Washington State Department of Transportation

The 2017 Corridor Capacity Report

The 16th edition of the annual *Congestion Report*

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Roger Millar, Secretary of Transportation, PE, AICP

WSDOT's comprehensive annual analysis of multimodal state highway system performance

Developed in partnership with

Community Transit smile & ride · C-TRAN · INTERcity TRANSIT · King County METRO · Puget Sound Regional Council PSRC · Sound Transit · RTC Southwest Washington Regional Transportation Council · Pierce Transit · SRTC Spokane Regional Transportation Council · Spokane Transit · thurston regional planning council · TRAC

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As Great Recession impacts fade, traffic congestion coming into focus

The 2007 recession may be moving further and further away in the rearview mirror, but the vehicle in that mirror is inching closer and closer as traffic in Washington continues to slow down. Statewide congestion during peak hours and beyond is resulting in historically long commute times.

Working to improve travel times, WSDOT uses a Practical Solutions approach to identify system performance needs, agree on performance expectations, and collaborate with community partners to evaluate and implement the most efficient and cost-effective multimodal options. The agency analyzes the state's system performance through the Corridor Sketch Initiative and the annual Corridor Capacity Report (CCR). These processes inform transportation policymakers, planners and engineers about congestion trends and congested areas, and about strategies to improve mobility on the state highway system in Washington.

These efforts provide a planning-level look at statewide congestion by analyzing the transportation system and determining the usable capacity on state highways, transit, ferries and passenger rail. The CCR not only analyzes congestion's impacts on the transportation system as whole, but looks at how it affects air quality and ultimately people's wallets.

The CCR generates discussion between WSDOT, the Legislature, external stakeholders, businesses, research institutions and the public to promote an understanding of the complex issues that surround congestion and what it truly takes to reduce travel times in Washington state.

This report consists of the 2017 Corridor Capacity Report, the 2nd edition of the Handbook for Corridor Capacity Evaluation, and a data appendix.

WSDOT working with MPO's to establish MAP-21 performance targets

The Moving Ahead for Progress in the 21st Century Act and the Fixing America's Surface Transportation Act (collectively referred to as MAP-21 throughout this report), aim to transform the federal-aid program for transportation projects by establishing new performance requirements that help ensure the most efficient investment of these funds.

The Federal Highway Administration (FHWA) approved the final MAP-21 rules on system performance, freight, and congestion mitigation and air quality on May 20, 2017. WSDOT is currently collaborating with Metropolitan Planning Organizations (MPOs) from around the state to set new performance targets for each of the measures (see p.6 for more information).

The collaborative targets are expected to increase the accountability and transparency of the federal-aid highway program. They are also intended to provide a framework to support improved investment decision-making through a focus on performance outcomes for key national transportation goals.

For more details on WSDOT's response to the above federal rules, please visit www.wsdot.wa.gov/Accountability/MAP-21.htm.

Interactive Corridor Capacity Report maps help readers visualize data

Corridor Capacity Report readers can explore each corridor's performance data through interactive online maps (marked with the icon at left). For an overview of Washington state's transportation capacity, visit bit.ly/agolCCR17statewidemap.

On the cover: Traffic backs up on eastbound SR 240 in Richland. (Photo courtesy of WSDOT South Central Regional Office)

Executive Summary

A summary of statewide and regional multimodal travel indicators

Washington state saw an increase in drivers on the road in 2016. Passenger vehicle registrations increased 3.2% while licensed drivers increased 4.3% between 2014 and 2016.

- More drivers in 2016 contributed to a 4.8% increase in the number of vehicle miles traveled (VMT) on all public roadways, up from 58.060 billion miles in 2014 to a new high of 60.851 billion miles.
- More drivers also had a hand in a 6.4% increase in VMT exclusively on state highways, which hit a new high of 34.227 billion in 2016, up from 32.177 billion in 2014.
- Total VMT on the five monitored major corridors in the central Puget Sound region (I-5, I-405, SR 520, I-90 and SR 167) increased by 2.8% between 2014 and 2016.

Higher VMT—likely due to an improved economy, increased population and a stronger job market—led to increased congestion on many major corridors throughout the state.

Total congestion on the five monitored freeway corridors in the central Puget Sound region increased by 22.3% between 2014 and 2016, surpassing 2007 pre-recession levels for the third consecutive year (2016 statewide delay data was unavailable at the time of this publication).

- Of the five monitored freeway corridors in the central Puget Sound region, three (I-5, I-405 and I-90) saw congestion increases (of 76%, 33% and 117%, respectively) over 2007 pre-recession levels.
- Tolling and carpooling brought congestion on SR 520 to 61% below pre-recession peak levels, while SR 167 saw a slight increase by 4% above pre-recession levels. (See table and charts on p. 3 of the appendix.)
- After the I-405 express toll lanes (ETLs) opened on September 27, 2015, the traffic volumes using the express lanes continue to grow, saving an average of 11 to 14 minutes during peak periods.

In 2016, approximately 42% of all person miles traveled on freeways in the central Puget Sound region were in HOV lanes, which make up 24% of the region's lane miles.

- Travel times are shorter and person throughput is higher in HOV lanes than in general purpose (GP) lanes (see appendix pp. 27-29).
- The HOV lane on I-5 at Northgate moved nearly 2.5 times as many people as the adjacent GP lanes, and had reliable travel times up to 10 minutes faster.

WSDOT Incident Response teams responded to 25.4% more incidents (58,235 total) in 2016 than in 2014, with average clearance times around 12 minutes for both 2014 and 2016.

- Proactive work by Incident Response teams resulted in nearly $88 million in economic benefit in 2016, an 18.4% increase from 2014.

Urban transit on commute corridors

More people are taking transit. Transit ridership on urban commute corridors during daily peak periods increased 8%, from roughly 88,150 in 2014 to 95,300 in 2016. For example, transit on I-5 between Federal Way and Everett moved 52,887 people during peak periods on average weekdays. Without transit, more than 4.5 additional GP lanes would be needed to meet demand on this stretch of I-5.

- The number of miles passengers traveled using transit during daily peak periods increased 2% on urban commute corridors, from 1.19 million miles in 2014 to 1.23 million miles in 2016.
- Daily greenhouse gas emissions avoided due to transit ridership during peak periods improved by nearly 4%, from 602,265 pounds avoided in 2014 to 628,782 pounds avoided in 2016.

Ferries

The number of travelers using WSDOT ferries continued its upward trend as annual ridership increased more than 4%, going from 23.2 million in 2014 to 24.2 million in 2016. Meanwhile, annual vehicle capacity utilization decreased by one percentage point, dropping from 61% in 2014 to 60% in 2016. (See pp. 56-57.)

- Annual ferry trip reliability increased slightly, going from 99.4% in 2014 to 99.5% in 2016.
- Ferries on-time performance dropped just under one percentage point from 2014 to 93.9% in 2016.

Amtrak Cascades

Passenger miles traveled on Amtrak Cascades increased by 4.8% from 111.7 million miles in 2014 to 117.1 million miles in 2016, with ridership rising 5% during the same period (from approximately 700,000 to 735,000). Capacity utilization also went up by 1.4 percentage points, from 60.4% in 2014 to 61.8% in 2016. (See p. 58)

- Amtrak Cascades annual on-time performance rose by 4.2 percentage points between 2014 and 2016, going 70.0% to 74.2%.

Dashboard of Indicators

2017 *Corridor Capacity Report* Dashboard of Indicators[1]	2012	2013	2014	2015	2016	Difference '14 vs. '16[1]
Demographic and economic indicators						
State population (in millions)	6.82	6.88	6.97	7.06	7.18	3.1%
Gasoline price per gallon (annual average)[2]	$4.01	$3.75	$3.61	$2.73	$2.47	-31.6%
Washington total employment (in thousands of workers)[3]	2,919	2,986	3,065	3,154	3,244	5.8%
Taxable retail sales (in billions of dollars)[2]	$114.0	$120.7	$126.6	$137.1	$146.4	15.7%
Statewide multimodal performance measures						
Drive alone commuting rate[4]	72.2%	72.7%	72.4%	72.4%	72.1%	-0.3%[5]
Carpool commuting rate[4]	10.7%	10.1%	10.1%	9.8%	9.9%	-0.2%[5]
Bicycling and walking commuting rate[4]	4.5%	4.3%	4.5%	4.7%	4.6%	0.1%[5]
Public transit commuting rate[4]	5.8%	6.3%	6.3%	6.2%	6.4%	0.1%[5]
Transit ridership[6] (in millions)	218.1	221.2	227.2	227.4	233.3	2.7%
WSDOT Ferries ridership[6,7] (in millions)	22.2	22.5	23.2	23.9	24.2	4.4%
Amtrak Cascades ridership[8] (in thousands)	725	694	700	672	735	5.0%
Statewide congestion indicators						
Per person, total vehicle miles traveled on all public roads, state highways only						
All public roads vehicle miles traveled (VMT) (in billions)	56.607	57.211	58.060	59.653	60.851	4.8%
All public roads per person VMT (miles)	8,303	8,313	8,332	8,448	8,471	1.7%
State highways VMT (in billions)	31.214	31.649	32.177	33.335	34.227	6.4%
State highways per person VMT (miles)	4,578	4,599	4,618	4,721	4,765	3.2%
Congestion on state highway system						
Total state highway lane miles	18,659	18,662	18,680	18,699	18,715	0.2%
Percent of state highway system congested[9]	5.5%	5.5%	5.8%	N/A	N/A	N/A
Per person, total, and cost of delay on state highways						
Annual hours of per person delay on state highways[10]	4.7	4.7	4.7	N/A	N/A	N/A
Total vehicle hours of delay (in millions of hours)[10]	30.9	32.5	32.3	N/A	N/A	N/A
Cost of delay on state highways (in millions)[2,10]	$773	$823	$834	N/A	N/A	N/A
Results Washington system performance measures						
Throughput productivity[11]	95.7%	95.2%	94.6%	94.0%[11]	93.1%	-1.5%[5]
Reliability index[11]	1.17	1.19	1.24	1.26	1.30	4.9%
Reliability index—% difference from 3-year average[12]	3.3%	3.2%	6.4%	5.1%	5.5%	-1.1%[5]
Corridor-specific congestion indicators (88 commutes statewide)[13]						
Annual Maximum Throughput Travel Time Index (MT^3I)	1.29	1.34	1.38	1.42	1.47	7.2%
Number of commute routes with $MT^3I > 1$[14]	59	61	66	68	71	7.6%
WSDOT congestion relief projects (cumulative)						
Number of completed Nickel and Transportation Partnership Account mobility projects as of December 31 each year	91	94	98	99	103	5.1%
Project value (in millions of dollars)	$3,851	$3,985	$4,287	$4,669	$5,058	18.0%

Data sources: Washington State Office of Financial Management, U.S. Energy Information Administration, Bureau of Labor Statistics – Consumer Price Index, Washington State Employment Security Department, Washington State Department of Revenue, WSDOT State Highway Log, U.S. Census Bureau - American Community Survey, National Transit Database, Washington Department of Ecology, WSDOT Ferries Division, WSDOT Rail, Freight and Ports Division, WSDOT Capital Program Development and Management Division, WSDOT Transportation Data, GIS & Modeling Office.

Notes: N/A = Not available. **1** Due to rounding, some percentages are not computable based on numbers in the table. **2** These dollar values are inflation-adjusted using the Consumer Price Index, and are reported in 2016 dollars. **3** Employment only includes non-agricultural workers. **4** Based on 1-year estimates from the American Community Survey, commuting rates are of workers age 16 and older. Totals do not equal 100 because "Worked at home" and "Other" categories not included. **5** Difference in percentage points, not percent change. **6** Ridership is the number of boardings, also called unlinked passenger trips. **7** Ferries ridership figures are for calendar years, and therefore may differ from numbers in other publications which use fiscal years. **8** These figures include riders on Washington segments only. **9** Based on below 70% of posted speed. **10** Based on maximum throughput speed threshold (85% of posted speed). Statewide delay data for 2015 and 2016 was unavailable at the time of this publication. **11** See p. 6 for descriptions of these measures. **12** This measure has been updated since the publication of the 2016 *Corridor Capacity Report*. This measure is now the percentage difference between the value of the reliability index in a given year and the average of the value of the reliability index in the three preceding years. **13** Does not include Tri-Cities data. For 2014 & 2016 includes newly added commute routes on SR-14 **14** MT^3I greater than one means the commute route experiences congestion.

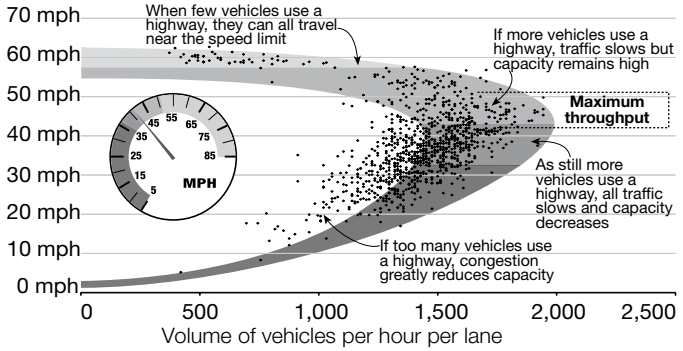
Maximum Throughput and Other Key Concepts

Maximum Throughput

WSDOT aims to provide and maintain a transportation system that maximizes capacity, productivity and efficiency. WSDOT uses maximum throughput speed (the speed at which the largest number of vehicles can pass through a roadway segment) as the baseline speed for congestion and capacity performance measurement on highways. Maximum throughput is achieved on highways when vehicles travel at 70% to 85% of the posted speed limit (42 to 51 mph for a 60 mph speed limit). At this speed, vehicles can safely travel closer together than they can at posted speeds, allowing more vehicles to pass through a segment.

Maximum throughput: adapted speed/volume curve

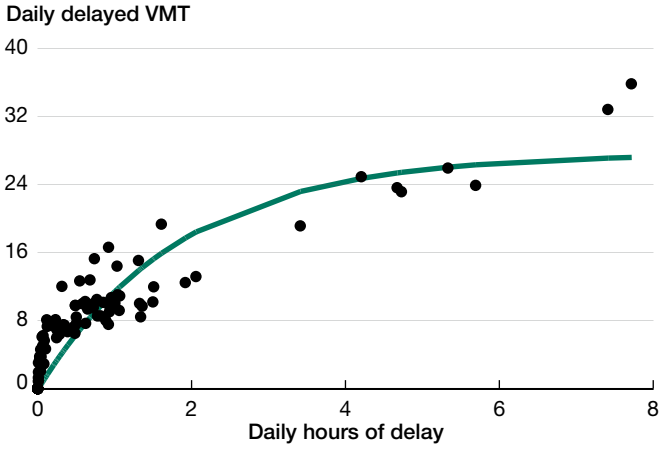
Speed limit 60 mph; Maximum throughput speed ranges between 70%-85% of posted speed



Data source: WSDOT Northwest Region Traffic Office.

I-5 northbound delay increases while delayed vehicle miles traveled[1] levels off

Daily hours of delay and daily delayed VMT in thousands



Data sources and analysis: WSDOT Multimodal Planning Division and WSDOT Office of Strategic Assessment and Performance Analysis.

Note: **1** Delayed vehicle miles traveled (VMT) refers to miles traveled at speeds below the maxiumum throughput speed threshold.

Delay increases faster than delayed vehicle miles traveled

Delay measures the hours during which speeds are below 50 mph (threshold speed). Delayed VMT refers to the vehicle miles traveled at speeds below that threshold.

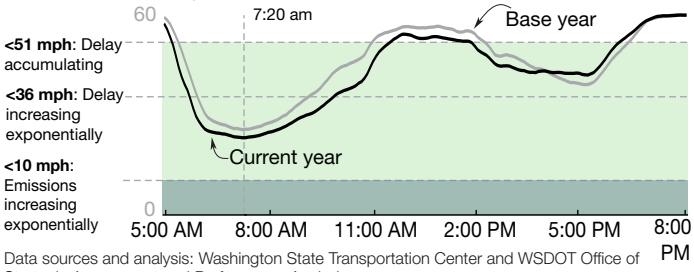
While it is impossible to have delayed vehicle miles traveled (VMT) without delay, the two measures do not have a linear relationship. Delayed VMT and vehicle hours of delay increase hand in hand until congestion becomes so severe that even though delay continues to accumulate, delayed VMT begins to level off (see graph at left). To use an extreme example, consider what happens when traffic stops dead for an hour: delay will increase by one hour, but no additional VMT will be recorded because the vehicles on the highway are not moving.

Delay not always a good indicator of emissions

For speeds slower than 10 mph, CO_2e emissions from vehicles quickly escalate. However, there is little variation in emissions per vehicle mile traveled between 35 and 60 mph, the typical range of highway speeds. For this reason, emissions often hold steady even as delay begins to accumulate. In addition, vehicle fuel economy improves each year, negating marginal changes in emissions caused by slower speeds or, on some corridors, leading to decreased emissions. The Puget Sound Regional Council provides WSDOT with the factors used to calculate the greenhouse gas emissions measures in this report.

Speeds on I-5 from Federal Way to Seattle not low enough to trigger increases in emissions between years[1]

Base and Current year; Northbound; Speed in miles per hour



Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Note: **1** Average speeds did not drop below 10 mph, the speed at which greenhouse gas emissions start rising exponentially. While emissions begin to rise around 25 mph, this is offset by lower emissions factors in current year due to improved efficiency of vehicles on the roadway. At 7:20 a.m. (the 5-minute peak), the average speed in current year was 23.1 mph, down from 25.5 mph in base year.

See the 2nd edition of WSDOT's Handbook for Corridor Capacity Evaluation for details on WSDOT's measurement and analysis approach for these and other system evaluation metrics.

Performance-Based Transportation System Management (State and Federal Requirements)

WSDOT, MPOs working on performance targets

The Moving Ahead for Progress in the 21st Century Act and the Fixing American's Surface Transportation Act (collectively referred to as MAP-21 throughout this publication) are federal laws that establish a new framework for investment in the nation's transportation infrastructure. MAP-21 is intended to make states more accountable and transparent in their investment of federal taxpayer dollars, and to ensure that states invest federal money in transportation projects that make progress toward achieving national transportation goals.

On May 20, 2017, the U.S. Department of Transportation (USDOT) released the final rules for performance measure requirements for system performance, freight movement, and congestion mitigation and air quality.

National MAP-21 goals include reducing congestion, improving system reliability, supporting freight movement and economic vitality, and ensuring environmental sustainability (See chart below).

Important dates for PM3 performance measures

October 1, 2017	First Performance Period for Emissions Reduction Measure starts
January 1, 2018	Performance Period starts for 2018
May 20, 2018	States set Performance Targets for 2018
October 1, 2018	Baseline Performance Period Report due
October 1, 2020	Mid-Performance Period Progress Report due (2-year)
October 1, 2021	First Performance Period for Emissions Reduction Measure ends
October 1, 2022	Full-Performance Period Progress Report due (4-year)

Teamwork continues to be a core driver of MAP-21 progress

WSDOT has assembled several layers of teams addressing MAP-21 target setting, including a core group of internal experts on system performance, freight movement, and congestion mitigation and air quality (CMAQ). The core group works directly with a technical group that is charged with providing input and guidance while providing insight into WSDOT's various modes and divisions.

A team comprised of WSDOT and representatives from Metropolitan Planning Organizations (MPOs) offers additional technical expertise and a more statewide view of the potential impacts of the targets.

Additionally, a framework group comprised of WSDOT's executive leadership team and MPO directors is responsible for making final determinations as the state moves forward to set MAP-21 targets.

MAP-21 final rules for system performance

Measure groups	Performance measures	Measure/target applicability	Metric data source and collection frequency	Metric
System Performance	Percent of person-miles traveled on the interstate system providing for reliable travel	Mainline of the interstate system within a state or each MPO	All traffic/vehicles data in NPMRDS[1] or equivalent every 15 minutes	Level of Travel Time Reliability (LOTTR)
	Percent of person-miles traveled on the non-interstate national highway system (NHS) providing for reliable travel	Mainline of the non-interstate NHS within a state or each MPO	All traffic/vehicles data in NPMRDS[1] or equivalent every 15 minutes	LOTTR
Freight Movement	Truck travel time reliability index (TTTR)	Mainline of the interstate system within a state or each MPO	Truck data in NPMRDS[1] or equivalent every 15 minutes	TTTR Index
Congestion Mitigation & Air Quality	Annual hours of peak-hour excessive delay per capita	Mainline of NHS in urbanized areas with populations over 200,000/1 million in non-attainment and maintenance for any CMAQ criteria pollutants	All traffic/vehicles data in NPMRDS[1] or equivalent every 15 minutes (bus, car and truck volumes in HPMS; occupancy factors published by FHWA	Total peak hour excessive delay person hours
	Percent of non-Single Occupancy Vehicle travel	Urbanized areas with populations over 200,000/ 1 million in non-attainment and maintenance for any CMAQ criteria pollutants	ACS, local survey or local counts (includes bicycle/pedestrian counts)	N/A
	Total emissions reduction	All non-attainment and maintenance areas for CMAQ criteria pollutants	CMAQ public access system	N/A

Note: **1** National performance management research data set

Travel reliability worsens as economy improves

Results Washington emphasizes performance and accountability

Results Washington, the state's performance management system, outlines Gov. Jay Inslee's priorities for the state. WSDOT manages Results Washington performance measures related to Sustainable, Efficient Infrastructure, which fall within the Prosperous Economy goal. The measures related to multimodal highway system performance focus on alternative commute methods, travel and freight reliability, and highway system efficiency.

WSDOT also has an interest in the clean transportation measures (which are focused on reducing transportation-related greenhouse gas [GHG] emissions) that fall under the Sustainable Energy and A Clean Environment goal area. Detailed reports for all Results Washington measures are available at results.wa.gov.

Alternative Commute Methods: Increase the percentage of Washingtonians using alternative transportation commute methods to 29% by 2020.

In 2016, 27.9% of Washington workers age 16 years and older used an alternative commute method (including teleworking) to get to work, an increase of 0.3% over 2015, falling short of the goal. Data for this measure comes from the American Community Survey.

Increasing the use of alternative modes of transportation helps maximize capacity on the entire transportation system, improves mobility and accessibility, and reduces greenhouse gas emissions.

Reliability and efficiency decline since 2012 baseline
80th percentile reliable travel times for 5 a.m. to 8 p.m.; Throughput productivity averages weighted by average daily volume per lane

Year	Reliability index	% Difference from 3-year rolling average[1,2]	Throughput productivity %[2]
2012	1.17	3.3%	95.7%
2013	1.19	3.2%	95.2%
2014	1.24	6.4%	94.6%
2015	1.26	5.1%	94.0%[3]
2016	1.30	5.5%	93.1%

Data source: WSDOT Office of Strategic Assessment and Performance Analysis.
Notes: **1** The percentage difference between the value of the reliability index in one year and the average of value of the reliability index in the three preceding years. **2** Results Washington performance measure. **3** Updated since publication of the 2016 *Corridor Capacity Report*.

Reliability: Ensure travel and freight reliability on strategic corridors does not deteriorate beyond 5% through 2020.

As of April 2017, this measure is based on the percentage difference between the value of the reliability index in the current year and the average of the value of the index in the three previous years. In 2016, the reliability index was 5.5% higher than the average of 2013, 2014 and 2015, missing the target of staying below 5%.

A reliability index greater than 1 indicates that the highway system is delayed during the daytime travel period (5 a.m. to 8 p.m.); an increase in the index over time indicates worsening delay and less reliable travel times.

System Efficiency: Operate strategic corridors at 90% efficiency or higher through 2020

For 2016, Washington operated strategic corridors at 93.1% efficiency, meeting the goal of 90% or higher (see table below left). However, system efficiency has worsened every year since 2009, tracking the overall trend of economic growth since the Great Recession; increased economic activity means more people and freight on the roads. An increase in throughput productivity indicates that system efficiency has improved, meaning more people and/or goods are being moved along Washington freeway corridors.

Efficiency across all transportation modes allows commuters to make better use of their own time and shippers and freight carriers to remain competitive.

Results WSDOT sets the agency's direction and priorities

Results WSDOT, the agency's strategic plan for 2014-2017, aligns with Results Washington. It focuses on maximizing capacity for the entire multimodal system, emphasizes working across all modes, and strives to provide and support safe, reliable and cost-effective transportation options to improve livable communities and economic vitality for people and businesses.

The 2017 *Corridor Capacity Report* is designed to help inform WSDOT policy makers, planners and engineers as they examine opportunities for maximizing multimodal capacity. It supports MAP-21 and Results Washington, as well as Results WSDOT's emphasis on innovation through Practical Solutions and performance-based planning initiatives. For more information on Results WSDOT, see https://www.wsdot.wa.gov/secretary/results-wsdot.

