident information
- Mountain pass conditions
- Weather information
- State ferry system information, and
- Phone numbers for transit, passenger rail, airlines and travel information systems in adjacent states and for British Columbia.

For additional information about highway traffic flow and cameras, ferry routes and schedules, Amtrak Cascades rail, and other transportation operations, as well as WSDOT programs and projects, visit www.wsdot.wa.gov

For more information about performance measurement and reporting, visit www.wsdot.wa.gov/accountability

Prepared by the Strategic Assessment Office of the Washington State Department of Transportation.
310 Maple Park Ave SE, Olympia, WA 98504.