Statewide Congestion Indicators

Statewide vehicle miles traveled reach new high in 2016

Statewide vehicle miles traveled (VMT) on all public roads in Washington state reached a new high of 60.851 billion miles in 2016, an increase of 4.8% from 58.060 billion in 2014. Similarly, VMT on state highways alone reached a new high at 34.227 billion miles, an increase of 6.4% from 2014 (32.177 billion).

In 2016, VMT on all public roads and on state highways saw one-year increases of 2.0% and 2.7% over 2015 levels, respectively.

Per person vehicle miles traveled holds steady in 2016

In 2016, per person (per capita) VMT on all roads was measured at 8,471 miles—about 139 miles (or 1.7%) higher than in 2014 (8,332 miles), but only 0.3% higher than the 8,448 miles recorded in 2015. The increase over 2014 is largely explained by a jump that occurred in 2015, when per person VMT increased significantly after holding steady for three years—indicating that VMT grew faster than the state's population.

Total vehicle miles traveled (VMT) outpaces population growth in 2016

2012 through 2016; Population in thousands

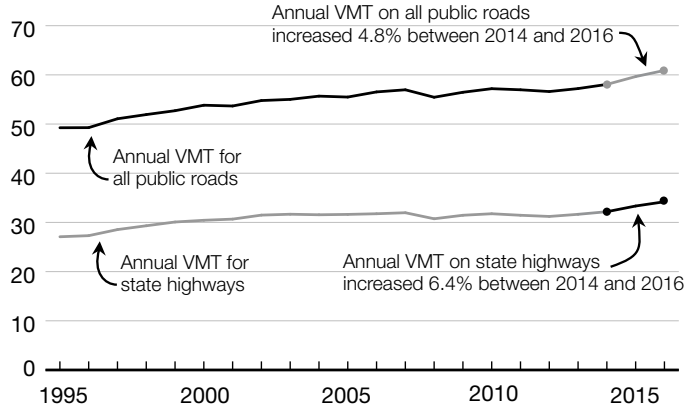
	Total vehicle miles traveled (billions)		Vehicle miles traveled per person	
Year (population)	All public roads	State highways	All public roads	State highways
2012 (6,818)	56.607	31.214	8,303	4,578
2013 (6,882)	57.211	31.649	8,313	4,599
2014 (6,968)	58.060	32.177	8,332	4,618
2015 (7,061)	59.653	33.335	8,448	4,721
2016 (7,183)	60.851	34.227	8,471	4,765
Δ 2016 vs. 2014	2.791	2.050	139	146
%Δ 2016 vs. 2014	4.8%	6.4%	1.7%	3.2%

Data sources: WSDOT Multimodal Planning Division and Washington State Office of Financial Management.

Looking at state highways alone, per person VMT remained around 4,600 from 2012 to 2014, but rose to 4,721 miles per person in 2015 and 4,765 miles per person in 2016, resulting in a 146-mile (or 3.2%) increase in VMT per Washingtonian from 2014 to 2016.

Record high statewide vehicle miles traveled in 2016

1995 through 2016; Miles in billions



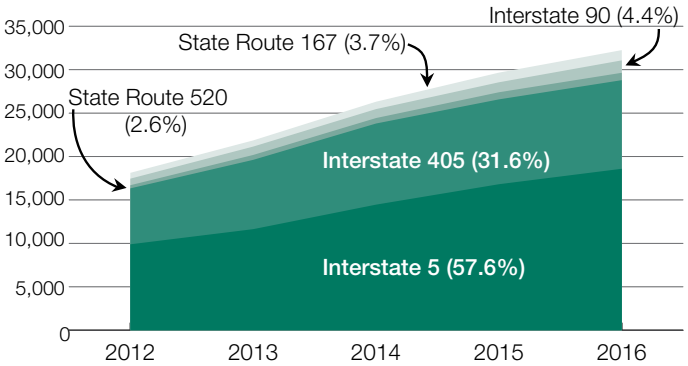
Data sources: WSDOT Multimodal Planning Division.

Long-term upward trend in Central Puget Sound region delay continues

Average daily weekday delay on freeway corridors (Interstate 5, I-405, I-90, State Route 520 and SR 167) in King and Snohomish counties grew roughly 22.3% from 26,376 daily vehicle hours of delay in 2014 to 32,250 hours in 2016. This growth can be partially attributed to growing employment during this period (see p. 9).

Major urban freeways in the central Puget Sound region see delay increases

2012 through 2016; Vehicle hours of delay per weekday (and percent of total delay) by major urban freeway



Data source: WSDOT Multimodal Planning Division.
Notes: The central Puget Sound region includes King and Snohomish counties. Percentages may not add to 100% due to rounding.

The five-year trend also shows a significant delay increase, at 78.0% more delay in 2016 than in 2012 (which had 18,121 average daily vehicle hours of delay, and was the third year of growth in delay after the low point of 13,058 daily vehicle hours at the height of the recession in 2009).

Transportation accounts for 43% of Washington emissions

Average daily weekday delay on major central Puget Sound freeways
2012 through 2016; Vehicle hours of delay per day

Corridor	2012	2013	2014	2015	2016	2014 vs. 2016
I-5	9,894	11,638	14,389	16,810	18,590	**29.2%**
I-405	6,439	7,978	9,427	9,768	10,200	**8.2%**
SR 520	363	564	633	818	850	**34.3%**
I-90	756	963	1,064	1,149	1,430	**34.4%**
SR 167	669	712	863	1,111	1,180	**36.7%**
Total	**18,121**	**21,855**	**26,376**	**29,656**	**32,250**	**22.3%**

Data source: WSDOT Multimodal Planning Division.
Notes: To make accurate comparisons, the 2014 data was recalculated for this report. To learn why delay and miles traveled do not increase hand in hand, see p. 10 of the 2nd edition of the *Handbook for Corridor Capacity Evaluation*. See the lane mile inventory on p. 4 of the Appendix for delay context.

From 2012 to 2016, I-5, which has more lane miles than the other monitored freeways and is a key freight corridor (connecting to Canada in the north and Mexico in the south), saw more delay than the other four monitored freeways combined (see graph on p. 8).

Emissions on high-demand urban commute corridors down by 3.3%

In 2016, the weekday annual greenhouse gas emissions from vehicles on high-demand commute corridors in urban areas statewide were estimated to be 2.75 million metric tons (or 6.07 billion pounds) of carbon dioxide equivalents (CO2e)—3.3% less than in 2014. Although VMT and delay both increased from 2014 to 2016, emissions improved due to increased efficiency of vehicles and the non-linear relationship between VMT, delay and emissions (see p. 5 of this report, and p. 10 and p. 16 of the 2nd edition of the *Handbook for Corridor Capacity Evaluation*).

According to the Washington State Department of Ecology, transportation-related activities contributed 42.8% of all greenhouse gases released into the atmosphere in 2013 (the most recent year with available data). Washington state generates more clean energy than the national average; as a result, transportation as a percent of statewide emissions is higher compared to the national average of 27%.

Multiple economic factors affect congestion levels in Washington

Increased employment: Maintaining the steady economic recovery, non-farm employment in Washington reached 3.245 million workers in 2016, a 5.8% increase from 2014. Much like congestion on some of Washington's highways, employment now exceeds (by 9.2%) 2007 pre-recession levels. Washington's unemployment rate dropped to 5.4% in 2016, from 6.1% in 2014.

While the statewide unemployment rate is at a eight-year low and continues to approach the pre-recession rate of 4.7%, this can likely be partially attributed to workers leaving the labor force or to young adults delaying entry into the labor force. Washington's labor force participation rate has fallen from 66.2% in 2007 to 63.5% in 2016 (up slightly from a low of 62.8% in 2014) because the labor force (the population currently working or actively seeking work) did not increase as quickly as the working age population. Additionally, average weekly hours worked by all Washington employees dropped slightly by 0.3% (about 5.5 minutes) between 2014 and 2016, and is 2.7% below 2007 pre-recession levels, likely due to a lingering shift toward part-time employment.

In the Seattle-Bellevue-Everett metropolitan area, employment grew 4.9% and the unemployment rate fell to a nine-year low of 4.0%, while the labor force participation rate held steady at an eleven-year low of 69.6%. Both statewide and metropolitan area

Summary of Washington's economic indicators
2014 and 2016

Indicator	2014	2016	%Δ	Actual Trend	Desired Trend
Employment (millions of workers)	3.07	3.24	5.8%	↑	↑
Unemployment rate	6.1%	5.4%	-0.7%[3]	↓	↓
Taxable retail sales[1] (billions of dollars)	$126.7	$146.4	15.7%	↑	↑
Gasoline price per gallon[1]	$3.61	$2.47	-31.6%	↓	N/A
Driving age population (ages 16 and over, in millions)	5.56	5.74	3.3%	↑	N/A
Licensed drivers (millions)[2]	5.47	5.71	4.3%	↑	N/A
Passenger vehicle registrations (millions)	4.62	4.76	3.2%	↑	N/A
Median home price (thousands)[1]	$269.6	$315.3	16.9%	↑	N/A

Data sources: Washington State Office of Financial Management, U.S. Bureau of Labor Statistics, Washington State Department of Revenue, U.S. Energy Information Administration, Washington State Department of Licensing.
Note: **1** Adjusted for inflation and reported in 2016 dollars. **2** Includes licensed military personnel; previous editions of the *Corridor Capacity Report* excluded military personnel. **3** **Δ**, not %**Δ**.

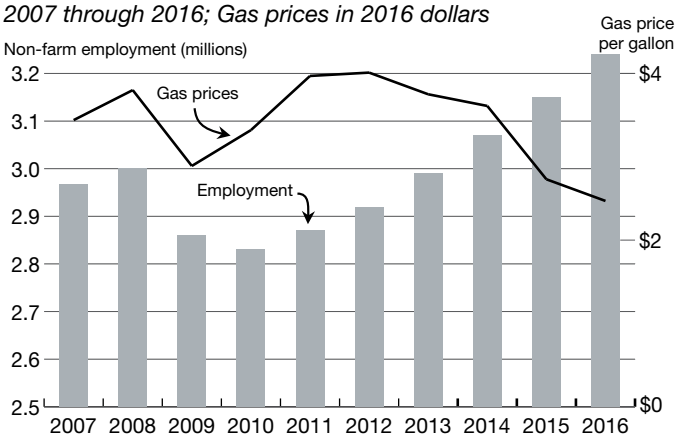
More vehicles on the road and more congestion in 2016

average hourly wages reached new highs in 2016, with statewide average wages increasing by $.69 per hour, and Seattle-Bellevue-Everett metropolitan area average wages increasing by $1.10 per hour.

Washington state retail sales (adjusted for inflation) increased by 15.7% between 2014 and 2016. This increase in consumption is likely a result of growth in wages and employment. Taxable retail sales can be an indicator of consumers' confidence in the economy, and, given that retail stores must be supplied with goods, are likely to influence freight truck traffic on Washington public roads.

Employment trends upwards as gas prices fall

2007 through 2016; Gas prices in 2016 dollars



Lower gas prices: Gas prices in Washington fell 31.6% (accounting for inflation) between 2014 and 2016, from an average of $3.61 per gallon in 2014 to $2.47 in 2016. Washington's gas prices have fallen substantially every year since 2012, when the average gas price was $4.01 (in 2016 dollars). Gas prices in Washington exceeded the national average by 33 cents in 2016. When gas prices fall, driving becomes less expensive and people are more likely to drive alone (or drive more) rather than using alternative commute modes such as transit or carpools; thus, as gas prices fall, VMT tends to increase and congestion tends to worsen.

More vehicles on the road: Washington's driving age population (age 16 and older) increased 3.3% between 2014 and 2016, reaching 5.74 million and exceeding the growth rate of total state population (3.1%) over the same period. In the frequently congested Seattle-Bellevue-Everett metropolitan area, the driving age population increased by 4.6% between 2014 and 2016, from 2.23 million to 2.33 million people.

In 2016, 5.71 million Washingtonians —or 99% of all Washingtonians over the age of 16—were licensed drivers (all types), up 4.3% from 2014 (see table at bottom of p. 9). In addition, Washington had 4.76 million registered passenger vehicles in 2016, 3.2% more than two years before, a sign of additional demand on the transportation system. This translates to about 0.83 passenger vehicles per licensed driver in Washington, down from 0.84 in 2014.

Alternative commutes and home prices: According to the American Community Survey, 72.1% of Washingtonians drove alone to work in 2016, a slight decrease from 72.4% in 2014. Of the remaining Washington workers in 2016, 9.9% carpooled, 6.4% rode public transportation, 4.6% walked or rode a bicycle, and the remainder either worked from home or used another form of transportation (such as motorcycle or taxi) to get to work. While the increase of 0.3% in the alternative commute rate is significant, the number of people employed in Washington state grew 5.8% over the same period, resulting in the absolute number of Washingtonians getting to work by driving alone going up between 2014 and 2016.

Additionally, median home prices in Washington rose 16.9% (accounting for inflation) between 2014 and 2016. Because the highest home prices are often in high-density urban and job centers, a general increase in home prices can make it unaffordable for people to live near their jobs, which increases the distance people travel to get to work. Like growth in the number of drivers on the road, increases in commute distance lead to more vehicle miles traveled—and consequently more congestion.

Major urban highways continue to experience increased delay

Between 2014 and 2016, urban highways throughout the state saw double- and triple-digit increases in delay during peak periods, with primarily single-digit increases in VMT—indicating substantial increases in congestion. Congestion, travel time and delay are influenced by multiple factors, including the number of people commuting (which increases as the economy improves), the distances they must travel to get to work (which tend to increase with housing prices), and how many of them are driving alone.

Detailed evaluations of each corridor begin on page 11, and more statewide indicators data appears in the Appendix (pp.3-4).

Visit bit.ly/agolCCR17CentralSoundmap for this article's interactive map.

Interstate 5 Corridor Capacity Analysis

Annual GP person miles traveled
2014 2,478 vs. 2016 2,550 (in millions of miles) ▲ 2.9%

Annual GP vehicle delay[1]
2014 3,774 vs. 2016 4,852 (in thousands of hours) ▲ 29%

Annual GP GHG emissions
2014 2,052 vs. 2016 1,993 (in millions of pounds of CO_2 equivalents) ▼ 2.9%

Annual passenger miles traveled on transit
2014 204.6 vs. 2016 224.6 (in millions of miles) ▲ 10%

Capacity savings due to transit
2014 4.1 vs. 2016 4.5 (in number of lanes) ▲ 9.8%

Percent transit seats occupied
2014 70% vs. 2016 73% (on average during peak periods) ▲ 3%

Percent park and ride spaces occupied
2014 92% vs. 2016 92% (on average during peak periods) ◆ 0%

Commute travel times

2014 and 2016 during the morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Weekday travel times in minutes at the 5-minute peak including average and reliable[2] travel times for general purpose lane (GP), high occupancy vehicle (HOV) and transit[3] trips.

Average GP · Reliable GP · Average HOV · Reliable HOV · Average transit · Reliable transit

Everett to Seattle
Morning; 7:15 a.m.; Trip length 23 miles

GP	2014	51	85
	2016	56	94
HOV	2014	45	74
	2016	46	75
Transit[3]	2014	68	89
	2016	52	64

Seattle to Everett
Evening; 4:20 p.m.; Trip length 23 miles

GP	2014	44	63
	2016	52	72
HOV	2014	41	56
	2016	46	61
Transit[3]	2014	55	66
	2016	40	49

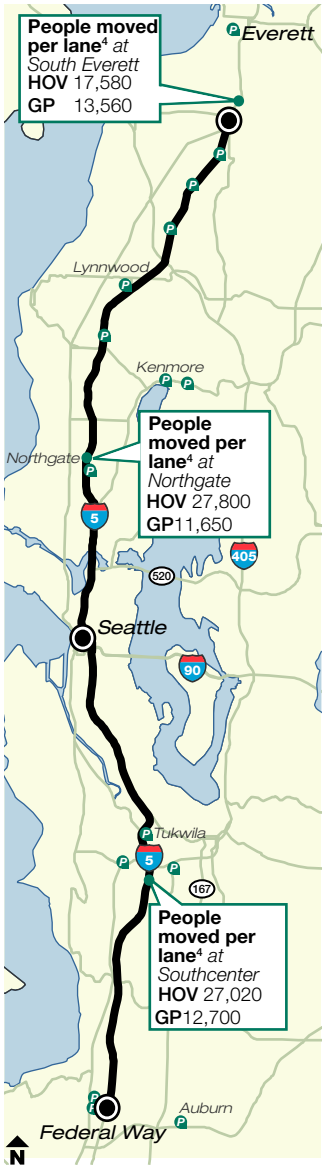
Federal Way to Seattle
Morning; 7:15 a.m.; Trip length 22 miles

GP	2014	52	76
	2016	58	82
HOV	2014	39	55
	2016	43	61
Transit[3]	2014	40	51
	2016	55	72

Seattle to Federal Way
Evening; 4:10 p.m.; Trip length 22 miles

GP	2014	35	52
	2016	39	54
HOV	2014	32	46
	2016	35	47
Transit[3]	2014	43	54
	2016	41	55

See Appendix pp. 5-29 for more commute routes



Transit system use

2014 and 2016; For typical weekday morning (6-9 a.m.) and evening (3-6 p.m.) transit[3] peak periods; Ridership and percent of available seats occupied on select commutes

By commute	Daily peak period riders		Percent of seats occupied	
Morning (6-9 a.m.)	2014	2016	2014	2016
Everett to Seattle	10,860	11,666	72%	68%
Federal Way to Seattle *Includes Tacoma to Seattle transit routes	6,761	5,051	65%	57%
SeaTac to Seattle	5,318	7,192	88%	101%
Evening (3-6 p.m.)				
Seattle to Everett	10,738	11,030	66%	67%
Seattle to Federal Way *Includes Seattle to Tacoma transit routes	5,621	4,583	65%	53%
Seattle to SeaTac	5,992	8,429	94%	113%

Park & ride capacity

2014 and 2016; Average percent occupied for select park and rides (see map for locations); Rates over 100% denote vehicles parked in unmarked space

Everett-Seattle commute

Park and ride (spaces)	2014 percent occupied	2016 percent occupied
Ash Way (1,042)	106%	105%
Kenmore area (696)	100%	100%
Lynnwood Transit Ctr. (1,370)	100%	100%
S. Everett Freeway Station (397)	100%	100%
Northgate area (1,024)	100%	100%
Mountlake Terrace (877)	100%	100%
Mariner (644)	76%	68%
Everett Station (1,107)	67%	79%

Federal Way-Seattle commute

Park and ride (spaces)	2014 percent occupied	2016 percent occupied
Sumner train station (302)	94%	100%
Auburn area (633)	100%	100%
Tukwila area (867)	100%	100%
Kent area (996)	98%	100%
Tacoma Dome (2,337)	96%	98%
Puyallup area (583)	97%	95%
Lakewood area (1,093)	87%	89%
Federal Way area (2,067)	73%	70%

Data sources and analysis: Washington State Transportation Center, WSDOT Multimodal Planning Division, WSDOT Northwest Region Traffic Office, Sound Transit, Pierce Transit, King County Metro, Community Transit and WSDOT Office of Strategic Assessment and Performance Analysis.

Notes: Measures at the top of the page are for the I-5 corridor between Everett and Federal Way for GP trips only. **1** WSDOT defines delay as when average speeds are slower than 85% of the posted speed limit. **2** Reliable travel time will get commuters to their destination on time 19 out of 20 weekdays (95% of the time). **3** Transit travel times by bus and Link light rail may not be directly comparable to GP/HOV trips due to different start and end points or off-highway travel to stops. WSDOT attempts to match transit trips as closely as is practical to GP/HOV. Some transit trips were adjusted for 2016 to more closely match the GP/HOV trips (see Appendix pp. 19-20). Transit travel times are calculated using a representative trip that occurs as close as possible to the 5-minute peak. **4** Person throughput values include morning (6-9 a.m.) and evening (3-7 p.m.) traffic.

I-5 experiences 58% of Puget Sound region's delay

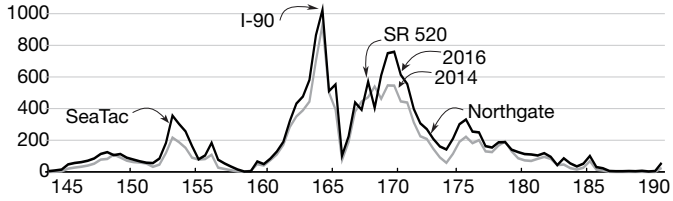
Interstate 5 (I-5) is one of the key commute and economic corridors in the central Puget Sound region. More than 2.5 billion person miles were traveled between Federal Way and Everett in 2016, a 2.9% increase over 2014. Highway capacity constraints vary based on the presence of managed lanes and multimodal travel options; parts of the I-5 corridor in the central Puget Sound region are served by Link light rail, Sounder commuter rail, transit buses and high occupancy vehicle (HOV) lanes. In 2016, the HOV lane at Northgate on this corridor moved more than two times as many people as each adjacent general purpose (GP) lane. This speaks to the efficiencies of the HOV network and transit options on the corridor in moving more people.

Despite these efficiencies, traffic at specific locations on the corridor worsened from 2014 to 2016, with morning and evening weekday commutes experiencing severe congestion on a daily basis. Delay increased 29% on I-5 between Federal Way and Everett. To learn why delay and miles traveled do not increase hand in hand, see p.5. In addition to delaying commuters, this congestion directly impacted the movement of goods in Washington, as trucks accounted for over 7% of the total daily traffic volume on the corridor in 2016.

Booming economy increases traffic

Increasing congestion on the I-5 corridor is a key indicator that Seattle's economy is booming once again and the Great Recession is a thing of the past. Pushed out of the city by its high-priced housing market, many people who work in Seattle now live outside it and commute into the city on I-5. It is also important to note that many of the highways that cross I-5 also face significant congestion during the peak commute periods. Congestion on nearby corridors such as SR 520, I-90, I-405 and major city off-ramps often create backups that overflow onto I-5 and create congestion on a regular basis.

Delay along the I-5 corridor by milepost
2014 and 2016; Northbound and southbound combined; Average daily vehicle hours of delay



Data sources and analysis: WSDOT Multimodal Planning Division and WSDOT Office of Strategic Assessment and Performance Analysis.

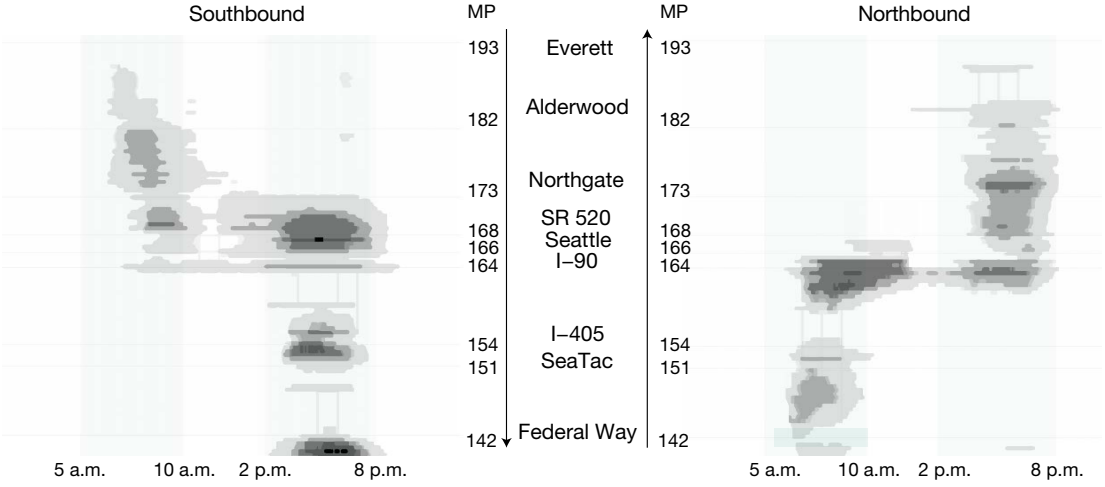
Greenhouse gas (GHG) emissions declined by 2.9% between 2014 and 2016. For more information on the relationship between GHG emissions and delay, see p. 5.

Corridor delay: Vehicle delay along the I-5 corridor was higher in 2016 than in 2014; the magnitude of the difference varied depending on the location and direction of travel (see graph above). In 2016, the I-5 corridor in the central Puget Sound region between Federal Way and Everett experienced vehicle delay northbound around the I-90 interchange and between Northgate and downtown Seattle, as well as southbound at SeaTac and the SR 520 interchange.

Delay would have been worse without transit. Data shows that even with conservative assumptions, transit ridership along the I-5 corridor translates to a capacity savings equivalent to 4.5 additional lanes of traffic during peak commute periods (see p.14 for more information on

I-5 delay between Federal Way and Everett
2016; Vehicle hours of delay; Weekdays only; By milepost (MP); Shading represents intensity of delay; Highlighted sections represent peak periods

In 2016, delay was prevalent throughout the Seattle area in both directions throughout the entire day. Delay on northbound I-5 was most intense from 6-11 a.m. approaching Seattle; evening delay extended from the I-90 interchange to Everett. During the morning commute, delay on southbound I-5 extended from Everett past Seattle. Delay was most intense from 2-6 p.m., with pockets of delay from Northgate to Federal Way.



Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Nearly 78% of I-5 peak direction miles routinely congested

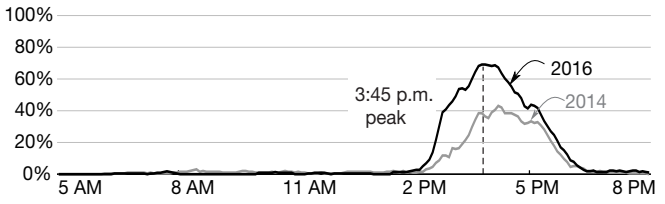
transit ridership). The heat map graph on p.12 shows the intensity of delay by time of the day and location in 2016.

The amount of delay significantly increased between 2014 and 2016 at specific locations on the I-5 corridor, including: southbound at SeaTac (up 62%), northbound at the I-90 interchange (up 18%) and in both directions near Northgate (up 37%).

A focus on hot spots: The percent of days the Seattle to SeaTac commute operated in severely congested conditions (speeds 36 mph or below) increased between 2014 and 2016 (see severe congestion chart below). For example, at 3:45 p.m. speeds on this commute were below 36 mph on 69% of weekdays in 2016—up from 39% of weekdays in 2014.

Severe congestion on the Seattle to SeaTac commute

2014 and 2016; Percent of days the average speed was slower than 36 mph

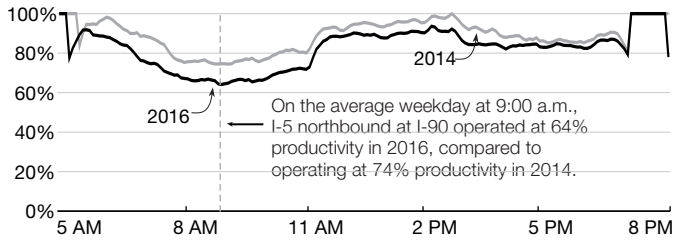


Data sources and analysis: WSDOT Multimodal Planning Division, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Highway productivity: As traffic increases and speeds drop below maximum throughput, congested roads carry fewer vehicles, resulting in a drop in throughput productivity. In order to gauge the lost productivity on I-5 in the central Puget Sound region, WSDOT analyzed vehicle throughput at three locations: near South 188th Street, near Northeast 103rd Street and at the I-90 interchange. In 2014 and 2016, productivity at these locations ranged from 64% to 83% at their most congested times. Throughput productivity varies by direction of travel, location and time of day. For example, at the I-90 interchange, nearly 36% of the freeway's capacity was unavailable due to congestion during part of the morning peak period (see graph below left).

Throughput productivity on northbound I-5 at I-90 interchange

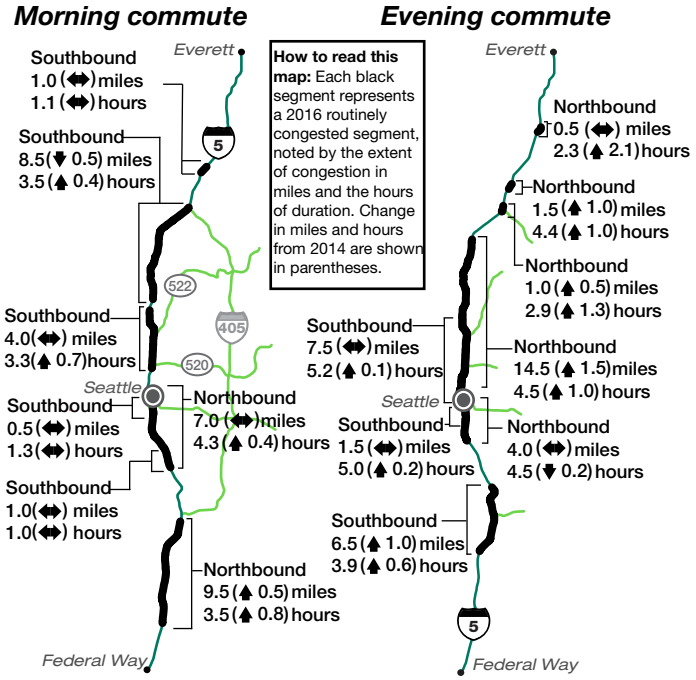
2014 and 2016; Based on the highest observed 5-minute flow rate; Northbound = 1,500 vehicles per hour per lane = 100%



Data sources and analysis: WSDOT Multimodal Planning Division, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Routinely congested segments of I-5

2016; For weekday morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Length of backup in miles; Daily duration of congestion in hours (compared to 2014).



Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Note: See pp. 7-8 in the Appendix for all central Puget Sound region routinely congested segment data.

Routinely congested segments: Of the 91-mile I-5 corridor between Federal Way and Everett (both directions), the segments leading to downtown Seattle experienced the worst routine congestion. Overall, the locations where routine congestion occurred increased by 11.9% (7.5 miles) between 2014 (63 miles total) and 2016 (70.5 miles total), while the duration of routine congestion increased by 31.5% (see map above).

In 2016, 16.5 miles of the 22-mile morning commute between Federal Way and Seattle and 17 miles of the 24-mile Everett to Seattle morning commute experienced routine congestion in 2016. Similarly, 17.5 miles of the Seattle to Everett evening commute and eight miles of southbound evening commute from Seattle to Federal Way experienced routine congestion in 2016.

Transit saves 4.5 lanes of highway capacity on I-5

What does severe congestion mean for travel times on the corridor?

General purpose lane trips: Capacity constraints impacted the Federal Way to Seattle northbound commute near the I-90 interchange, and the Everett to Seattle southbound commute in the Northgate and SR 520 areas, resulting in increased average and reliable travel times during the morning peak period (5-10 a.m.) for some commutes. The average and reliable travel times for the Federal Way to Seattle commute both increased by six minutes. Similarly, the average morning travel time from Everett to Seattle increased to 56 minutes in 2016, up five minutes (10%) from to 2014, while reliable travel time increased by 9 minutes (11%). Similar trends in increased average and reliable travel times were observed for evening commutes from Seattle.

The SeaTac to Seattle morning commute, a portion of the Federal Way to Seattle morning commute, has the highest maximum throughput travel time index (MT3I) of the twelve I-5 commutes that WSDOT tracks in the central Puget Sound region. The route's MT3I of 2.38 means the commute takes more than twice as long as it would if traffic was moving at maximum throughput speed (50 mph). WSDOT uses this index to compare the severity of congestion across commutes.

Transit trip travel times: Along the I-5 corridor, commuters can bypass bottlenecks in the corridor's GP lane by riding light rail or commuter rail, or by using a carpool or transit bus to travel in an HOV lane. For example, in 2016 the average and reliable transit travel times for the commute from Federal Way to Seattle in the morning were 55 and 72 minutes—3 and 10 minutes faster than the corresponding GP travel times. These times are 15 minutes slower than the average (40 minutes) and 21 minutes slower than the reliable (51 minutes) transit travel times in 2014. See p.11 for a comparison of transit trips to GP and HOV trips.

Transit ridership and GHG emissions avoided: Transit moved roughly 52,890 riders on the I-5 corridor during the peak periods on an average weekday in 2016, a 10.9% increase over 2014 (about 47,704 riders). This corresponds with an increase of approximately 9.8% in transit passenger miles traveled.

For example, peak period transit ridership on the I-5 corridor in the central Puget Sound region was equal to more than 4.5 extra lanes of capacity in 2016 (when compared to the peak efficiency of the roadway, which is a conservative approach to this measurement). Approximately 73% of available seats on transit on I-5 commutes were occupied during the morning and evening peak periods in 2016. Of the 990 daily peak period transit trips, 143 were at over 90% of seating capacity on a typical weekday. Transit use during peak periods avoided roughly 455,240 pounds of GHG emissions per day on the I-5 central Puget Sound corridor in 2016, a 13.7% improvement compared to 2014 (400,343 pounds).

Why are some transit travel times faster than HOV?
On the I-5 corridor map on p.11, two commutes have transit travel times which are faster than the corresponding HOV travel times. This is due to the transit routes being slightly shorter than the HOV commute. For example, on the Everett to Seattle morning commute the transit trip is about two miles shorter than the HOV trips, cutting out some of the worst congestion. The Sound Transit 510 bus uses the express lanes to travel between the South Everett Freeway Station park and ride and the Stewart Street and Yale Avenue intersection in downtown Seattle.

Park and ride: Along the I-5 corridor in the central Puget Sound region in 2016, park and ride (P&R) utilization rates ranged from 68% to 105%, with 13 out of 16 having utilization rates above 85%. Any P&R lot that has 85% or more utilization is identified as operating at capacity. Park and ride lots along the corridor serve a broad number of modes, including carpools, vanpools, transit, commuter rail passengers as well as bicyclists and pedestrians. Park and ride locations are essential for transit riders and carpoolers and must have high utilization rates to be considered successful. Targeted outreach efforts from transit agencies as well as employer initiatives to encourage participation in a Commute Trip Reduction program help address highway capacity needs in the central Puget Sound region.

How much is congestion costing you?

Costs due to congestion on I-5 in 2016 varied by commute trip. A commuter who made the 47-mile round trip between Everett and Seattle daily had congestion costs (measured in wasted time and gas for travel below maximum throughput speed) of about $3,100 per passenger vehicle annually in 2016, while one who made the 44-mile round trip between Federal Way and Seattle daily had congestion costs of over $2,700.

Visit bit.ly/agolCCR17CentralSoundmap for this article's interactive map.

Interstate 405 Corridor Capacity Analysis

Annual GP person miles traveled

2014 vs. 2016: 1,142 vs. 1,152 in millions of miles — ▲ 0.9%

Annual GP vehicle delay[1]

2014 vs. 2016: 2,438 vs. 2,662 in thousands of hours — ▲ 9.2%

Annual GP GHG emissions

2014 vs. 2016: 940.1 vs. 900.8 in millions of pounds of CO_2 equivalents — ▼ 4.2%

Annual passenger miles traveled on transit

2014 vs. 2016: 14.3 vs. 20.7 in millions of miles — ▲ 45%

Capacity savings due to transit

2014 vs. 2016: 0.2 vs. 0.5 in number of lanes — ▲ 150%

Percent transit seats occupied

2014 vs. 2016: 69% vs. 66% on average during peak periods — ▼ 3%

Percent park and ride spaces occupied

2014 vs. 2016: 97% vs. 100% on average during peak periods — ▲ 3%

Interstate 405 (I-405) is one of the key commute and economic corridors in the central Puget Sound region, running parallel to I-5 between Tukwila and Lynnwood. Over 1.1 billion person miles were traveled on I-405 in 2016, a 0.9% increase from 2014. This section refers to GP lanes on the full corridor, and excludes the express toll lanes (ETL) and high occupancy vehicle (HOV) lanes unless specifically referenced.

Highway capacity constraints vary based on the presence of managed lanes and multimodal travel options; the I-405 corridor in the central Puget Sound region is served by high occupancy vehicle (HOV) lanes, transit and, as of September 27, 2015, express toll lanes. The HOV lane at Newcastle on this corridor moved nearly two times as many people as each adjacent general purpose (GP) lane.

Despite these efficiencies, traffic at specific locations on the corridor worsened from 2014 to 2016, with morning and evening weekday commutes experiencing severe congestion on a daily basis. Delay increased 9% on I-405 between Tukwila and Lynnwood. To learn why delay and miles traveled do not increase hand in hand, see page 5. Corridor segments near State Route (SR) 169 in Renton, the I-90 interchange and the Kirkland area contributed to the significant delay increases between 2016 and 2014.

In addition to delaying commuters, this congestion directly impacted the movement of goods in Washington, as trucks accounted for 5% of the total daily traffic volume on the corridor in 2016. The greenhouse gas (GHG) emissions on I-405 decreased by 4.2% in 2016 compared to 2014.

See Appendix pp. 5-29 for more commute routes

Transit system use

2014 and 2016; For typical weekday morning (6-9 a.m.) and evening (3-6 p.m.) transit[2] peak periods; Ridership and percent of available seats occupied on select commutes

By commute

	Daily peak period riders		Percent of seats occupied	
Morning (6-9 a.m.)	2014	2016	2014	2016
Everett to Bellevue	736	745	94%	95%
Lynnwood to Bellevue	393	1,723[4]	83%	79%
Tukwila to Bellevue	193	311	43%	64%
Evening (3-6 p.m.)				
Bellevue to Everett	802	752	84%	89%
Bellevue to Lynnwood	277	1302[4]	71%	67%
Bellevue to Tukwila	326	393	63%	43%

Park and ride capacity

2014 and 2016; Average percent occupied for select park and rides (see map for locations); Rates over 100% denote vehicles parked in unmarked space

Lynnwood-Bellevue commute

Park and ride (spaces)	2014 percent occupied	2016 percent occupied
Kingsgate (502)	106%	115%
Ash Way (1,042)	106%	105%
Kenmore area (696)	100%	100%
Canyon Park (302)	99%	99%
Bothell (220)	98%	99%
South Kirkland (833)	82%	97%
Brickyard (443)	82%	87%

Tukwila-Bellevue commute

Park and ride (spaces)	2014 percent occupied	2016 percent occupied
South Bellevue (519)	107%	108%
Wilburton (186)	100%	97%
Renton Munipical (200, 150)[5]	96%	97%
Renton (150)	98%	95%
Newport Hills (275)	77%	73%

Data sources and analysis: Washington State Transportation Center, WSDOT Multimodal Planning Division, WSDOT Northwest Region Traffic Office, Sound Transit, Pierce Transit, King County Metro, Community Transit and WSDOT Office of Strategic Assessment and Performance Analysis.

Notes: Measures at the top of the page are only for GP trips on the I-405 corridor between Tukwila and Lynnwood. See travel time information for the Bellevue-Tukwila commute on p.17. **1** WSDOT defines delay as when average speeds are slower than 85% of the posted speed limit. **2** Transit travel times by bus may not be directly comparable to GP/HOV trips due to different start and end points or off-highway travel to stops. WSDOT attempts to match transit trips as closely as is practical to GP/HOV. Some transit trips were adjusted for 2016 to more closely match the GP/HOV trips (see Appendix pp. 19-20). **3** Person throughput values include morning (6-9 a.m.) and evening (3-7 p.m.) traffic. **4** The commutes between Lynnwood and Bellevue were served by many more transit trips in 2016 than in 2014 (see p.18) **5** The Renton Municipal park and ride was reduced from 200 to 150 spaces on January 1, 2015.

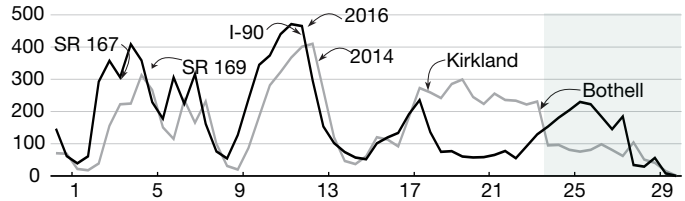
I-405 experiences 32% of Puget Sound region's delay

Corridor delay: In 2016, the I-405 corridor in the central Puget Sound region between Tukwila and Lynnwood experienced vehicle delay northbound near SR 169 (in Renton) and southbound at the I-90 interchange, while the Kirkland-Bothell area experienced a reduction in congestion in both directions with the implementation of express toll lanes.

Vehicle delay along the I-405 corridor was higher at most locations in 2016 than in 2014, except for the section between Kirkland and Bothell. The amount of delay varied between 2014 and 2016 at specific locations on the I-405 corridor, including: northbound at the SR 167 interchange in Renton (up 27%), southbound at the I-90 interchange (up 13%), and in both directions between Kirkland and Bothell (down 55%) where there are two ETLs.

Delay along the I-405 corridor

2014 and 2016; Northbound and southbound combined; Average daily vehicle hours of delay by milepost



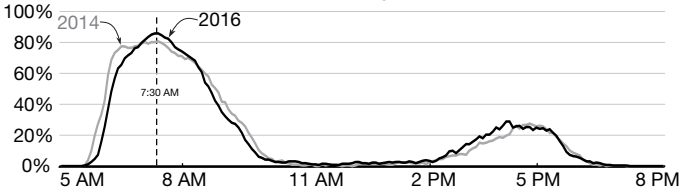
Notes: The highlighted section represents the section of I-405 which has only one ETL in each direction, and only three lanes total.
Data sources and analysis: WSDOT Multimodal Planning Division and WSDOT Office of Strategic Assessment and Performance Analysis.

The line graph above shows that the shift in the delay trend is mostly due to the reductions in delay between Kirkland and Bothell, where there are two ETLs and three GP lanes. The northbound commute between Bothell and Lynnwood experienced increased delay due to the bottleneck created by the reduction of I-405 from five lanes to three lanes. The delay experienced between Bothell and Lynnwood doubled between 2014 and 2016. The heatmap at the bottom of the page shows the intensity of delay by the time of day and location in 2016.

A focus on hot spots: The Lynnwood to Bellevue morning commute was severely congested (36 mph or below) on more weekdays in 2016 than in 2014 (see chart below). For example, at 7:30 a.m. during the morning commute, the percent of days speeds were below 36 mph worsened from 80% in 2014 to 86% in 2016.

Severe congestion on the Lynnwood to Bellevue commute

2014 and 2016; Percent of days the average speed was slower than 36 mph



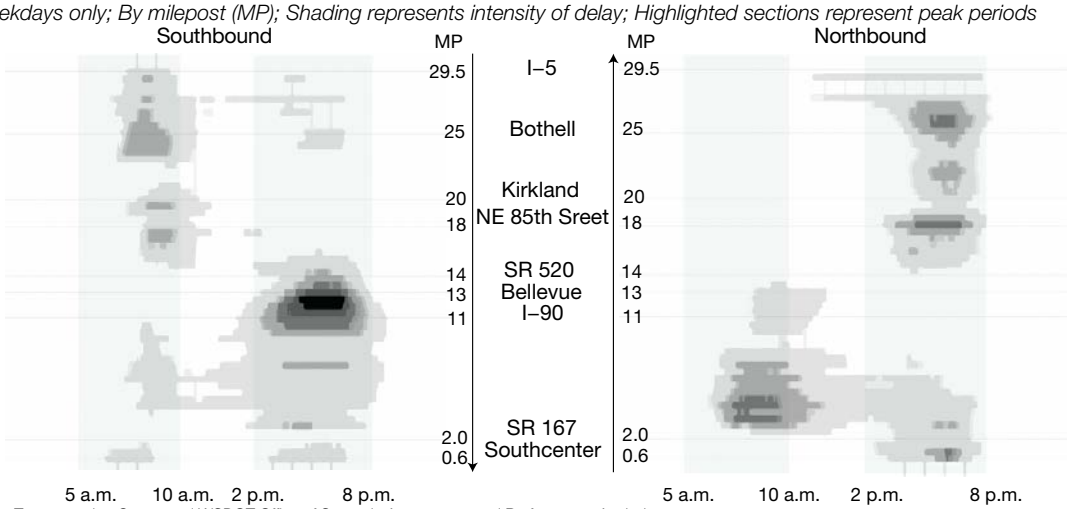
Data sources and analysis: WSDOT Northwest Region Traffic Office, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Highway productivity: As traffic increases and speeds drop below maximum throughput, congested roads carry fewer vehicles, resulting in a drop in throughput productivity. In order to gauge the lost productivity

I-405 delay between Tukwila and the Lynnwood I-5/I-405 interchange

2016; Vehicle hours of delay; Weekdays only; By milepost (MP); Shading represents intensity of delay; Highlighted sections represent peak periods

In 2016 on northbound I-405, the most delay occurred during the morning peak period north of the SR 167 interchange. There were pockets of delay from SR 520 to I-5 during the evening commute. On southbound I-405, the most delay extended from SR 520 past I-90, and lasted from 3-6:30 p.m. There was also delay during the morning commute from I-5 past Kirkland. For both directions on I-405, at certain locations delay lasted for most of the peak periods.

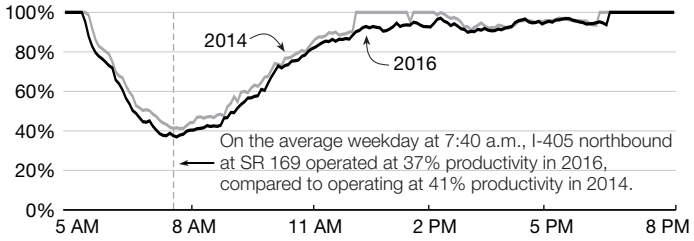


Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Bellevue to Tukwila commute severely congested in 2016

Throughput productivity on northbound I-405 at SR 169 near Renton

2014 and 2016; Based on the highest observed 5-minute flow rate; Northbound = 1,640 vehicles per hour per lane = 100%

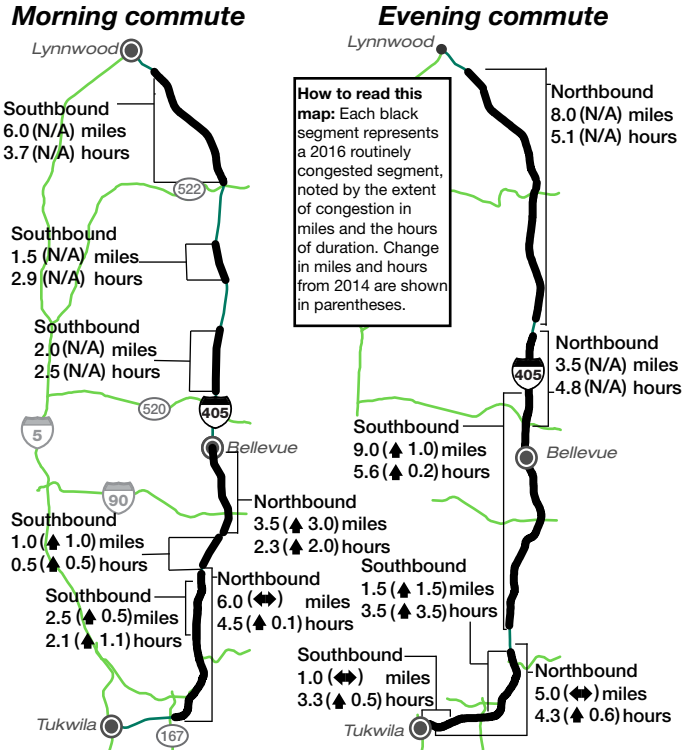


Data sources and analysis: WSDOT Multimodal Planning Division, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

on I-405 in the central Puget Sound region, WSDOT analyzed vehicle throughput at two locations: near SR 169 in Renton, and at NE 160th Street in Kirkland. In 2014 and 2016, productivity at these locations ranged from 37% to 90% at their most congested. The graph above shows how productivity on northbound I-405 at SR 169 in Renton varies by time of day.

Routinely congested segments of I-405

2016; For weekday morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Length of backup in miles; Daily duration of congestion in hours (compared to 2014).



Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.
Note: See pp. 7-8 in the Appendix for all central Puget Sound region routinely congested segment data. Introduction of ETL on I-405 changed the traffic characteristics along with the locations where the routine congestion usually formed. For this reason it is difficult to compare the 2016 RCS segment with that of 2014 RCS. In these cases the change in duration and length is shown as N/A.

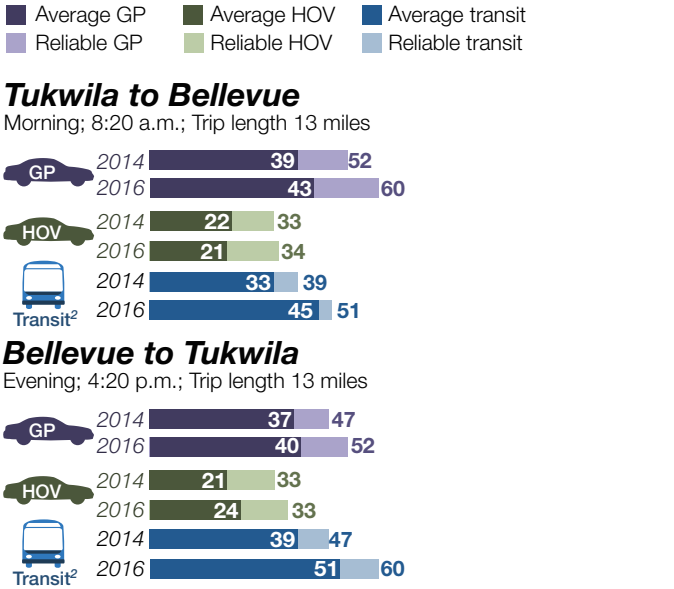
Routinely congested segments: Of the 58-mile I-405 corridor between Tukwila and Lynnwood, the segments leading to Bellevue (in both directions) experienced the most routine congestion. Overall, the locations where routine congestion occurred increased by 6 miles between 2014 (46 miles) and 2016 (52 miles), while the duration of routine congestion increased by 33% (see map below left).

What does severe congestion mean for travel times on the corridor?

General purpose lane trips: Capacity constraints impacted the entire I-405 corridor between Tukwila and Lynnwood—especially near the SR 169 and I-90 interchanges—resulting in slower average and reliable travel times during the morning and evening peak periods. The average travel time for I-405 commutes between Tukwila and Bellevue increased by up to four minutes (from 39 minutes to 43 minutes for the morning Tukwila to Bellevue commute) in 2016 compared to 2014.

Commute travel times

2014 and 2016 during the morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Weekday travel times in minutes at the 5-minute peak including average and reliable[1] travel times for general purpose lanes (GP), high occupancy vehicle (HOV) and transit[2] trips.



Data sources and analysis: Washington State Transportation Center, Sound Transit and WSDOT Office of Strategic Assessment and Performance Analysis.
Notes: In fall 2015, WSDOT deployed express toll lanes on I-405 between Bellevue and Lynnwood. Please see the special report on pp. 17-20. For detailed quarterly reports, see www.wsdot.wa.gov/tolling/405/library.htm. **1** Reliable travel time will get commuters to their destination on time 19 out of 20 weekdays (95% of the time). **2** Transit travel times by bus may not be directly comparable to GP/HOV trips due to different start and end points or off-highway travel to stops. WSDOT attempts to match transit trips as closely as is practical to GP/HOV. Some transit trips were adjusted for 2016 to more closely match the GP/HOV trips (see Appendix pp. 19-20). Transit travel times are calculated using a representative trip that occurs as close as possible to the 5-minute peak.

All but one I-405 park and ride lot at capacity

The largest increase in reliable travel time was also on the morning Tukwila to Bellevue commute, which saw an increase of eight minutes (15%). In contrast, the average travel time for the morning Lynnwood to Bellevue commute improved by four minutes, and reliable travel time improved by nine minutes.

For additional travel time information on the commutes between Lynnwood and Bellevue, where the new express toll lanes were implemented in mid-2015, see pp. 19-22 or WSDOT's quarterly tolling performance reports at www.wsdot.wa.gov/tolling/405/library.htm.

The morning Tukwila to Bellevue commute has the highest maximum throughput travel time index (MT3I) of the commutes tracked on I-405. The route's MT3I of 2.60 means that the commute takes more than two and a half times as long as it would if traffic was moving at maximum throughput speed (50 mph). WSDOT uses this index to compare the severity of congestion across commutes.

Transit trip travel times: On I-405, managed lanes such as the new express toll lanes (which opened in September 2015) and HOV lanes allow transit vehicles to bypass highway capacity constraints in the corridor's GP lanes. For the 2016 morning commute from Tukwila to Bellevue, the average and reliable transit travel times were 45 and 51 minutes, respectively. Both measures are 12 minutes slower they were in 2014. The reliable transit travel time was 9 minutes faster than the reliable GP travel time (60 minutes), and the average transit travel time was two minutes slower than the GP average (43 minutes). See p. 17 for a comparison of transit trips to GP and HOV trips.

Transit ridership and GHG emissions avoided: Transit moved approximately 5,375 riders during the peak periods on an average weekday in 2016, an 88% increase from 2014 (about 2,850 riders). Transit passenger miles traveled increased by about 46% in the same time period. Both of these changes are likely related to the increase in the number of trips (some of which travel less than the full length of their respective commutes) on this corridor, which went from 87 in 2014 to 161 in 2016.

Riding transit helps alleviate traffic congestion by making the most efficient use of available highway capacity. For example, peak period transit ridership on the I-405 corridor in the central Puget Sound region was equal to approximately half an extra lane of capacity in 2016 (when compared to the peak efficiency of the roadway, which is a conservative approach to this measurement).

Why did ridership on I-405 increase so much?
The I-405 corridor map on p.15 shows that ridership grew on two commutes while the percent of seats occupied decreased. This occurred because there were more bus trips on those commutes in 2016 than in 2014.

For example, the Lynnwood to Bellevue morning commute had 11 trips in 2014 and 44 in 2016, leading ridership to increase from 393 to 1,723. Similarly, the Bellevue to Lynnwood evening commute increased from 9 trips in 2014 to 39 trips in 2016.

Approximately 66% of available transit seats on I-405 commutes were occupied during the morning and evening peak periods in 2016. Of the 161 daily transit trips during the peak periods, 34 were at over 90% of seating capacity on a typical weekday. Transit use during peak periods avoided roughly 37,900 pounds of GHG emissions per day on the I-405 central Puget Sound corridor in 2016, a 40% improvement over 2014 (27,000 pounds).

Park and ride: Along the I-405 corridor in the central Puget Sound region in 2016, park and ride (P&R) utilization rates ranged from 73% to 115%, with 10 out of 12 having utilization rates at or above 95%. Any P&R lot that has 85% or more utilization is identified as operating at capacity. P&R locations are essential parts of the transit service network and need to consistently have enough available spaces for transit riders and carpoolers. To be considered effective, P&R lots must also have high utilization rates. Targeted outreach efforts from transit agencies as well as employer initiatives to encourage participation in Commute Trip Reduction programs help address highway capacity needs in the central Puget Sound region.

How much is congestion costing you?

Commuters making round trips between Tukwila and Bellevue on I-405 experienced costs due to congestion in 2016. For example, congestion on the 27-mile roundtrip between Tukwila and Bellevue cost an average driver over $2,800 (measured in wasted time and gas for travel below maximum throughput speed).

Before and After Analysis of I-405 Express Toll Lanes

Notable results

- *Vehicle volumes in I-405 express toll lanes (ETL) continue to grow*
- *Most tolled vehicles save 11-14 minutes during peak periods in the express toll lanes*

ETLs providing faster, more predictable trips

WSDOT launched the express toll lanes (ETLs) on Interstate 405 (I-405) between the cities of Bellevue and Lynnwood on Sept. 27, 2015. The express toll lanes are designed to provide faster, more predictable trips for transit, vanpools and carpools while providing a choice for solo drivers to pay a toll for a faster trip. As of June 30, 2017, drivers made nearly 25 million trips on the express toll lanes.

This before and after analysis looks at fiscal year (FY) 2017 data (July 2016 to June 2017), and compares it to the fiscal year before tolling began (July 2014 to June 2015).

ETLs give commuters on I-405 the option to pay to save time

During FY2017, the express toll lanes consistently provided travel time savings relative to the adjacent general purpose (GP) lanes, giving drivers the option of saving an average of 11 minutes southbound and 14 minutes northbound for full corridor trips during the peak periods (see table above right).

Compared to FY2015, morning commuters in the southbound I-405 ETL saved an additional minute on average travel time during FY2017, while reliable travel time improved by three minutes. Evening commuters in the northbound ETL saw an average travel time improvement of four minutes, along with a seven-minute improvement in reliable travel time compared to FY2015.

GP lane average travel time improved by three minutes for the southbound morning commute in FY2017 compared to FY2015, while reliable travel times improved by four minutes. Average and reliable travel time for the northbound evening GP commute went largely unchanged between FY2015 and FY2017.

Travel times for northbound commutes improved significantly during the last three months of FY2017 (from an average travel time of 33 minutes for the first nine months of FY2017 to 26 minutes during April - June 2017), likely due to the added capacity provided by a northbound peak-use shoulder lane.

I-405 average and reliable travel times decrease
FY2015 through FY2017; In minutes

			FY2015	FY2017
Southbound 5-9 a.m. (Trip length 16 miles)	GP	Average	35	32
		Reliable	64	60
	ETL	Average	21	20
		Reliable	37	34
Northbound 3-7 p.m. (Trip length 16 miles)	GP	Average	33	32
		Reliable	50	50
	ETL	Average	23	19
		Reliable	33	26

Data source: WSDOT Toll Division, WSDOT loop data accessed using TRACFLOW Software.

How tolling works on I-405

The express toll lanes operate as a tolled facility on weekdays between 5 a.m. and 7 p.m., except on major holidays. During all other days and times, the express toll lanes are open to all traffic, free of charge. Peak periods are between the hours of 5-9 a.m. and 3-7 p.m. , as this is when there is the greatest strain on the corridor's capacity. During peak periods, carpools with three or more occupants qualify for toll-free trips. During non-peak periods (9 a.m. to 3 p.m.), vehicles with two occupants can use the lanes for free.

I-405 sees an increase in vehicle miles traveled since ETL implementation

Along with improved travel times, corridor-wide vehicle travel has increased since ETL implementation. Vehicle miles traveled (VMT) in the express toll lanes saw a marked increase during peak periods; southbound ETL/HOV VMT increased by 85%, from 53,710 in FY2015 to 99,103 in FY2017, and northbound ETL/HOV VMT increased by 76%, from 63,375 in FY2015 to 111,555 in FY2017 (see charts on p. 20).

Express toll lanes continue to show improvement

I-405 vehicle miles traveled southbound and northbound see increases since FY2015

Volume percentage changes during tolling periods (5 a.m.7 p.m.) and peak periods (5 a.m.-9 a.m. and 3 p.m.-7 p.m.) from FY2015 to FY2017

	Southbound ETL/HOV	
	5 a.m. to 7 p.m.	5-9 a.m.
FY2015	173,451	53,710
FY2017	242,271	99,103
% Change	49%	85%
	Southbound GP	
FY2015	665,722	185,089
FY2017	779,445	221,219
% Change	17%	20%

	Northbound ETL/HOV	
	5 a.m. to 7 p.m.	3-7 p.m.
FY2015	123,052	63,375
FY2017	179,799	111,555
% Change	46%	76%
	Northbound GP	
FY2015	703,580	232,263
FY2017	713,431	225,066
% Change	1%	-3%

Data source: WSDOT Toll Division, WSDOT loop data accessed using CDR Software.

This growth in VMT can be partially attributed to the additional capacity in the dual-lane section (see p. 21). However, this analysis does not provide an adjustment for population and economic growth, which are both factors contributing to the increasing travel activity in and around the tolled portion of the I-405 corridor. Together with the improvement in travel times, the increase in VMT indicates that the ETLs have effectively accommodated latent demand and absorbed the additional peak-period traffic that resulted from the road expansion in the dual-lane section.

Southbound GP lanes had VMT increase by 20% during the evening peak period. Meanwhile, the northbound GP lanes saw VMT decrease by 3% in the afternoon peak period, but this was not accompanied by a significant improvement in travel times. Further analysis of FY2017 reveals that prior to the opening of the peak-use shoulder lane in April 2017, the lanes were operating close to capacity in certain areas, and unable to handle additional volume in the hours that followed, which led to the drop in VMT.

However, the peak-use shoulder lane resolved the choke point in the single-lane section around SR 527, and VMT increased from April to June 2017 by 1.7% when compared to FY2015 values.

ETL implementing solutions to drive performance up to standards

The legislation that authorized the construction and operation of the I-405 express toll lanes requires WSDOT to report a set of performance measures, identified by RCW 47.56.880. One of these performance targets restates the Federal Highway Administration's (FHWA) speed performance requirement for HOV facilities. WSDOT is required to report to the FHWA on whether the express toll lanes maintain speeds of 45 miles per hour at least 90 percent of the time during peak periods (5 a.m.-9 p.m. and 3 p.m.-7 p.m.).

Drivers in the express toll lanes traveled at 45 mph or faster 78% of the time during peak periods from July to December 2016, and 81% of the time from January to June 2017. This is an improvement over the traveling conditions experienced during the year before the ETLs were activated (July 2014 to June 2015).

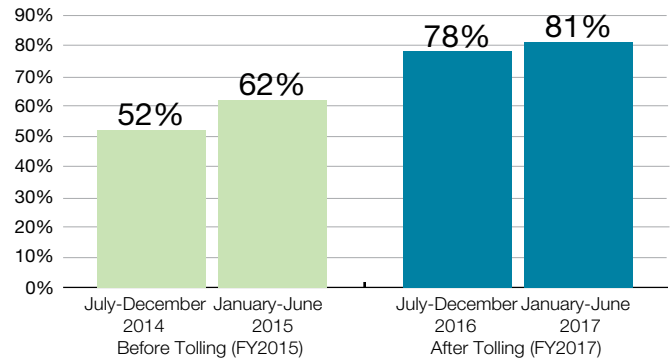
From July to December 2014, 52% of peak period drivers on I-405 traveled at 45 mph or faster and 62% did so from January to June 2015.

Dual-lane section on I-405 helps improve northbound speeds

WSDOT has observed a considerable difference in speed performance between the dual- and single-lane sections of I-405. The portion of the system with two express toll

ETL Performance

Percent of peak period when ETL speeds are greater than 45 mph



Data source: WSDOT Toll Division, WSDOT loop data accessed using CDR Software.
Note: This performance measure is compiled for six-month periods per the Federal Highway Administration's direction.

WSDOT express toll lanes help manage congestion

lanes in each direction between Bellevue and Bothell is referred to as the dual-lane section. The portion of the system with one express toll lane in each direction between Bothell and I-5 in Lynnwood is referred to as the single-lane section. Each section covers approximately half of the express toll lane corridor (see graphic at right).

Overall, the ETLs have improved travel times and predictability for trips on the corridor. However, southbound travel in the single-lane section remains congested due to heavy demand and the lack of capacity. Improvements funded by tolls, such as the northbound peak-use shoulder lane, have demonstrated the potential to further improve travel times.

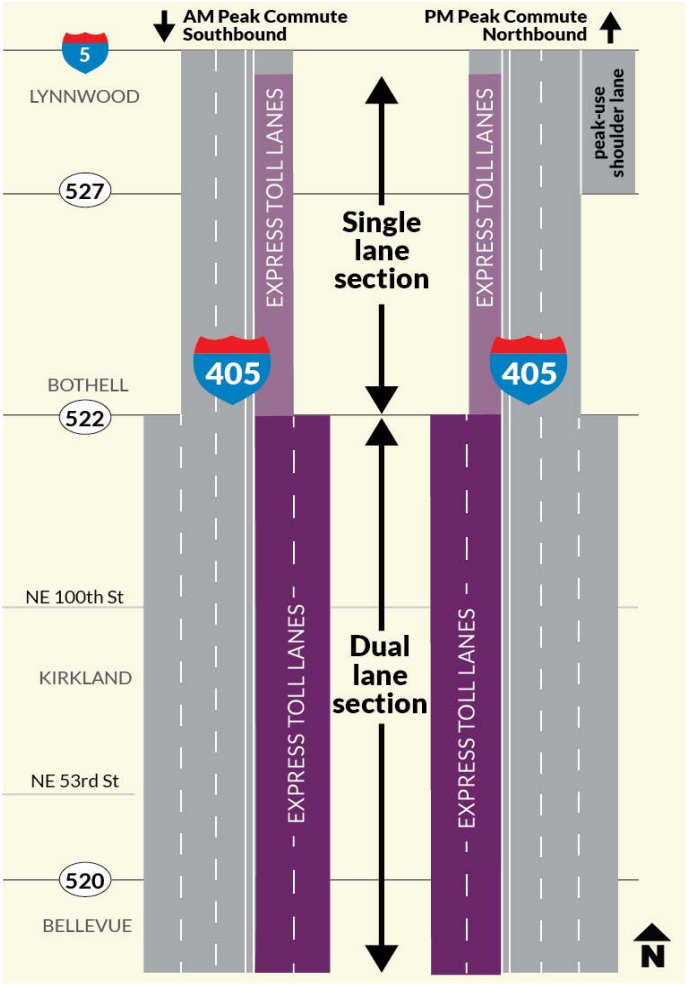
The table below provides a breakdown of performance during the second half of fiscal year (FY) 2017. During this period, the peak-use shoulder lane has improved northbound speeds between SR 522 and I-5. Before the the peak-use shoulder lane opened, speeds on this segment met the target 73% of the time, and afterward they met it 94% of the time. Since opening, the entire northbound direction of the I-405 ETL is on target to meet the legislatively mandated performance target. The southbound single-lane section remains the only segment not meeting the metric.

I-405 speed performance meeting targets
January 2017 through June 2017; percent of peak-period hours speeds were at least 45 mph

Northbound (3-7 p.m.)	Semester total	Before shoulder lane (Jan 1-Apr 21, 2017)	After shoulder lane (Apr 24-Jun 30, 2017)
Single lane	81%	73%	94%
Double lane	92%	91%	94%
Total	88%	84%	93%
Southbound (5-9 a.m.)			
Single lane		62%	
Double lane		94%	
Total		74%	
Overall total		**81%**	

Data source: WSDOT Toll Division, WSDOT loop data accessed using CDR Software.

In FY2017, drivers on average traveled at 49 mph in the express toll lanes during the southbound morning peak period (an average of 18 mph faster than general purpose lanes), and at 52 mph during the afternoon



northbound peak period (22 mph faster than the average speed in the general purpose lanes). In the dual lane section, speeds in the express toll lanes and general purpose lanes improved after tolling began. In FY2017, drivers in the dual express toll lanes traveled at an average of 57 mph southbound and 55 mph northbound during peak periods (see chart on p. 22).

I-405 lanes see overall speeds increase since fiscal year 2015
Fiscal year (FY) 2015 through FY2017; In miles per hour

Overall	FY2015	FY2017
Northbound		
ETL	41	52
General purpose	29	29
Southbound		
ETL	48	49
General purpose	27	30

Data source: WSDOT Toll Division, WSDOT loop data accessed using CDR Software.

Peak-use shoulder lane helps manage congestion

In the single-lane section, average speeds initially slowed in the northbound direction after tolling began due to high traffic volumes and increased demand for the lanes. The peak-use shoulder lane provided additional general purpose capacity, which has helped improve speeds during the April-June 2017 quarter. In the southbound single-lane section, however, speeds continue to decline as demand grows. This section does not have sufficient capacity in the express toll lane to meet the demand. Additional capacity in this section would allow higher traffic volumes to move through the corridor faster.

Toll-funded peak-use shoulder lane improves northbound performance

With funding from I-405 toll revenue, WSDOT built a new northbound peak-use shoulder lane (PUSL), providing additional capacity for general-purpose traffic and helping ease congestion. The new lane extends for 1.8 miles between SR 527 and I-5. The project also included four paved emergency pull out locations and one new noise wall.

The lane is generally open to traffic during the peak afternoon commute, typically from 2 to 7 p.m., but is also available to help manage the highway during incidents or other unexpected congestion. Dynamic overhead lane control signs indicate when the lane is open. The lane may be closed during the typical operating hours should there be a vehicle breakdown, emergency response or blocking event.

The PUSL handles approximately 13% of northbound peak period volumes in the SR 527 area. The added capacity has reduced congestion, increased throughput, and decreased travel times on northbound I-405 during the afternoon commute. The improved operation has also resulted in lower toll rates.

I-405 dual lanes and single lanes see different trends in speeds since fiscal year 2015
FY2015 through FY2017; Speed in miles per hour

Single lanes		
Northbound	**FY2015**	**FY2017**
ETL/HOV	53 mph	49 mph
General purpose	35 mph	29 mph
Southbound		
ETL/HOV	49 mph	42 mph
General purpose	23 mph	24 mph

Dual lanes		
Northbound	**FY2015**	**FY2017**
ETL/HOV	34 mph	55 mph
General purpose	24 mph	30 mph
Southbound		
ETL/HOV	48 mph	57 mph
General purpose	34 mph	42 mph

Data source: WSDOT Toll Division, WSDOT loop data accessed using CDR Software.

I-405 peak shoulder lane helps relieve chokepoint
FY2015 through FY2017 vehicle miles traveled and percentage changes between 3-7 p.m.

Northbound vehicle miles traveled 3-7 p.m.		
FY2015 total	232,263	**Change from FY2015-FY2017**
FY2017 total	225,066	**-3.1%**
Jul 2016-Apr 2017	220,127	-5.2%
Apr 2017-Jun 2017 with peak-use shoulder lane	236,282	1.7%

Data source: WSDOT Toll Division, WSDOT loop data accessed using CDR Software.

Operational improvements

In addition, WSDOT is constantly on the lookout for operational enhancements in the express toll lanes. Longer access points, algorithm changes, and additional signage and pavement markings are part of the solutions to provide a more efficient response to evolving traffic volumes and patterns.

Traffic is flowing smoothly on I-405 just south of NE 160th while the express toll lane rate sign displays current toll prices.

Visit bit.ly/agolCCR17CentralSoundmap for this article's interactive map.

State Route 520 Corridor Capacity Analysis

Annual GP person miles traveled
2014 vs. 2016
235.6 vs. 250.4
in millions of miles
▲ 6.3%

Annual GP vehicle delay[1]
2014 vs. 2016
164.4 vs. 221.9
in thousands of hours
▲ 35%

Annual GP GHG emissions
2014 vs. 2016
222.7 vs. 227.1
in millions of pounds of CO_2 equivalents
▲ 2%

Annual passenger miles traveled on transit
2014 vs. 2016
40.9 vs. 29.5
in millions of miles
▼ 28%

Capacity savings due to transit
2014 vs. 2016
1.5 vs. 1.4
in number of lanes
▼ 6.7%

Percent transit seats occupied
2014 vs. 2016
63% vs. 67%
on average during peak periods
▲ 4%

Percent park and ride spaces occupied
2014 vs. 2016
89% vs. 94%
on average during peak periods
▲ 5%

Commute travel times

2014 and 2016 during the morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Weekday travel times in minutes at the 5-minute peak including average and reliable[2] travel times for general purpose (GP), high occupancy vehicle (HOV) and transit[3] trips.

See Appendix pp. 5-29 for more commute routes

Average GP | Reliable GP | Average HOV | Reliable HOV | Average transit | Reliable transit

Bellevue to Seattle
Morning; *8:30 a.m.*;
Trip length 10 miles

	2014	2016
GP	17 / 25	23 / 33
HOV	16 / 23	18 / 24
Transit[3]	N/A	19 / 23

Seattle to Bellevue
Evening; 5:25 p.m.;
Trip length 10 miles

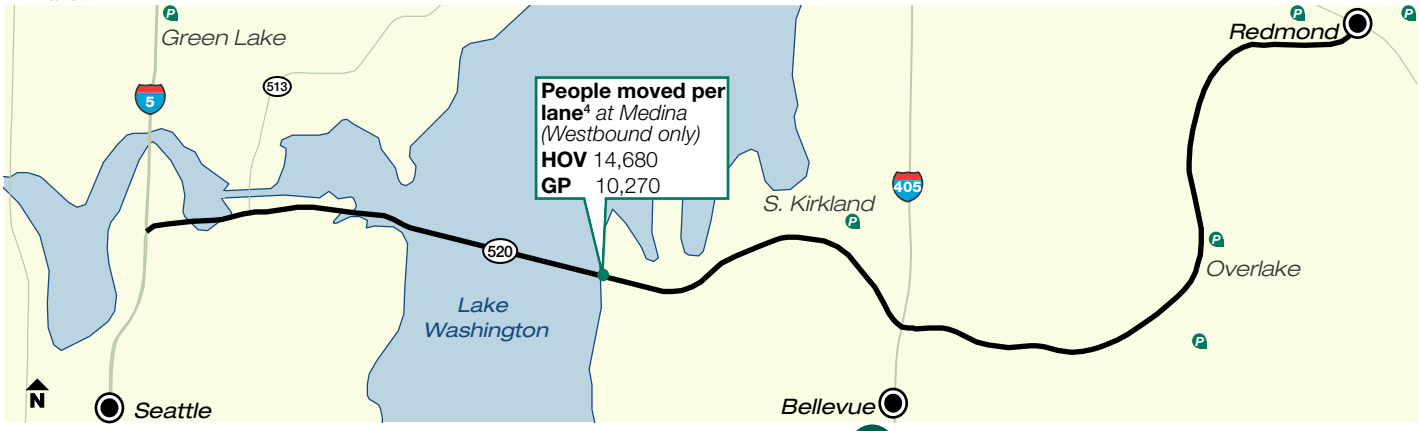
	2014	2016
GP	17 / 24	19 / 26
HOV	N/A	
Transit[3]	14 / 15	16 / 18

Redmond to Seattle
Morning; 8:30 a.m.;
Trip length 13 miles

	2014	2016
GP	20 / 26	26 / 39
HOV	19 / 25	21 / 27
Transit[3]	29 / 30	21 / 25

Seattle to Redmond
Evening; 5:30 p.m.;
Trip length 13 miles

	2014	2016
GP	18 / 24	19 / 27
HOV	18 / 22	18 / 24
Transit[3]	29 / 30	24 / 27



Transit system use

2014 and 2016; For typical weekday morning (6-9 a.m.) and evening (3-6 p.m.) transit[3] peak periods; Ridership and percent of available seats occupied on select commutes

By commute	Daily peak period riders		Percent of seats occupied	
Morning (6-9 a.m.)	2014	2016	2014	2016
Redmond to Seattle	4,613	4,415	76%	82%
Seattle to Redmond	1,939	1,654	58%	56%
Bellevue to Seattle	1,055	1,241	63%	63%
Evening (3-6 p.m.)				
Seattle to Redmond	4,203	3,901	70%	75%
Redmond to Seattle	1,968	1,798	60%	59%
Seattle to Bellevue	1,116	1,262	62%	61%

Park and ride capacity

2014 and 2016; Average percent occupied for select park and rides (see map for locations); Rates over 100% denote vehicles parked in unmarked space

Seattle-Bellevue commute

Park and ride (spaces)	2014 percent occupied	2016 percent occupied
Greenlake (411)	100%	103%
South Kirkland (833)	82%	97%

Redmond-Bellevue commute

Park and ride (spaces)	2014 percent occupied	2016 percent occupied
Overlake Transit Center (222)	102%	102%
Redmond (377)	99%	99%
Bear Creek (283)	106%	99%
Overlake (203)	39%	41%

Data sources and analysis: Washington State Transportation Center, WSDOT Multimodal Planning Division, WSDOT Northwest Region Traffic Office, Sound Transit, Pierce Transit, King County Metro, Community Transit and WSDOT Office of Strategic Assessment and Performance Analysis.

Notes: Measures at the top of the page are for GP trips only on the SR 520 corridor between Seattle and Redmond. **1** WSDOT defines delay as when average speeds are slower than 85% of the posted speed limit. **2** Reliable travel time will get commuters to their destination on time 19 out of 20 weekdays (95% of the time). **3** Transit travel times by bus may not be directly comparable to GP/HOV trips due to different start and end points or off-highway travel. WSDOT attempts to match transit trips as closely as is practical to GP/HOV. The endpoints of some transit trips were adjusted for 2016 to more closely match the GP/HOV trips; see Appendix pp. 19-20 for details. Transit travel times are calculated using a representative trip that occurs as close as possible to the 5-minute peak. **4** Person throughput values include morning (6-9 a.m.) and evening (3-7 p.m.) traffic.

HOV lane moves 43% more people on SR 520

State Route 520 (SR 520) is one of the key commute and economic corridors connecting I-5 and I-405 in the central Puget Sound region. Over 250 million person miles were traveled on the corridor in 2016, a 6.3% increase over 2014, while greenhouse gas emissions increased by 2%. Highway capacity constraints vary based on the presence of managed lanes and multimodal travel options; parts of the SR 520 corridor were served by high occupancy vehicle (HOV) lanes in 2014 and 2016, although HOV lanes did not span the entire corridor.

In 2016, HOV lanes in both directions between the floating bridge and I-405 were on the left side of the roadway in the direction of travel, while the HOV lanes east of I-405 were on the right side of the road, often interrupted by traffic merging onto SR 520.

Tolling on the SR 520 bridge was implemented to fund the new floating bridge, which opened with an HOV lane in each direction in spring 2016. The westbound HOV lane at Medina on this corridor moved nearly 43% more people in 2016 than each adjacent general purpose (GP) lane.

Despite this efficiency, traffic at specific locations on the corridor worsened from 2014 to 2016, with morning and evening weekday commutes experiencing moderate to severe congestion on a daily basis. Delay increased by 35% on SR 520 between Seattle and Redmond. In addition to delaying commuters, this congestion directly impacted the movement of goods in Washington, as trucks accounted for 4% of the total daily traffic volume on the corridor in 2016.

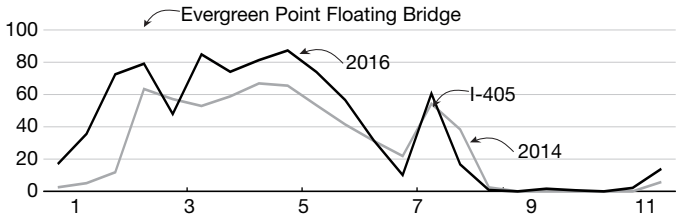
Increases in delay on SR 520 can be attributed to the booming regional economy. SR 520 has two major destination points: I-5 and I-405, both of which are typically congested during the peak commute periods. Thus, traffic is slow to enter I-5 or I-405, which in turn increases delay on SR 520.

WSDOT has completed construction on the new floating bridge and on SR 520 between Bellevue and Medina. This stretch of highway now includes two GP lanes and one 3+ HOV lane in each direction. This new lane configuration has improved the flow of traffic. However, WSDOT has yet to replace the section of SR 520 between the floating bridge and I-5, which only has two GP lanes.

When traveling on westbound SR 520, drivers are forced to merge out of the 3+ HOV lane as they reach the end of the new floating bridge, causing congestion that affects westbound traffic during the evening commute. Delays on westbound SR 520 are further exacerbated as congestion increases on I-5 and Montlake Boulevard, reducing the rate at which vehicles can exit SR 520.

Corridor delay: The SR 520 corridor between Seattle and Redmond experienced more vehicle delay in 2016 than 2014 in some locations and less in others (see graphs below). The amount of delay significantly increased between 2014 and 2016 in the westbound direction on the Evergreen Point Floating Bridge (up 72%; see graph below), while delay decreased in the eastbound direction near the Evergreen Point Floating Bridge (down 56%) and the I-405 interchange (down 32%). The heatmap graph at the bottom of p. 24 shows

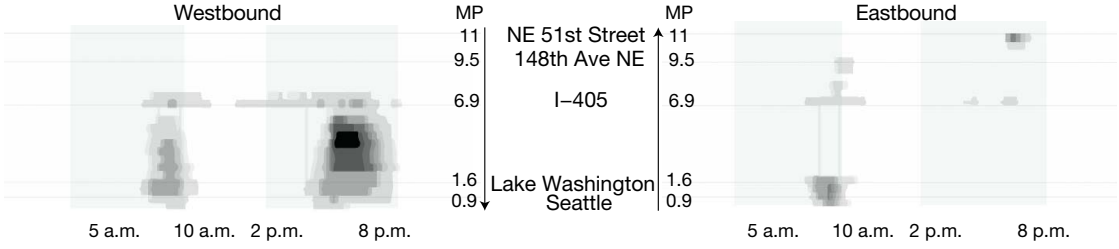
Delay along the SR 520 corridor by milepost
2014 and 2016; Eastbound and westbound combined; Average daily vehicle hours of delay



Data sources and analysis: WSDOT Multimodal Planning Division and WSDOT Office of Strategic Assessment and Performance Analysis.

SR 520 delay between Seattle and Redmond
2016; Vehicle hours of delay; Weekdays only; By milepost (MP); Shading represents intensity of delay; Highlighted sections represent peak periods

In 2016 on eastbound SR 520, morning delay lasted from 7-10 a.m. On westbound SR 520, delay extended from the I-405 interchange to Seattle during the evening commute, with the most intense delay occuring from 4-6:30 p.m.



Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

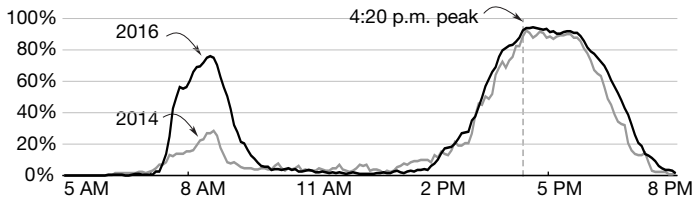
SR 520 westbound morning congestion increases

delay changes in intensity and duration. For a detailed comparison of 2014 and 2016 delay, see appendix p. 14.

A focus on hot spots: Commuters driving between Bellevue and Seattle drove in severely congested

Severe congestion on the SR 520 Bellevue to Seattle commute

2014 and 2016; Westbound; Percent of days the average speed was slower than 36 mph

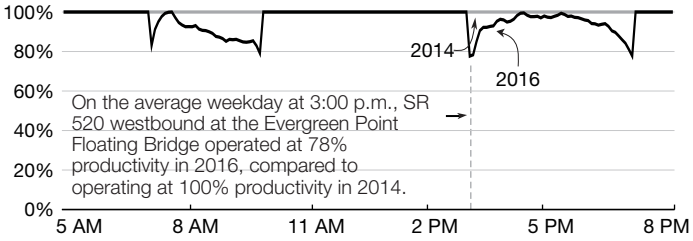


Data sources and analysis: WSDOT Northwest Region Traffic Office, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

conditions (36 mph or less) more often in 2016 than in 2014. Although severe westbound congestion started around the same time in both 2014 and 2016, it ended 45 minutes later during the morning peak period in 2016. Between 3 p.m. and 7 p.m., most weekday commuters experienced speeds below 36 mph (see graph above) in 2014 and 2016. For example, at 4:20 p.m. during the evening commute from Bellevue to Seattle, the percent of days speeds were below 36 mph worsened from 92% in 2014 to 94% in 2016.

Throughput productivity on westbound SR 520 at the Evergreen Point Floating Bridge

2014 and 2016; Based on the highest observed 5-minute flow rate; Westbound = 1,750 vehicles per hour per lane = 100%



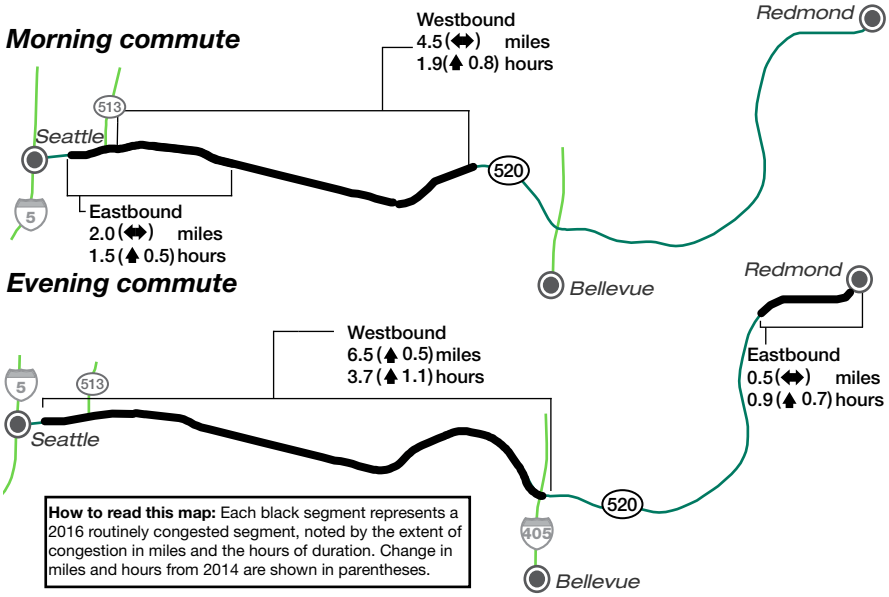
Data sources and analysis: WSDOT Multimodal Planning Division, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Highway productivity: As traffic increases and speeds drop below maximum throughput, congested roads carry fewer vehicles, resulting in a drop in throughput productivity. In order to gauge the lost productivity on SR 520 in the central Puget Sound region, WSDOT analyzed vehicle throughput at the Evergreen Point Floating Bridge across Lake Washington. In 2014, SR 520 operated at 100% productivity in this location but dropped as low as 78% during peak periods in 2016 (see graph above).

Routinely congested segments: Of the approximately 26-mile SR 520 corridor between Seattle and Redmond (both directions), the segments on SR 520 between the I-5 and I-405 interchanges contributed to the most routine congestion. Overall, the locations where routine congestion occurred increased by one mile between 2014 (13.5 miles) and 2016 (14.5 miles), while the duration of routine congestion increased by 29%.

Routinely congested segments of SR 520

2016; For weekday morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Length of backup in miles; Daily duration of congestion in hours (compared to 2014).



Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Notes: See pp. 7-8 in the Appendix for all central Puget Sound region routinely congested segment data.

What does severe congestion mean for travel times on the corridor?

General purpose lane trips: Capacity constraints impacted the SR 520 corridor between Seattle and Redmond most heavily between the I-5 interchange in Seattle and the I-405 interchange in Bellevue. This resulted in longer average and reliable travel times during the morning and evening peak periods. The average travel time for the morning

Five of six park and ride lots on SR 520 over capacity

SR 520 commute from Bellevue to Seattle increased by six minutes (up 35%) in 2016 from 2014 while reliable travel time increased by eight minutes (up 32%).

The Bellevue to Seattle evening commute has the highest maximum throughput travel time index (MT3I) of the 12 tracked commutes on SR 520 between Seattle, Bellevue and Redmond. The route's MT3I of 2.53 means the commute takes more than two and a half times as long as it would if traffic was moving at maximum throughput speed (50 mph). WSDOT uses this index to compare the severity of congestion across commutes.

Transit trip travel times: On SR 520, HOV lanes allow transit vehicles to bypass highway capacity constraints in the corridor's GP lanes. Until 2016, only the westbound corridor of SR 520 had an HOV lane—and for only part of its length. This reduced the benefits of transit riders at a key location on the corridor. A project completed in 2016 added HOV lanes in both directions, improving transit travel times. For example, in 2016 the average and reliable transit travel times for the SR 520 morning commute from Redmond to Seattle were 21 and 25 minutes, respectively. This is eight and five minutes faster than the average (29 minutes) and reliable (30 minutes) transit travel times in 2014. Average and reliable transit travel times were five and 14 minutes faster than GP average (26 minutes) and reliable (39 minutes) travel times for 2016. See p. 23 for a comparison of transit trips to GP and HOV trips.

Transit ridership and GHG emissions avoided: Transit moved roughly 16,456 riders during the morning and evening peak periods on an average weekday in 2016, a 5% decrease from 2014 (17,318 riders). Daily transit passenger miles traveled decreased by about 28% in 2016 (113,047 miles) compared to 2014 (156,706 miles). The larger decrease in passenger miles traveled may be partly attributable to a change in methodology designed to align the transit commute trips more closely with the GP commute distances. There were a total of 486 peak period transit trips during a typical weekday in 2016, down from 550 in 2014.

Riding transit helps alleviate traffic congestion by making the most efficient use of available highway capacity. For example, peak period transit ridership on the SR 520 corridor in the central Puget Sound region was equal to about 1.4 extra lanes of capacity in 2016 (when compared to the peak efficiency of the roadway, which is a conservative approach to this measurement). Approximately 67% of available transit seats on SR 520 commutes were occupied during the morning and evening peak periods in 2016. Of the 486 daily transit trips during the peak periods, 121 were over 90% of seating capacity on a typical weekday. Transit use during peak periods avoided approximately 52,689 pounds of GHG emissions per day on the SR 520 corridor in 2016, a 28% decrease compared to 2014 (73,104 pounds), which corresponds to the drop in passenger miles traveled.

Park and ride: Along the SR 520 corridor in the central Puget Sound region in 2016, park and ride (P&R) utilization rates ranged from 41% to 103%, with five out of six having utilization rates above 95%. Any P&R lot that has 85% or more utilization is identified as operating at capacity. P&R locations are essential parts of the transit service network and need to consistently have enough available spaces for transit riders and carpoolers. To be considered effective, P&R lots must also have high utilization rates. Targeted outreach efforts by transit agencies as well as employer initiatives to encourage participation in Commute Trip Reduction programs help address highway capacity needs in the central Puget Sound region.

How much is congestion costing you?

Drivers making trips between Seattle and Redmond paid tolls to speed up trips across the Evergreen Point Floating Bridge. For travel east of the bridge (between Bellevue and Redmond), the additional cost due to congestion (measured in wasted time and gas for travel below maximum throughput speed) was less than $250 per passenger vehicle annually in 2016.

Visit bit.ly/agolCCR17CentralSoundmap for this article's interactive map.

Interstate 90 Corridor Capacity Analysis

Annual GP person miles traveled
2014 498.7 vs. 2016 510.9 in millions of miles — ▲ 2.4%

Annual GP vehicle delay[1]
2014 268.8 vs. 2016 373.2 in thousands of hours — ▲ 39%

Annual GP GHG emissions
2014 609.8 vs. 2016 573.3 in millions of pounds of CO_2 equivalents — ▼ 6%

Annual passenger miles traveled on transit
2014 36.3 vs. 2016 32.5 in millions of miles — ▼ 11%

Capacity savings due to transit
2014 1.2 vs. 2016 1.2 in number of lanes — 0%

Percent transit seats occupied
2014 80% vs. 2016 74% on average during peak periods — ▼ 6%

Percent park and ride spaces occupied
2014 96% vs. 2016 100% on average during peak periods — ▲ 4%

Commute travel times

See Appendix pp. 5-29 for more commute routes

2014 and 2016 during the morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Weekday travel times in minutes at the 5-minute peak including average and reliable[2] travel times for general purpose (GP), high occupancy vehicle (HOV) and transit[3] trips.

Average GP | Reliable GP | Average HOV | Reliable HOV | Average transit | Reliable transit

Bellevue to Seattle
Morning; 8:30 a.m.; Trip length 10 miles

	2014	2016
GP	19 / 26	22 / 35
HOV	14 / 18	16 / 25
Transit[3]	27 / 28[4]	13 / 15[4]

Seattle to Bellevue
Evening; 4:50 p.m.; Trip length 11 miles

	2014	2016
GP	17 / 29	16 / 22
HOV	12 / 18	11 / 14
Transit[3]	26 / 26[4]	11 / 12[4]

Issaquah to Seattle
Morning; 8:20 a.m.; Trip length 15 miles

	2014	2016
GP	29 / 42	31 / 51
HOV	19 / 23	21 / 30
Transit[3]	28 / 31	22 / 25

Seattle to Issaquah
Evening; 5:25 p.m.; Trip length 16 miles

	2014	2016
GP	22 / 33	23 / 33
HOV	16 / 22	16 / 21
Transit[3]	22 / 24	22 / 25

Transit system use

2014 and 2016; For typical weekday morning (6-9 a.m.) and evening (3-6 p.m.) transit[3] peak periods; Ridership and percent of available seats occupied on select commutes

By commute

	Daily peak period riders		Percent of seats occupied	
Morning (6-9 a.m.)	**2014**	**2016**	**2014**	**2016**
Issaquah to Seattle	3,421	3,326	87%	73%
Bellevue to Seattle	2,286	2,237	81%	93%
Issaquah to Bellevue	337	229	73%	56%
Evening (3-6 p.m.)				
Seattle to Issaquah	3,121	2,895	83%	72%
Seattle to Bellevue	2,343	2,112	78%	91%
Bellevue to Seattle	914	832	83%	90%

Park and ride capacity

2014 and 2016; Average percent occupied for select park and rides (see map for locations); Rates over 100% denote vehicles parked in unmarked space

Seattle-Bellevue commute

Park and ride (spaces)	2014 percent occupied	2016 percent occupied
South Bellevue (519)	107%	108%
Mercer Island (447)	100%	100%

Issaquah-Bellevue commute

Park and ride (spaces)	2014 percent occupied	2016 percent occupied
Eastgate (1,614)	99%	100%
Issaquah Transit Center (819)	93%	99%
Issaquah Highlands (1,010)	87%	96%

Data sources and analysis: Washington State Transportation Center, WSDOT Multimodal Planning Division, WSDOT Northwest Region Traffic Office, Sound Transit, King County Metro, Community Transit and WSDOT Office of Strategic Assessment and Performance Analysis.

Notes: Measures at the top of the page are for the I-90 corridor between Seattle and Issaquah for GP trips only. **1** WSDOT defines delay as when average speeds are slower than 85% of the posted speed limit. **2** Reliable travel time will get commuters to their destination on time 19 out of 20 weekdays (95% of the time). **3** Transit travel times by bus may not be directly comparable to GP/HOV trips due to different start and end points or off-highway travel. WSDOT attempts to match transit trips as closely as is practical to GP/HOV. Some transit trips were adjusted for 2016 to more closely match the GP/HOV trips (see Appendix pp. 19-20). Transit travel times are calculated using a representative trip that occurs as close as possible to the 5-minute peak. **4** Distance for these trips changed between 2014 and 2016 (see p. 30) **5** Person throughput values include morning (6-9 a.m.) and evening (3-7 p.m.) traffic.

I-90 experiences 4% of the Puget Sound region's delay

Interstate 90 (I-90) is one of the key commute and economic corridors connecting I-5 and I-405 in the central Puget Sound region and runs parallel to SR 520 across Lake Washington. The I-90 floating bridge is the non-tolled alternative to SR 520 across Lake Washington. Around 500 million person miles were traveled on the corridor each year in 2016 and 2014. Highway capacity constraints vary based on the presence of managed lanes and multimodal travel options; parts of the I-90 corridor are served by high occupancy vehicle (HOV) lanes and transit. The HOV lanes on the floating bridge west of Mercer Island and in Issaquah move 9% and 48% more people than each adjacent general purpose (GP) lane, respectively.

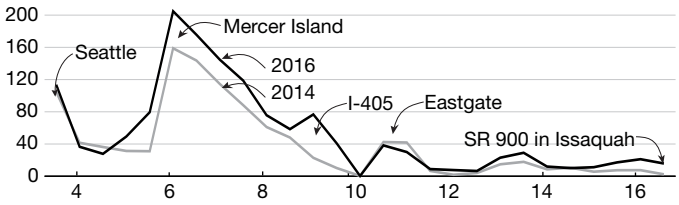
Much like on SR 520, traffic on this corridor is heavily influenced by congestion on the major north/south routes: I-5 and I-405. These routes are primary destinations for a large number of drivers. If I-5 and I-405 are congested, traffic will back up onto I-90, resulting in delays.

Despite the efficiencies created by HOV lanes, traffic at specific locations on the corridor worsened from 2014 to 2016, with morning and evening weekday commutes experiencing moderate to severe congestion on a daily basis. Delay increased by 39% on I-90 between Seattle and Issaquah, likely because of the region's economic growth. Westbound corridor segments on Mercer Island and eastbound segments near I-405 also saw delay increases in 2016 compared to 2014. In addition to delaying commuters, this congestion directly impacted the movement of goods in Washington, as trucks accounted for 5% of the total daily traffic volume on the corridor in 2016. The corridor-wide greenhouse gas (GHG) emissions decreased by 6% in 2016 compared to 2014.

Corridor delay: The I-90 corridor in the central Puget Sound region between Seattle and Issaquah experienced

Delay along the I-90 corridor

2014 and 2016; Eastbound and westbound combined; Average daily vehicle hours of delay by milepost



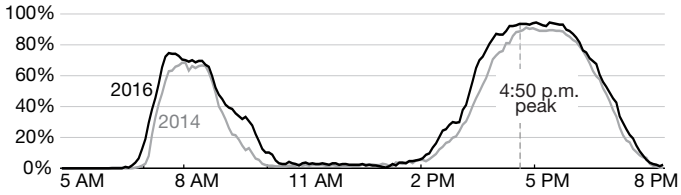
Data sources and analysis: WSDOT Multimodal Planning Division and WSDOT Office of Strategic Assessment and Performance Analysis.

vehicle delay in 2016 than in most locations (see graph above). The amount of delay significantly increased between 2014 and 2016 in some locations on the westbound I-90 corridor, including at Mercer Island (up 25%) and on the floating bridge (up 59%). However, delay at Eastgate was 19% lower in 2016 than in 2014. The amount of delay on eastbound I-90 approaching I-405 increased significantly between 2014 and 2016. The heatmap graph at the bottom of the page shows that eastbound delay was less intense than in the westbound direction.

A focus on hot spots: Commuters driving between Bellevue and Seattle via I-90 drove in severely congested conditions (36 mph or less) more often in 2016 than in 2014. From Bellevue to Seattle, between 3-6 p.m., most weekday commuters experienced speeds below 36 mph

Severe congestion on the I-90 Bellevue to Seattle commute

2014 and 2016; Westbound; Percent of days the average speed was slower than 36 mph

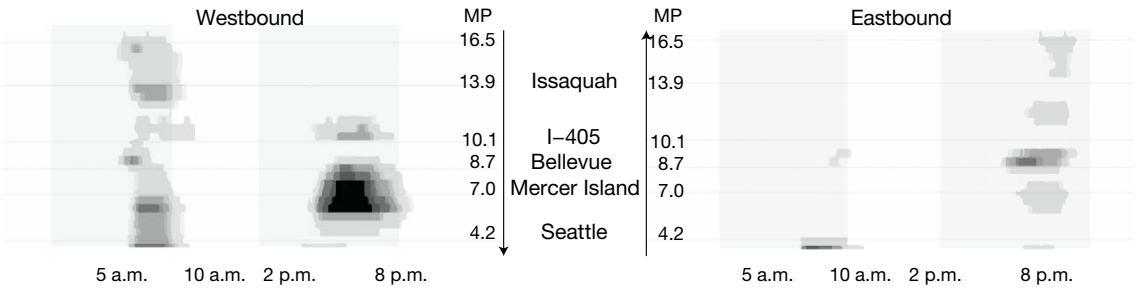


Data sources and analysis: WSDOT Northwest Region Traffic Office, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

I-90 delay between Seattle and Issaquah

2016; Vehicle hours of delay; Weekdays only; By milepost (MP); Shading represents intensity of delay; Highlighted sections represent peak periods

In 2016 on eastbound I-90, there were pockets of delay during both peak periods from Seattle to Issaquah. On westbound I-90, morning delay extended along the entire corridor. Delay during the evening commute extended from the I-405 interchange to Seattle, with the most intense delay occurring from 3-6 p.m.



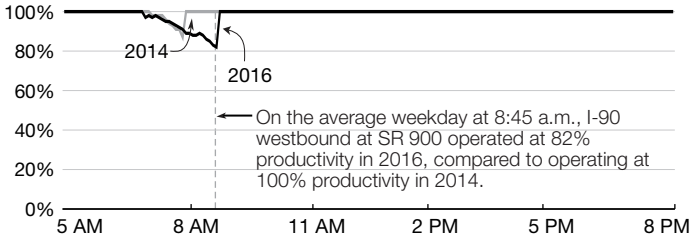
Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Routine congestion on I-90 on the rise

(see congestion graph on p. 28). For example, at around 4:50 p.m. during the evening commute from Bellevue to Seattle, the percent of days speeds were below 36 mph worsened from 90% in 2014 to 95% in 2016.

Highway productivity: As traffic increases and speeds drop below maximum throughput, congested roads carry fewer vehicles, resulting in a drop in throughput productivity. In order to gauge the lost productivity on I-90 in the central Puget Sound region, WSDOT analyzed vehicle throughput at SR 900 near Issaquah. In 2014 and 2016, productivity at this location ranged from 82% to 100% throughout the day (see throughput graph below).

Throughput productivity on westbound I-90 at SR 900
2014 and 2016; Based on the highest observed 5-minute flow rate; Westbound = 1,590 vehicles per hour per lane = 100%



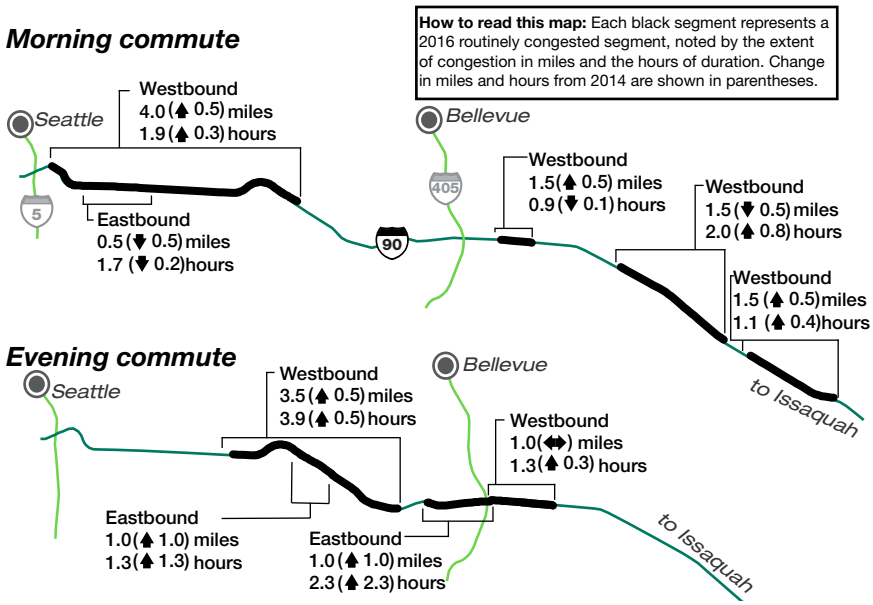
Data sources and analysis: WSDOT Multimodal Planning Division, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Routinely congested segments: Of the approximately 30-mile I-90 corridor between Seattle and Issaquah (both directions), the segments on the I-90 floating bridge, Mercer Island and in the Eastgate area had the most routine congestion in 2016. Overall, the locations where routine congestion occurred increased from 13 miles in 2014 to 16.5 miles in 2016, while the amount of time of routine congestion increased by 42%.

What does severe congestion mean for travel times on the corridor?

General purpose lane trips: Capacity constraints impacted the I-90 corridor between Seattle and Issaquah heavily in the westbound direction near Mercer Island and the Eastgate area. This resulted in increased average and reliable travel times during the morning and evening peak periods. The average GP lane travel time for the morning I-90 commute from Bellevue to Seattle increased by three minutes (16%) between 2014 and 2016, while reliable travel time increased by nine minutes (35%). On the other hand, the average travel time for the evening commute from Seattle to Bellevue improved by one minute (6%) from 2014 to 2016, while reliable travel time improved by seven minutes (24%).

Routinely congested segments of I-90
2016; For weekday morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Length of backup in miles; Daily duration of congestion in hours (compared to 2014).



Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.
Note: See pp. 7-8 in the Appendix for all central Puget Sound region routinely congested segment data.

The Bellevue to Seattle evening commute has the highest maximum throughput travel time index (MT3I) of the 12 commutes tracked on I-90 between Seattle, Bellevue and Issaquah. The route's MT3I of 2.43 means that the commute takes more than twice as long as it would if traffic was moving at maximum throughput speed (50 mph). WSDOT uses this index to compare the severity of congestion across commutes. In contrast, the Issaquah to Seattle morning commute and the reverse evening commute take 67% and 24% longer than they should under maximum throughput conditions.

Transit trip travel times: On I-90, transit and managed lanes—such as the reversible express lane or HOV lanes—allow people to bypass highway capacity constraints in the corridor's GP lanes. However, the I-90 corridor does not have HOV lanes for its full length, including part of the floating bridge, which minimizes the benefits of taking transit

All five park and ride lots along I-90 at capacity

at a key location on the corridor. For example, in 2016 the average and reliable transit travel times for the I-90 commute from Issaquah to Seattle in the morning were 22 and 25 minutes, respectively. This is six minutes faster than the average (28 minutes) and reliable (31 minutes) transit travel times in 2014. Some of this improvement may be due to a change in methodology designed to align transit commute trips more closely with the GP commute distances. In 2016, average and reliable transit travel times proved to be faster than corresponding GP travel times by nine and 26 minutes, respectively. See p. 25 for a comparison of transit trips to GP and HOV trips.

Why did I-90 transit travel times drop in 2016?

The I-90 corridor map on p. 27 shows decreases in transit travel times between Seatte and Bellevue on both the morning and evening commutes, and between Seattle and Issaquah in the morning. These drops are likely at least partly due to changes in methodology.

For 2014, the transit trips used to calculate travel times on I-90 extended well past the endpoints of the GP commutes and off the highway. For 2016, these endpoints were adjusted to match the GP commute more closely, resulting in shorter transit commute distances and faster transit travel times (see Appendix pp. 19-20).

Transit ridership and GHG emissions avoided: Transit moved roughly 13,642 riders on the I-90 corridor during the morning and evening peak periods on an average weekday in 2016, a 6% decrease from 2014 (about 14,500 riders). Daily transit passenger miles traveled decreased by approximately 11% from 2014 (139,200 miles) to 2016 (124,500 miles). The larger decrease in passenger miles traveled may be partly attributable to a change in methodology designed to align the transit commute trips more closely with the GP commute distances.

Riding transit helps alleviate traffic congestion by making the most efficient use of available highway capacity. For example, peak period transit ridership on the I-90 corridor in the central Puget Sound region was equal to more than one extra lane's worth of capacity in 2016 (when compared to the peak efficiency of the roadway, which is a conservative approach to this measurement).

Approximately 74% of available seats on transit on I-90 commutes were occupied during the morning and evening peak periods in 2016, a decrease of approximately 6% from 2014. Of the 343 daily transit trips during the peak periods, 112 were over 90% of seating capacity on a typical weekday.

Transit use during peak periods avoided roughly 58,900 pounds of GHG emissions per day on the I-90 central Puget Sound corridor in 2016, a 14% decline compared to 2014 (73,104 pounds). This drop is driven primarily by the decline in transit passenger miles traveled.

Park and ride: Along the I-90 corridor in the central Puget Sound region in 2016, park and ride (P&R) utilization rates ranged between 96% and 108%. Any P&R lot that has 85% or more utilization is identified as operating at capacity, meaning that all five P&R lots are operating close to (or above) 100% of their current capacity. P&R locations are essential parts of the transit service network and need to consistently have enough available spaces for transit riders and carpoolers. To be considered effective, P&R lots must also have high utilization rates. Targeted outreach efforts from transit agencies as well as employer initiatives to encourage participation in Commute Trip Reduction programs help address highway capacity needs in the central Puget Sound region.

How much is congestion costing you?

Commuters making round trips on I-90 between Seattle and Bellevue, and Seattle and Issaquah experienced costs due to congestion. Each passenger vehicle that made round trips between Seattle and Bellevue using I-90, the non-tolled, cross-lake alternative to SR 520, paid more than $1,500 annually in 2016 due to congestion (measured in wasted time and gas for travel below maximum throughput speed).

Bike/walk trips on I-90 trail surpass 242,000 in 2016

Bike/walk trips on the I-90 trail avoided over 242,000 vehicle miles traveled in 2016, the first full year for which data from a permanent counter was available.

A counter will also be installed on the SR 520 bike/walk path to measure its contributions to overall corridor capacity. Data collection and analysis are underway to enhance the understanding of active transportation capacity and demand.

Visit bit.ly/agolCCR17CentralSoundmap for this article's interactive map.

State Route 167 Corridor Capacity Analysis

Annual GP person miles traveled
2014 vs. 2016: 303.2 vs. 314.5 in millions of miles — ▲ 3.7%

Annual GP vehicle delay[1]
2014 vs. 2016: 221.9 vs. 308.0 in thousands of hours — ▲ 39%

Annual GP GHG emissions
2014 vs. 2016: 261.3 vs. 261.3 in millions of pounds of CO_2 equivalents — ▬ 0%

Annual passenger miles traveled on transit
2014 vs. 2016: 13.3 vs. 8.5 in millions of miles — ▼ 36%

Capacity savings due to transit
2014 vs. 2016: 0.4 vs. 0.5 in number of lanes — ▲ 25%

Percent transit seats occupied
2014 vs. 2016: 53% vs. 58% on average during peak periods — ▲ 5%

Percent park and ride spaces occupied
2014 vs. 2016: 81% vs. 82% on average during peak periods — ▲ 1%

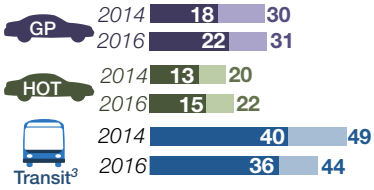
Commute travel times

2014 and 2016 during the morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Weekday travel times in minutes at the 5-minute peak including average and reliable[2] travel times for general purpose (GP), high occupancy vehicle (HOT) and transit[3] trips.

Average GP | Average HOT | Average transit
Reliable GP | Reliable HOT | Reliable transit

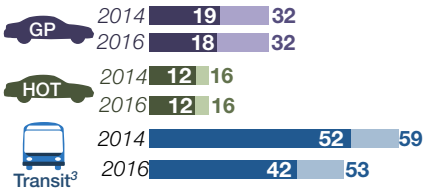
Auburn to Renton

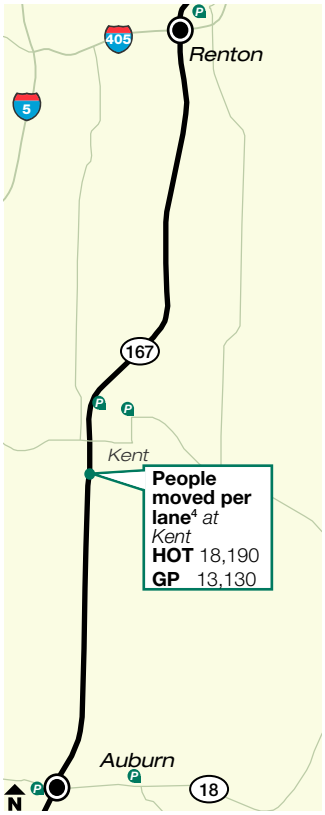
Morning; 6:45 a.m.; Trip length 10 miles



Renton to Auburn

Evening; 3:50 p.m.; Trip length 10 miles





Transit system use

2014 and 2016; For typical weekday morning (6-9 a.m.) and evening (3-6 p.m.) transit[3] peak periods; Ridership and percent of available seats occupied on select commutes

By commute

	Daily peak period riders		Percent of seats occupied	
Morning (6-9 a.m.)	**2014**	**2016**	**2014**	**2016**
Auburn to Renton	2,385	3,194	53%	60%
Evening (3-6 p.m.)				
Renton to Auburn	2,851	2,571	53%	56%

Park and ride capacity

2014 and 2016; Average percent occupied for select park and rides (see map for locations)

Auburn-Renton commute

Park and ride (spaces)	2014 percent occupied	2016 percent occupied
Auburn Station (633)	100%	100%
South Renton (373)	100%	100%
Kent area (996)	98%	101%
Renton (150)	98%	95%
Peasley Canyon (54)	84%	87%
Renton Municipal[5] (150)	87%	90%
Auburn (244)	65%	63%
Kent/James Street (713)	29%	34%

Data sources and analysis: Washington State Transportation Center, WSDOT Multimodal Planning Division, WSDOT Northwest Region Traffic Office, Sound Transit, Pierce Transit, King County Metro, Community Transit and WSDOT Office of Strategic Assessment and Performance Analysis.

Notes: Measures at the top of the page are for GP trips only on the SR 167 corridor between Auburn and Renton. **1** WSDOT defines delay as when average speeds are slower than 85% of the posted speed limit. **2** Reliable travel time will get commuters to their destination on time 19 out of 20 weekdays (95% of the time). **3** Transit travel times by bus may not be directly comparable to GP/HOV trips due to different start and end points or off-highway travel. WSDOT attempts to match transit trips as closely as is practical to GP/HOV. The endpoints of some transit trips were adjusted for 2016 to more closely match the GP/HOV trips (see Appendix pp. 19-20). Transit travel times are calculated using a representative trip that occurs as close as possible to the 5-minute peak. **4** Person throughput values include morning (6-9 a.m.) and evening (3-7 p.m.) traffic. **5** The Renton Municipal park and was reduced from 200 spaces to 150 on January 1, 2015.

State Route 167 (SR 167) is one of the key commute and economic corridors in the central Puget Sound region and a virtual extension of Interstate 405 (I-405) south of the Tukwila/Renton area. Nearly 315 million person miles were traveled between Renton and Auburn in 2016, a 3.7% increase over 2014. Highway capacity constraints vary based on the presence of managed lanes and multimodal travel options; the SR 167 corridor is served by Sounder commuter rail, transit buses, and high occupancy toll (HOT) lanes. The HOT lane (a high occupancy vehicle lane open to solo drivers who choose to pay a toll) at Kent on this corridor moves over 39% more people than each adjacent general purpose (GP) lane. Carpools of two or more, vanpools and buses use the HOT lanes toll-free. Toll rates adjust to ensure traffic in the HOT lane is free flowing even when the regular lanes are congested.

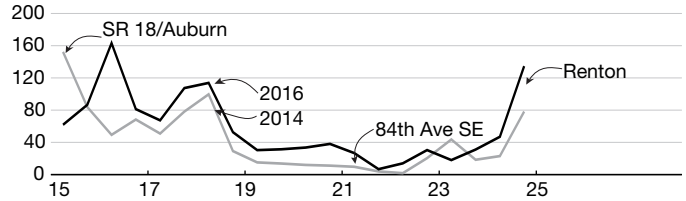
Despite these efficiencies, traffic at specific locations on the corridor worsened from 2014 to 2016, with morning and

SR 167 experiences nearly 4% of the region's delay

evening weekday commutes experiencing severe congestion on a daily basis. Delay increased 39% on SR 167 between Auburn and Renton in 2016 compared to 2014. In addition to delaying commuters, this congestion directly impacted the movement of goods in Washington as trucks accounted for 11% of the total daily traffic volume on the corridor in 2016. Greenhouse gas (GHG) emissions remained steady at 261 million pounds during 2016 and 2014.

Delay along the SR 167 corridor

2014 and 2016; Northbound and southbound combined; Average daily vehicle hours of delay by milepost



Data sources and analysis: WSDOT Multimodal Planning Division and WSDOT Office of Strategic Assessment and Performance Analysis.

Corridor delay: In 2016, the SR 167 corridor in the central Puget Sound region between Auburn and Renton experienced vehicle delay in both directions of travel in Auburn near SR 18 and northbound in Renton. Vehicle delay on the SR 167 corridor was higher in 2016 than in 2014 in general (see graphs above and below). This area of the central Puget Sound region has also seen delay increase as the region's economy has grown. People are moving to this area to find affordable housing, which results in more commuters using the highway. Traffic delays on SR 167 are influenced by delays on I-405 as well. The amount of delay increased between 2014 and 2016 at specific locations on the SR 167 corridor including: northbound in Renton near the I-405 interchange (up 35%), and in both directions near the SR 18 interchange in Auburn (up 18%). The heatmap graph at the bottom of the page shows the intensity of delay in 2016 by the time of day and location.

A focus on hot spots: Commuters driving on SR 167 drove in severely congested conditions (36 mph or less) more often in 2016 than in 2014. For example, at around 6:40 a.m. during the morning commute from Auburn to Renton, speeds were below 36 mph 80% of weekdays in 2016—a large increase from 44% in 2014. The chart below also shows that severe congestion peaked 20 minutes earlier in 2016 than in 2014.

Severe congestion on the SR 167 Auburn to Renton commute

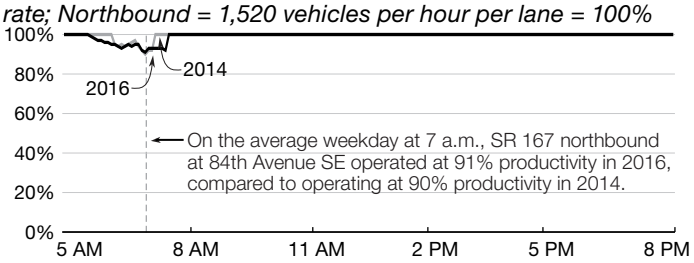
2014 and 2016; Northbound; Percent of days the average speed was slower than 36 mph

Data sources and analysis: WSDOT Northwest Region Traffic Office, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Highway productivity: As traffic increases and speeds drop below maximum throughput, congested roads carry fewer vehicles, resulting in a drop in throughput productivity. In order to gauge the lost productivity on SR 167 in the central Puget Sound region, WSDOT analyzed vehicle throughput at 84th Avenue SE in Kent. In 2014 and in

Throughput productivity on northbound SR 167 at 84th Avenue SE

2014 and 2016; Based on the highest observed 5-minute flow rate; Northbound = 1,520 vehicles per hour per lane = 100%

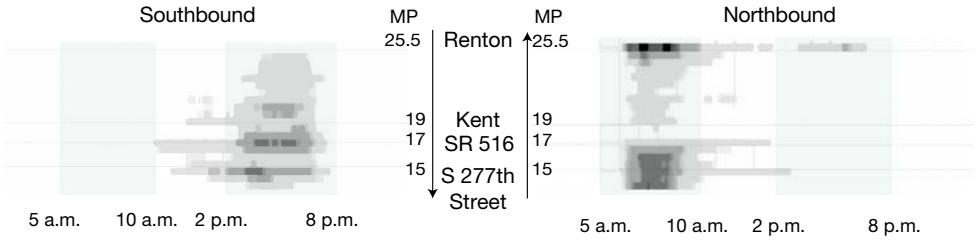


Data sources and analysis: WSDOT Multimodal Planning Division, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

SR 167 delay between Auburn and Renton

2016; Vehicle hours of delay; Weekdays only; By milepost (MP); Shading represents intensity of delay; Highlighted sections represent peak periods

In 2016 on northbound SR 167, delay lasted for the entire morning commute, with the most intense delay occurring between South 277th Streeth and SR 516. On southbound SR 167, delay extended along the entire corridor, with the most intense delay occuring from 2-4:30 p.m.



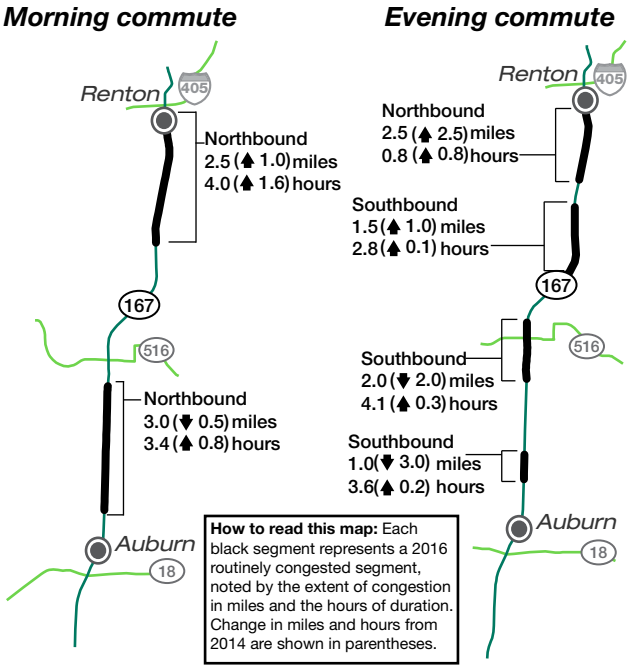
Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

SR 167 congestion increases in duration and extent

2016, productivity at this location at its most congested ranged between 91% and 85% in the northbound and southbound directions (see throughput graph on p. 32). This high yield in throughput on SR 167 indicates that HOT lanes as an operational strategy relieve congestion and make traffic flow better for all users on the corridor.

Routinely congested segments: Of the 20-mile SR 167 corridor between Auburn and Renton (both directions), the most congested segments in 2016 were between SR 516 and SR 18 in both directions, and northbound near the SR 167/I-405 interchange. Overall, the locations where routine congestion occurred increased by 3.5 miles between 2014 and 2016, and the duration of routine congestion increased by 42% (see map below).

Routinely congested segments of SR 167
2016; For weekday morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Length of backup in miles; Daily duration of congestion in hours (compared to 2014).



Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.
Note: See pp. 7-8 in the Appendix for all central Puget Sound region routinely congested segment data.

What does severe congestion mean for travel times on the corridor?

General purpose lane trips: Capacity constraints impacted the SR 167 corridor between Auburn and Renton near the SR 18 interchange in Auburn and on the northbound segment leading up to the SR 167/I-405 interchange in 2016. This resulted in longer average and reliable travel times during the morning and evening peak periods. Between 2014 and 2016, the average travel time for the Auburn to Renton morning commute worsened by four minutes (22%), while the return commute in the evening saw a one minute improvement (17%). The reliable travel time for the Auburn to Renton morning commute was one minute longer in 2016 than in 2014, while the Renton to Auburn evening reliable commute time remained at 32 minutes.

The Auburn to Renton morning commute has the highest maximum throughput travel time index (MT3I) of the four commutes tracked on SR 167. The route's MT3I of 1.77 means the commute takes more than one and a half times as long as it would if traffic was moving at maximum throughput speed (50 mph). The Renton to Auburn evening commute has an MT3I of 1.54. WSDOT uses this index to compare the severity of congestion across commutes.

Why are some transit travel times slower than HOT?

On the SR 167 corridor map on p. 31, the two commutes have average transit travel times which are 21 and 30 minutes slower than HOT lane travel times. This is caused by buses needing to use the GP lanes to exit the highway to reach stops along their routes as there are no HOT direct access ramps on the corridor. Off-highway travel to stops also increases transit travel times.

For example, on the Renton to Auburn evening commute, the Sound Transit 566 exits the highway at Kent and makes three stops before re-entering the highway.

Six of eight park and ride lots over capacity

Transit trip travel times: On SR 167, Sounder commuter rail, bus transit and HOT lanes allow people to bypass highway capacity constraints in the corridor's GP lanes. HOT lanes reduce travel times for carpoolers, transit riders, and solo drivers who pay a toll to use the lanes. However, it is difficult for transit travel times to get close to GP travel times on this corridor due to the frequent stops made by buses (see box on p. 33) For example, in 2016 the average and reliable transit travel times for the SR 167 commute from Auburn to Renton in the morning were 36 and 44 minutes, respectively. This is four minutes faster than the average (40 minutes) and five minutes faster than the reliable (49 minutes) transit travel times in 2014. However, average transit travel times in 2016 were slower than the corresponding GP average by 14 minutes, and reliable transit travel times were slower by 13 minutes. See p. 31 for a comparison of transit trips to GP and HOV trips.

Transit ridership and GHG emissions avoided: Transit moved approximately 5,765 riders during the morning and evening peak periods on an average weekday in 2016, a 10% increase from 2014 (5,235 riders). Daily transit passenger miles traveled decreased by roughly 36% in 2016 (32,650 miles) compared to 2014 (51,110 miles). The larger decrease in passenger miles traveled may be partly attributable to a change in methodology designed to align the transit commute trips more closely with the GP commute distances.

Riding transit helps alleviate traffic congestion by making the most efficient use of available highway capacity. For example, peak period transit ridership on the SR 167 corridor in the central Puget Sound region was equal to approximately half of a lane of capacity in 2016 (when compared to the peak efficiency of the roadway, which is a conservative approach to this measurement). Approximately 58% of available seats on transit on SR 167 commutes were occupied during the morning and evening peak periods in 2016. Transit use during peak periods avoided about 18,300 pounds of GHG emissions per day on the SR 167 central Puget Sound corridor in 2016, 36% less than in 2014 (28,400 pounds). This drop parallels the decline in transit passenger miles traveled.

Park and ride: Along the SR 167 corridor in the central Puget Sound region in 2016, park and ride (P&R) utilization rates ranged from 34% to 101%, with four out of eight having utilization rates at or above 95%. The Renton Municipal P&R decreased in size by 50 spaces in January 2015. Any P&R lot that has 85% or more utilization is identified as operating at capacity. P&R locations are essential parts of the transit service network and need to consistently have enough available spaces for transit riders. To be considered effective, P&R lots must also have high utilization rates. Targeted outreach efforts by transit agencies as well as employer initiatives to encourage participation in Commute Trip Reduction programs help address highway capacity needs in the central Puget Sound region.

Commuters and freight move along SR 167 smoothly. Vehicles on SR 167 with more than one person in them can use the high occupancy toll lane for free with a Good to Go! pass.

How much is congestion costing you?

Commuters making roundtrips between Auburn and Renton on SR 167 in 2016 experienced costs due to congestion (measured in wasted time and gas for travel below maximum throughput speed) of nearly $1,000 per passenger vehicle annually.

High Occupancy Vehicle Trip Analysis

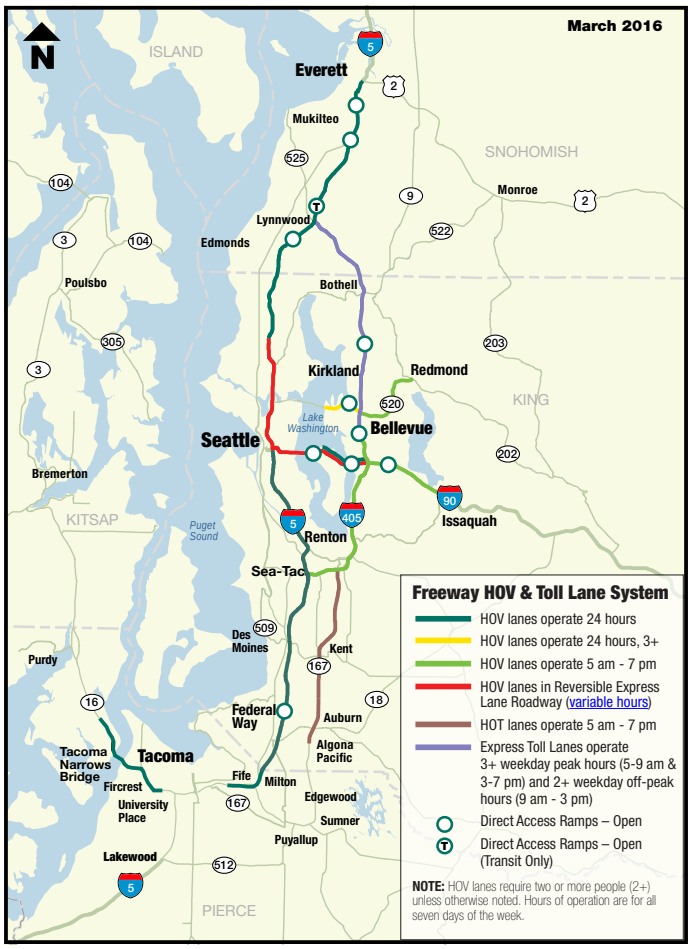
High occupancy vehicle (HOV) lanes are reserved for carpools, vanpools, buses, motorcycles or any vehicle carrying two or more people. The central Puget Sound region freeway network includes a system of HOV lanes designed to provide faster and more reliable options for travelers. This system also enhances the efficient operation of the freeway network by moving more people in fewer vehicles than adjacent general purpose (GP) lanes. About 244 lane-miles of the planned 369-mile Puget Sound region HOV network have been completed. These figures reflect the HOV freeway system and exclude ramps and arterials; the planned freeway lane-miles have been updated based on new projects funded through Connecting Washington and additional HOV options such as high occupancy toll lanes and express toll lanes. More information about the HOV lane network can be found at http://www.wsdot.wa.gov/hov/.

WSDOT monitors three aspects of Puget Sound region HOV lane performance: 1) the person-carrying performance of HOV lanes as compared to the adjacent GP lanes, 2) travel time performance for HOV lane users, and 3) overall travel performance and reliability on freeway HOV corridors.

HOV lanes outperform GP lanes for person throughput

One of the key metrics for HOV lane performance is the ability of the HOV network to efficiently move more travelers. WSDOT estimates the number of vehicles and travelers at 10 locations on the major freeway corridors in the central Puget Sound region to evaluate HOV network performance.

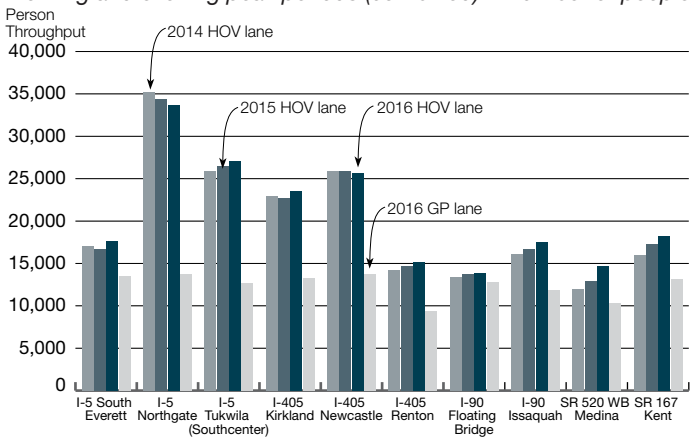
In 2016, changes in person volume varied by location, with eight of the 10 monitored locations showing higher person throughput compared to 2014. The magnitude of HOV person volume in 2016 across the entire central Puget Sound HOV network increased by about 13% when compared to 2014, while the general purpose vehicle (adjacent to HOV network) person volume decreased by about 1%. The significant increase in HOV person volume can be attributed to the introduction of the I-405 Express Toll Lanes in 2015. The person volume estimates are based on a point location and are not a reflection of the vehicle miles traveled on the central Puget Sound region freeway network as a whole.



Approximately 244 lane-miles of a planned 369-mile freeway system of HOV-type lanes have been built in the Puget Sound region since 1970. In addition to the freeway mainline system, approximately 75 miles of transit or HOV lanes exist on state highway arterials and freeway ramps. Image from www.wsdot.wa.gov/hov.

Person throughput[1] higher in HOV than GP lanes

2014 through 2016; Average daily person throughput volumes for morning and evening peak periods (combined) in number of people



Data source: Washington State Transportation Center.

Notes: **1** Person volume estimates are based on most recent 2014-2016 transit ridership and other data. The GP lane volumes are the estimated person volumes for the average GP lane at each location.

Puget Sound HOV lanes account for 42% of miles traveled

Across all the point monitoring locations, an average of 39% of the people using the freeway during the peak periods at these locations are traveling in an HOV lane. These values have been generally consistent from year to year.

The number of people using HOV lanes varies by location and time of day. The most successful examples of HOV system use occur when using an HOV lane offers a clear person throughput and travel time benefit for users combined with strong transit service. GP lanes at all 10 monitored locations saw a reduction in person throughput volumes while most of the adjacent HOV lanes showed an increase. This indicates persistent demand for HOV lanes in the central Puget Sound region.

Puget Sound region HOV network reaches 7.7 million person miles traveled daily

2014 and 2016 during peak periods; Average daily person miles traveled in thousands

Highway	2014	2016	% change
Interstate 5	3,554	3,919	10.27%
Interstate 405	1,790	2,087	16.59%
State Route 520	493	668	35.50%
Interstate 90	415	531	27.95%
State Route 167	404	486	20.30%
Total	**6,656**	**7,691**	**15.55%**

Data source: WSDOT Office of Strategic Assessment and Performance Analysis.

The Northgate area on I-5 north of downtown Seattle is a good example of a freeway segment with high person throughput, as it is in a heavily traveled freeway corridor served by a number of transit routes. In previous years, this location has consistently shown HOV lane travel time benefits and significant usage. In 2016, during the average morning peak period, the southbound I-5 HOV lane at Northgate carried more than 48% (15,450) of all travelers toward downtown Seattle in 23% (4,200) of the vehicles. The HOV lane at this location carried an average of 3.7 persons per vehicle, which is calculated by dividing the HOV person throughput with number of vehicles in the HOV lane. The average number of people carried in HOV lane is nearly 2.5 times the number of persons per vehicle in the adjacent GP lanes. Ridesharing travelers and high levels of transit service and ridership are major contributing factors to the person throughput on I-5 and the HOV system overall.

Roughly 7.7 million person miles were traveled on the central Puget Sound region freeway HOV network on an average weekday in 2016, 15.6% more than in 2014. Approximately 42% of all freeway person miles traveled in the central Puget Sound region were on the HOV network in 2016. HOV lanes comprise approximately 24% of total lane miles on the tracked corridors (see Appendix p. 4). I-5 carried more than half of the region's HOV person miles traveled (3.9 million miles). SR 520 saw the biggest two-year increase in the region (35.5%), due to the addition of more HOV lane miles in 2016.

Carpool, transit and vanpool critical to higher HOV person throughput

Bus riders make up a significant portion of HOV network users. At a rate of 3.6% per year, the region's transit boardings have grown faster than in any other large metropolitan area in the nation. In the central Puget Sound region, King County Metro (KCM), Sound Transit (ST) and Community Transit all showed noticeable annual ridership growth in 2016, continuing the trend from recent years. All of the transit agencies in the region combined deliver 163 million trips in King County. KCM's 2016 transit boardings were up 0.5% from 2014, which was itself a record-setting year (with ridership of 122 million). KCM experienced significant ridership growth on routes that benefited from new investments funded by the voter-approved Seattle Proposition 1, which provides additional funding for bus routes that primarily serve the city of Seattle.

The ST Express regional bus service reported a 0.9% increase in boardings—2016 saw 18.5 million boardings, which was the highest number of commuter bus boardings in the nation. Commuter bus service typically uses freeway HOV lanes, and is defined as service connecting suburban and other areas with a central city and at least five miles of continuous, limited-stop service. Community Transit fixed-route bus ridership grew by 2% in 2016, primarily due to the restoration of Sunday and holiday service that was cut during the recession. WSDOT will continue to track bus ridership trends and levels of transit service as part of its ongoing HOV performance monitoring efforts.

According to the National Transit Database, the Puget Sound region is considered the vanpool capital of the nation, with one million more vanpool trips than the next closest region (Los Angeles). Puget Sound region vanpools logged over 30 million miles in 2016, and made up 82% of the vanpools statewide (2,559 of 3,088).

Two of 12 HOV corridors meet reliability standards in 2016

HOV lanes continue to provide speed and reliability benefits for travelers

WSDOT monitors the benefits for HOV lane users by tracking the travel times and reliability of HOV trips that parallel each of WSDOT's 40 high-demand commute corridors. On I-5 and I-90, alternate HOV routes are provided in the reversible lanes.

Of the 42 HOV trips analyzed for 2016, 31 had average travel times more than two minutes faster than the associated GP trip (during times of peak congestion). The other 11 trips showed no significant average travel time difference between the GP and HOV route options. Overall, the 2016 HOV travel time results are similar to those seen in previous years.

In 2016, 38 of the 42 HOV trips had reliable travel times that were more than two minutes faster than those of their GP counterparts, indicating that HOV lanes were the more dependable option. The other four trips showed little or no difference between HOV and GP reliable travel times.

See Appendix pp. 22-29 for the travel time and reliability performance of each monitored HOV and GP lane.

I-405 HOV performance improves in 2016 compared to 2014

The performance and reliability standard for freeway HOV lanes that was adopted by WSDOT and the Puget Sound Regional Council in 1991 states that travelers in the HOV lane should be able to maintain an average speed of at least 45 mph 90% of the time during the peak hour of travel.

Two of the 12 monitored HOV peak-direction corridors met the state performance standard—which is different from the Legislatively mandated I-405 express toll lane (ETL) performance standard—in 2016 (one in the morning and one in the evening); three corridors met the standard in 2014. I-90 commutes between Issaquah and Seattle met the standard. The degree of compliance with the performance standard held steady or worsened for 10 of the 12 monitored locations in 2016 compared to 2015. Two ETL sections between Bellevue and Lynnwood failed to meet the HOV lane performance standard but still showed improvement. For more detailed information on I-405 ETL performance see pp. 19-22 for a Before and After analysis.

Even when performance is reduced during congested periods, HOV lanes still generally provide speed and reliability benefits over adjacent GP lanes. During the off-peak times of day, all HOV corridors generally meet the standard.

See the table below for a summary of the degree to which each HOV corridor met the state performance standards in recent years in the peak direction of travel. For more detailed performance on I-405 see www.wsdot.wa.gov/tolling/405/library.htm.

High occupancy vehicle lane speed and reliability performance on major central Puget Sound corridors
2012 through 2016; Goal is to maintain 45 mph for 90% of peak hour; Percent of peak hour goal was met

Commute routes	2012	2013	2014	2015	**2016**	Commute routes	2012	2013	2014	2015	**2016**
Morning commutes						**Evening commutes**					
I-5, Everett to Seattle SB	54%	42%	28%	26%	**19%**	I-5, Seattle to Everett NB	68%	66%	46%	36%	**21%**
I-5, Federal Way to Seattle NB	51%	43%	30%	18%	**18%**	I-5, Seattle to Federal Way SB	63%	53%	40%	32%	**21%**
I-405, Tukwila to Bellevue NB	93%	65%	35%	26%	**24%**	I-405, Bellevue to Tukwila SB	43%	41%	26%	21%	**18%**
I-90, Issaquah to Seattle WB	100%	100%	98%	98%	**97%**	I-90, Seattle to Issaquah EB	100%	99%	100%	99%	**97%**
SR 520, Redmond to Bellevue WB	51%	50%	44%	63%	**61%**	SR 520, Redmond to Bellevue WB	54%	52%	52%	73%	**71%**
SR 167, Auburn to Renton NB[1]	96%	94%	86%	66%	**45%**	SR 167, Renton to Auburn SB[1]	98%	98%	98%	95%	**87%**

Data source: Washington State Transportation Center.
Notes: The above HOV reliability performance standards are based on the peak hour, when average travel time is slowest. To meet the standard, a speed of 45 mph must be maintained for 90% of the peak hour. Numbers represent the percentage of the peak hour when speeds are faster than 45 mph. The Washington State Transportation Center analyzes performance data for all complete segments of HOV lanes that have a loop detector. In some cases, like southbound SR 167, data cannot be analyzed for the very beginning and ends of the lanes because there are no detectors at these locations. I-405 commutes between Lynnwood and Bellevue are no longer listed above, as they now have different legislatively mandated speed and reliability performance measures per RCW 47.56.880. For performance information, see www.wsdot.wa.gov/tolling/405/library.htm.
1 High occupancy toll lanes replaced regular HOV lanes May 3, 2008.

Special report: Accessibility of jobs in Puget Sound region

WSDOT analyzes access to jobs by car in Puget Sound region

The Washington State Department of Transportation (WSDOT) conducted a pilot study that analyzed access to jobs by car in King, Pierce, and Snohomish counties during the morning commute. The agency used private sector speed data from 2013 and land use data on employment location from Puget Sound Regional Council to assess how well land use patterns and the transportation system function to facilitate residents' access to job markets by car. WSDOT also looked at how system reliability affects that function. Results of the study showed that:

- Residents of King, Pierce, and Snohomish counties could reach an average of approximately 670,000 jobs within a 30-minute commute at average travel speeds,
- The areas with the most access to jobs were all located in core urban cities or adjacent areas,
- Average access to jobs was 6% less at 95th percentile speeds (travelers experience speeds at least as fast as the 95th percentile speed on 19 weekdays out of 20) than at average speeds, and
- The locations with the greatest reduction in accessibility at 95th percentile speeds tended to be on the suburban fringe.

The agency is interested in accessibility as a performance measure because it considers the influence of land use patterns and the purpose of travel in addition to roadway performance. Most broadly used measures of transportation system performance such as congestion or delay look at mobility, which is the ease of moving through the transportation system regardless of destination. This focus on mobility skews performance measurement, and management, toward the costs of travel (time or delay) while ignoring the benefits to travelers of reaching destinations they value.

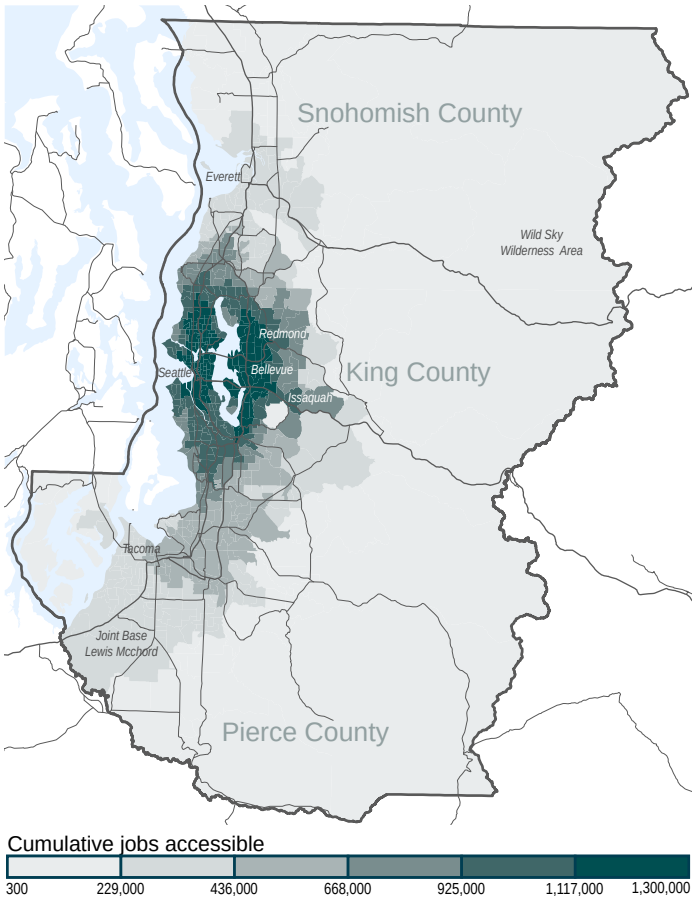
Access to jobs greatest in urban King County

The census tract from which residents could reach the most jobs during the morning commute in 2013 was located in downtown Bellevue (see map to the right). A person living there had access to roughly 1.3 million jobs within a 30-minute commute at average speeds. Eight of the ten census tracts with the highest access to jobs during the morning commute were in Seattle, either downtown or near the University of Washington. The other tract was in Kirkland near the I-405 interchange with NE 85th Street. All of these areas featured a high number of jobs close by, proximity to other job centers, and quick access to multiple highway facilities.

The lowest level of accessibility was in rural Snohomish County near the Wild Sky and Henry M. Jackson Wilderness Areas in national forest lands. In general, areas on the rural eastern King, Pierce, and Snohomish counties had the lowest access to jobs. This was largely due to fewer local jobs and greater distances to job centers.

Central urban areas had the most jobs accessible in Puget Sound area during morning rush

2013; Jobs accessible within 30 minutes by a car traveling at average travel speeds; Morning peak (7-9 a.m.); By census tract

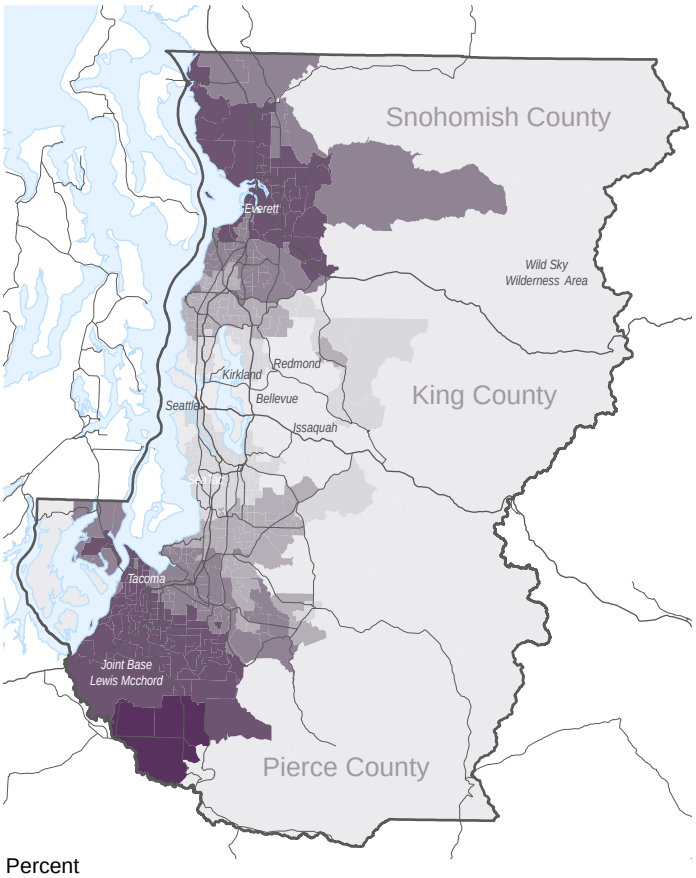


Data source: WSDOT Multimodal Planning Division, Puget Sound Regional Council.
Notes: Darker color denotes more jobs accessible. Analysis only includes access to jobs in King, Pierce and Snohomish counties. For more information on analysis see WSDOT's Handbook for Corridor Capacity Evaluation, p. 39.

System reliability impact greatest on suburban fringe

Access to jobs least impacted by travel time reliability in urban centers and rural periphery

2013; Percent of jobs accessible within 30 minutes by a car traveling at average speeds that are also accessible by a car traveling at 95th percentile speeds; Morning peak (7-9 a.m.); By census tract



Data source: WSDOT Multimodal Planning Division, Puget Sound Regional Council.

Notes: Darker color denotes greater loss of accessibility. Analysis only includes access to jobs in King, Pierce and Snohomish counties. For more information on analysis see WSDOT's Handbook for Corridor Capacity Evaluation, p. 39.

Access to jobs most affected by travel time reliability in the suburban fringe

Residents of the study area could access an average of 632,000 jobs within a 30-minute commute at 95th percentile speeds, about 6% fewer than at average speeds. This difference was not evenly distributed throughout the study area. The locations most impacted by system reliability tended to be on the fringes of suburban development where differences between average and 95th percentile speeds made major job centers unreachable within 30 minutes.

The areas with the greatest difference between the number of jobs accessible at average speeds compared to 95th percentile speeds were adjacent to downtown Tacoma near I-5 (see map to the left). People living in these areas were unable to access some major job centers such as Seattle-Tacoma International Airport at 95th percentile speeds that were accessible at average speeds. This resulted in a 13-14% reduction in job accessibility for these locations.

The areas with the greatest reduction in access to jobs within the study area as a percentage were located at the southern end of Joint Base Lewis McChord and just north of Everett. These areas tend to be near a single major job center but relatively isolated from the rest of the study area.

Locations with a reduction of 1% or less in accessibility to jobs by car were generally in very rural areas like eastern Snohomish County or urban parts of the study area like Seattle and Bellevue. Despite being in suburban areas, some census tracts located along I-90 and SR 520 in locations like Issaquah and Redmond/Overlake also had a reduction of 1% or less in accessibility. These were notable exceptions to the general pattern as can be seen in the map to the left.

What is accessibility and why measure it?

Accessibility is the ease of reaching valued destinations. As the purpose of most travel is to fulfill our daily needs at various destinations, measuring how well land use and the transportation system facilitates our ability to reach these destinations makes sense as a metric for system-wide performance.

Accessibility is measured in terms of to what, for whom, when, and by what means. WSDOT conducted this pilot project to measure accessibility for commuters to jobs within an average commute (roughly 30 minutes) during the height of the morning commute (7-9 a.m.). The agency measured the total number of jobs accessible from each census tract in the study area at average and 95th percentile speeds. While this does not measure how easy it is for an individual to reach their job, it gives WSDOT and decision-makers a region-wide look at access to jobs and can help inform investments.

For further discussion on accessibility as a concept, see the background section in WSDOT's Handbook for Corridor Capacity Evaluation, p. 39.

South Puget Sound I-5 Corridor Capacity Analysis

Visit bit.ly/agolCCR17SouthSoundmap for this article's interactive map.

Annual GP person miles traveled
2014 1,645 vs. 2016 1,629 — in millions of miles — ↓ 1%

Annual vehicle delay[1]
2014 2,092 vs. 2016 2,504 — in thousands of hours — ↑ 20%

Annual GHG emissions
2014 1,442 vs. 2016 1,359 — in millions of pounds of CO_2 equivalents — ↓ 5.8%

Annual passenger miles traveled on transit
2014 25.9 vs. 2016 25.5 — in millions of miles — ↓ 1.5%

Capacity savings due to transit
2014 0.8 vs. 2016 0.7 — in number of lanes — ↓ 13%

Percent transit seats occupied
2014 47% vs. 2016 40% — on average during peak periods — ↓ 7%

Percent park and ride spaces occupied
2014 84% vs. 2016 85% — on average during peak periods — ↑ 1%

Commute travel times

2014 and 2016 during the morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Weekday travel times in minutes at the 5-minute peak including average and reliable[2] travel times for general purpose lane (GP) and transit[3] trips.

Average GP | Average transit | Reliable GP | Reliable transit

See Appendix pp. 30-37 for more commute routes

Olympia to Tacoma
Morning; 7:20 a.m.; Trip length 26 miles

		Average	Reliable
GP	2014	30	36
	2016	33	46
Transit	2014	36	43
	2016	40	52

Tacoma to Federal Way
Morning; 5:30 a.m.; Trip length 12 miles

		Average	Reliable
GP	2014	16	27
	2016	21	33
Transit	2014	16	18
	2016	18	19

Tacoma to Olympia
Evening; 4:50 p.m.; Trip length 26 miles

		Average	Reliable
GP	2014	38	61
	2016	40	61
Transit	2014	84	102
	2016	78	92

Federal Way to Tacoma
Evening; 5:00 p.m.; Trip length 12 miles

		Average	Reliable
GP	2014	33	45
	2016	38	51
Transit	2014	26	35
	2016	39	50

Transit system use

2014 and 2016; For typical weekday morning (6-9 a.m.) and evening (3-6 p.m.) transit[3] peak periods; Ridership and percent of available seats occupied on select commutes

By commute

	Daily peak period riders		Percent of seats occupied	
Morning (6-9 a.m.)	**2014**	**2016**	**2014**	**2016**
Olympia to Tacoma	282	243	29%	20%
Tacoma to Federal Way[4]	3,282	2,951	63%	50%
Evening (3-6 p.m.)				
Tacoma to Olympia[5]	434	274	35%	23%
Federal Way to Tacoma[4]	3,279	3,251	61%	57%

Park and ride capacity

2014 and 2016; Average percent occupied for select park and rides (see map for locations)

Olympia-Federal Way commute

Park and ride (spaces)	2014 percent occupied	2016 percent occupied
SR 512 Lakewood (493)	95%	99%
Tacoma Dome (2,337)	96%	98%
Lakewood Station (600)	79%	79%
DuPont (109)	77%	72%
Martin Way (318)	42%	42%
Hawks Prairie (332)	34%	28%

Data sources and analysis: Washington State Transportation Center, Sound Transit, Pierce Transit, Intercity Transit, WSDOT Olympic Region and WSDOT Office of Strategic Assessment and Performance Analysis.
Notes: Measures at the top of the page are for general purpose (GP) trips only on the I-5 corridor between Olympia and Federal Way. **1** WSDOT defines delay as when average speeds are slower than 85% of the posted speed limit. **2** Reliable travel time will get commuters to their destination on time 19 out of 20 weekdays (95% of the time). **3** Transit travel times by bus may not be directly comparable to GP/HOV trips due to different start and end points or off-highway travel. WSDOT attempts to match transit trips as closely as is practical to GP/HOV. Transit travel times are calculated using a representative trip that occurs as close as possible to the 5-minute peak. **4** Includes transit trips between Olympia/Tacoma and Seattle. **5** Transit routes on this trip were adjusted, shifting some trips outside the 3-6 p.m. peak period which decreased daily peak period riders. For more detail on transit utilization, refer to Appendix p. 37.

Fife area sees a significant increase in congestion

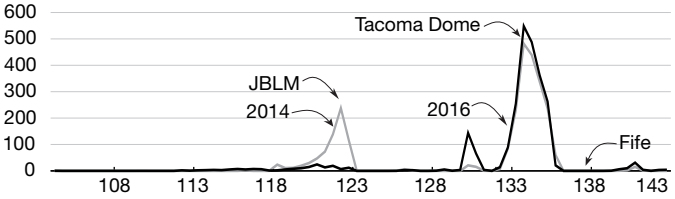
Interstate 5 (I-5) is the key commute and economic corridor connecting the south and central Puget Sound regions. More than 1.6 billion person miles were traveled between Olympia and Federal Way in 2016, a 1% decrease over 2014.

Traffic at specific locations on the corridor worsened from 2014 to 2016, with morning and evening weekday commutes experiencing moderate to heavy congestion on a daily basis. Delay increased 20% on the corridor, with the Tacoma Dome and Fife areas contributing to the significant increase from 2014 to 2016 (see chart below). To learn why delay and miles traveled do not increase hand in hand, see p. 5. In addition to delaying commuters, this congestion directly impacts the movement of goods in Washington as trucks accounted for 7% of the total daily traffic volume on the corridor in 2016. Greenhouse gas (GHG) emissions declined by 5.8% between 2014 and 2016. For more information on the relationship between GHG emissions and delay, see p. 5.

Corridor delay: The I-5 corridor in the south Puget Sound region between Olympia and Federal Way experiences a significant amount of vehicle delay on a daily basis. From 2014 to 2016, the Tacoma Dome and Fife areas experienced increases in corridor delay – about 13% and 84% respectively. Those increased corridor delays equate to up to 5 minutes of added travel time for drivers during peak hours. Construction and temporary lane re-configurations on I-5 in this area led to higher than normal traffic friction in 2016, which contributed to the delay increases. Delay was also influenced by population growth—the population of the Puget Sound Regional Council area (King, Kitsap, Pierce and Snohomish counties) grew by 3.9% between 2014 and 2016. Employment in the Seattle-Tacoma-Bellevue metropolitan area also increased significantly (by 6.6%) between 2014 and 2016. Despite these growth challenges to the north, the Joint Base Lewis McChord (JBLM) area saw an approximate 67% decrease in congestion compared to 2014. This can partially be attributed to the implementation of 18 new ramp meters through the JBLM corridor in May 2015. (See Before and After study on page 44 for more details). In addition to ramp metering, WSDOT partnered with local agencies to enact several other operational and capacity improvements. The delay graphs above indicate a potential correlation between reduction in congestion at JBLM and increase in congestion at the Tacoma Dome area, mostly in the northbound

Northbound delay along the I-5 corridor

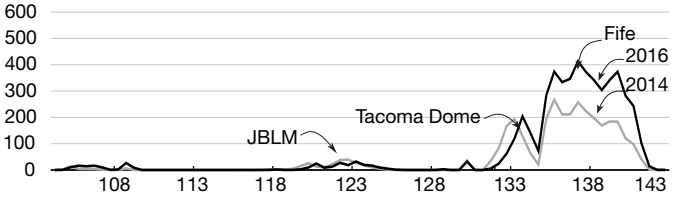
2014 and 2016; Northbound; Average daily vehicle hours of delay by milepost



Data sources and analysis: WSDOT Olympic Region Traffic Office and WSDOT Office of Strategic Assessment and Performance Analysis.

Southbound delay along the I-5 corridor

2014 and 2016; Southbound; Average daily vehicle hours of delay by milepost

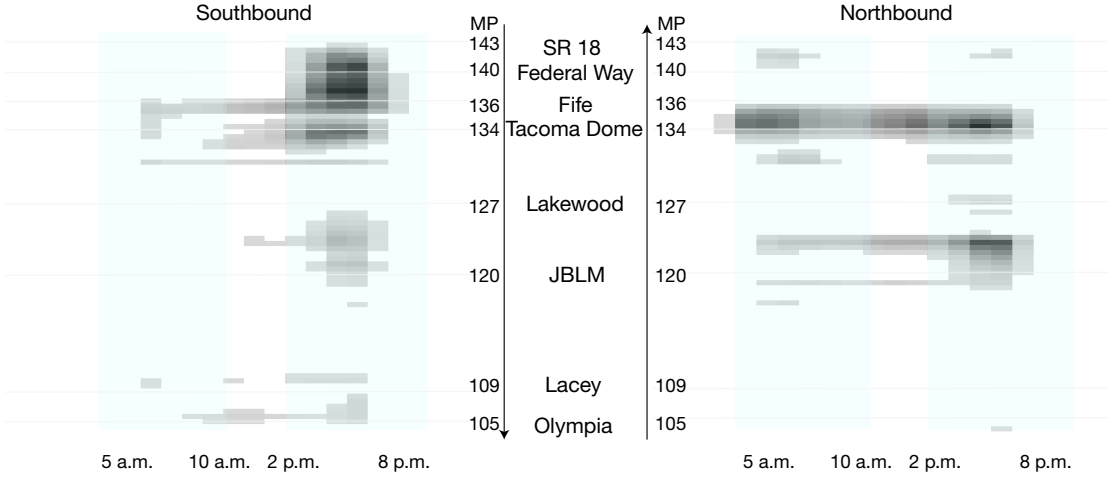


Data sources and analysis: WSDOT Olympic Region Traffic Office and WSDOT Office of Strategic Assessment and Performance Analysis.

I-5 delay between Olympia and Federal Way

2016; Vehicle hours of delay; Weekdays only; By milepost (MP); Shading represents intensity of delay; Highlighted sections represent peak periods

In 2016 on northbound I-5, delay lasted from 5 a.m. to 7 p.m. around the Tacoma Dome, with the most intense delay occurring during the morning commute. On southbound I-5, delay was most intense during the evening commute, extending from SR 18 past the Tacoma Dome and lasting between 2 p.m. and 8 p.m.

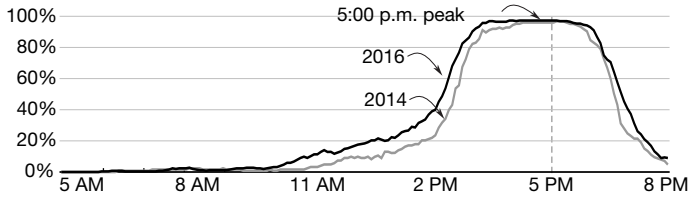


Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Capacity constraints evident at Tacoma Dome and Fife

Severe congestion on the Federal Way to Tacoma commute

2014 and 2016; Southbound; Percent of days the average speed was slower than 36 mph



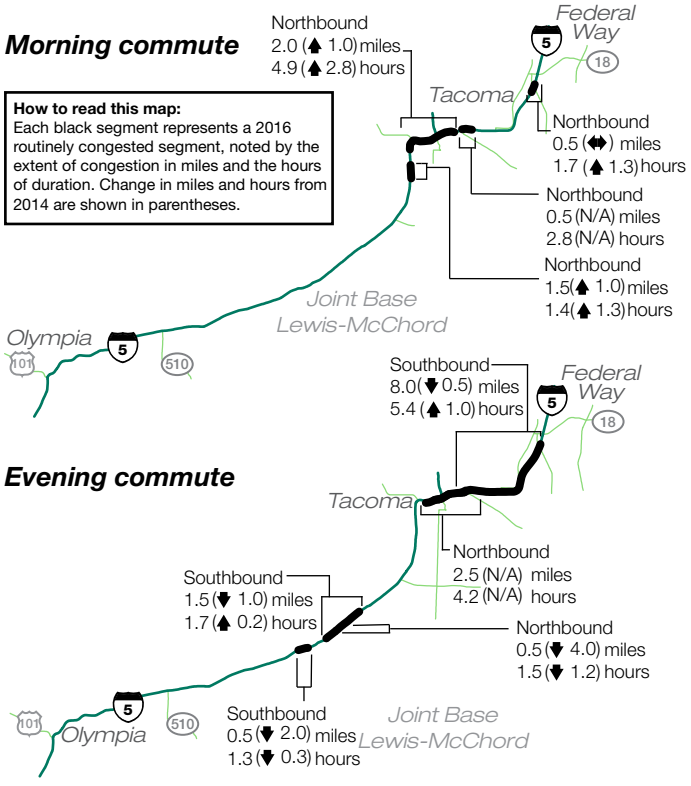
Data sources and analysis: WSDOT Olympic Region Traffic Office and WSDOT Office of Strategic Assessment and Performance Analysis.

direction. The majority of the Fife area congestion is in the southbound direction, which is likely due to the relocation of a bottleneck, and the end of HOV lane restrictions.

A focus on hot spots: The percent of days the Federal Way to Tacoma commute operated in severely congested (36 mph or below) condition remained the same between 2014 and 2016. The graph above shows that between

Routinely congested segments of I-5

2016; For weekday morning (5-10 a.m.) and evening (2-8 p.m.) peak periods; Length of backup in miles; Daily duration of congestion in hours (compared to 2014)

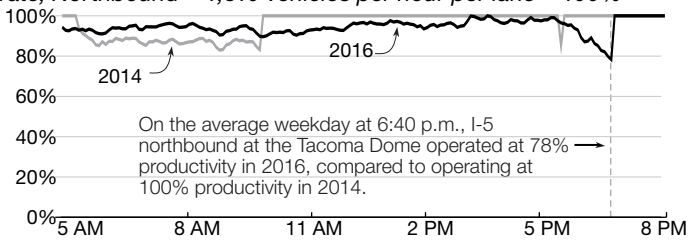


Data sources and analysis: Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

Notes: See p. 34 in the Appendix for all south Puget Sound region routinely congested segment data. **1** Routinely congested segments that dropped below 50 minutes in duration in 2016 from 2014 are noted with text on the map, but are not shown with the bold segment lines.

Throughput productivity on northbound I-5 at the Tacoma Dome

2014 and 2016; Based on the highest observed 5-minute flow rate; Northbound = 1,810 vehicles per hour per lane = 100%



Data sources and analysis: WSDOT Olympic Region Traffic Office, Washington State Transportation Center and WSDOT Office of Strategic Assessment and Performance Analysis.

2-8 p.m., most weekday commutes experienced speeds well below 36 mph. For example, at 5:00 p.m., 97% of days experienced severe congestion in 2014 and 2016.

Highway productivity: As traffic increases and speeds drop below maximum throughput, congested roads carry fewer vehicles, resulting in a drop in throughput productivity. In order to gauge the lost productivity on I-5 in the south Puget Sound region, vehicle throughput was analyzed at five locations: near 14th Avenue in Olympia, near JBLM, the Tacoma Dome area, and near SR 18. In 2014 and 2016, productivity at these locations ranged from 59% to 100% at their most congested.

Throughput productivity loss in the northbound direction during morning and evening peak hours near the Tacoma Dome in 2014 became an all-day productivity loss in 2016. This might be explained by the significant reduction in congestion in the northbound direction near JBLM, which previously acted as a meter restricting the volume of vehicles near the Tacoma Dome area. Similarly, the loss in throughput productivity at the Tacoma Dome in the southbound direction increased from approximately 5.5 hours (between 1:25 p.m. and 7:00 p.m.) in 2014 to roughly 8.5 hours in 2016 (between 10:30 a.m. and 7:05 p.m.).

Routinely congested segments: Of the 38-mile I-5 corridor between Olympia and Federal Way, the segment between JBLM and SR 18 experienced routine congestion, with hot spots in the Tacoma Dome and Fife areas. While the locations were similar in 2014 and 2016, the amount of time of routine congestion increased by 96%.

What does severe congestion mean for travel times on the corridor?

General purpose lane trips: In 2016, the Tacoma to Federal Way northbound commute was more severely impacted by capacity constraints near the Tacoma Dome than it was in 2014. Average travel times were five minutes (31%) longer in

Transit ridership saves most of a lane of capacity on I-5

2016 than in 2014 during the morning peak period (5-10 a.m.), and four minutes (29%) longer during the evening peak period (2-8 p.m.). Similarly, reliable travel times increased by six minutes (22%) for the morning and seven minutes (44%) for the evening commutes on this route. This 12-mile commute is routinely congested and saw a significant increase in the duration of congestion in 2016. While in 2014 average speeds did not dip below 45 mph, in 2016 speeds were below 45 mph for over nine hours per day. The delay increase in the Tacoma Dome area might be caused by the removal of a bottleneck at the JBLM area in the northbound direction.

The Federal Way to Tacoma southbound reverse commute was impacted by capacity constraints near the Fife area. This resulted in increased average and reliable travel times during the evening peak period (2-8 p.m.). The average travel time for this route increased by five minutes (15%) from 2014 to 2016, while the reliable travel time increased by six minutes (13%). This 12-mile commute is routinely congested, with a significant increase in the duration of congestion along this route. Speeds on this segment of the corridor were below 45 mph on the evening commute for five hours and five minutes in 2014, and seven hours and 25 minutes in 2016 – an increase of two hours and 20 minutes.

The maximum throughput travel time index (MT3I) WSDOT uses to compare severity of congestion across commutes shows that the Federal Way to Tacoma evening commute has the highest MT3I—2.56—of the 20 commute routes tracked in the south Puget Sound region.

Transit trip travel times: Transit travel times on I-5 in the south Puget Sound region provide a clear example of the difference HOV lanes can make to transit travel on highways. On the morning commute from Tacoma to Federal Way, where HOV lanes allow transit vehicles to bypass traffic in the GP lanes for most of the trip, average and reliable transit travel times (18 and 19 minutes) were shorter than GP travel times by 3 and 14 minutes, respectively.

In contrast, the morning transit travel times between Olympia and Tacoma, where there are no HOV lanes, were longer than the corresponding GP travel times by 7 and 6 minutes, respectively. They also increased between 2014 and 2016, with the average transit travel time going from 36 minutes to 40, and the reliable transit travel time increasing from 43 minutes to 52. These increases are slightly larger than those seen for general purpose lane travel on the same route.

Transit ridership and GHG emissions avoided: On an average weekday in 2016, transit moved approximately 7,793 people during the morning and evening peak periods—an 11% decrease from 2014 (8,753 riders). However, daily transit passenger miles traveled dropped by only 1.5% over the same period. The largest drop in ridership was on the evening commute from Tacoma to Olympia, which saw a 37% drop in ridership from 2014 to 2016. This route was one of those served by the express buses that were discontinued in 2015.

Riding transit helps alleviate traffic congestion by making the most efficient use of available highway capacity. Peak period transit ridership on the I-5 corridor in south Puget Sound was equal to 72% of an extra lane of capacity in 2016 (when compared to the peak efficiency of the roadway, which is a conservative approach to this measurement). Approximately 40% of available seats on transit on south Puget Sound I-5 commutes were occupied during the morning and evening peak periods in 2016. Of the 306 daily transit trips during the peak periods, two were over 90% of seating capacity on a typical weekday. Transit use on the south Puget Sound I-5 corridor during peak periods avoided approximately 43,779 pounds of GHG emissions per day in 2016, a 7.8% decrease from to 2014 (47,469 pounds).

Park and ride: Along the I-5 corridor in the south Puget Sound region in 2016, park and ride (P&R) utilization rates ranged from 28% to 99%. The SR 512 Lakewood P&R and the Tacoma Dome Station saw utilization rates of 99% and 98%, respectively. Any P&R lot that has 85% or more utilization is identified as operating at capacity. Lakewood Station and the DuPont P&R have utilization rates of 79% and 72%, respectively, which are considered to be nearing capacity.

P&R locations are essential parts of the transit service network. To be considered effective, P&R lots must also have high utilization rates. Targeted outreach efforts from transit agencies as well as employer initiatives to encourage participation in Commute Trip Reduction programs help address highway capacity needs in the south Puget Sound region.

How much is congestion costing you?

The southbound evening commute along I-5 from Federal Way to Tacoma experienced the most congestion of the south Puget Sound area commutes. This 12-mile trip claimed the highest cost due to congestion (compared to maximum throughput speed), making the round-trip congestion cost about $1,600 per passenger vehicle annually in 2016.

Before and After Analysis of Ramp Meter Activation in JBLM Corridor

WSDOT activated ramp meters in both directions of Interstate 5 (I-5) between Lacey (SR 510) and Lakewood (SR 512) on May 18, 2015. This section of I-5 is known locally as the Joint Base Lewis-McChord (JBLM) corridor.

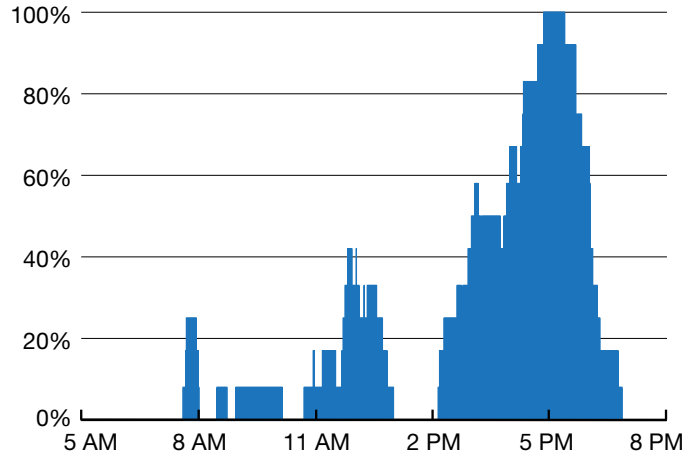
Between 2015 and 2016, the population in Pierce County increased from 842,767 to 861,312 and in Thurston County from 269,183 to 275,222, for a total increase of 24,584 (Source: United States Census Bureau). While this growth continues to strain the limited capacity of JBLM corridor, this Before and After study shows that ramp meters have helped improve throughput and reduced travel times for many drivers.

Ramp meters improve I-5 performance through JBLM

On most days observed, the northbound ramp meters were active between 6-9 a.m. and the southbound ramp meters from 2-6 p.m. The southbound ramp meter at Berkeley Avenue (MP 122) was active every day (Tues-Thurs) at 5 p.m. and usually active between 4-6 p.m. (see graph below). Corridor performance improved as a whole, but the most significant congestion reduction occurred during peak hours and correlates with ramp meter activity. Ramp meters operate based on a computer algorithm, which activates them specifically during peak hours to optimize freeway performance.

Peak travel times improve on I-5 JBLM corridor with active ramp meters

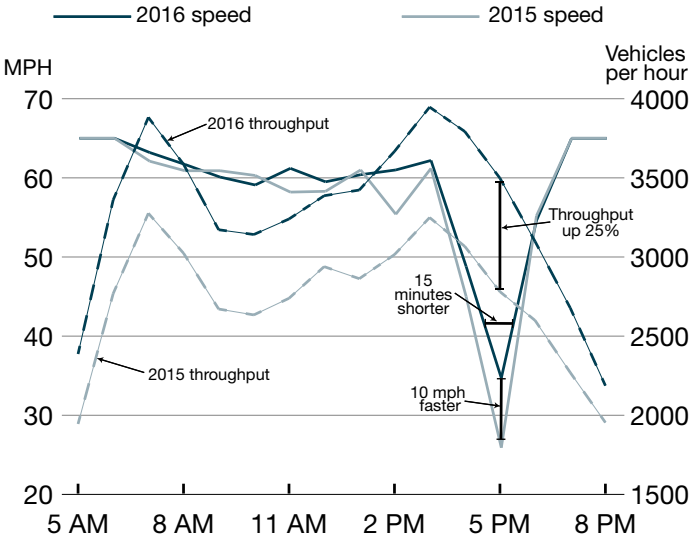
April 2016; Tues-Thurs; Berkeley Ave southbound; Percent of days when the ramp meter was on for that hour



Data source: WSDOT Olympic Region Traffic Management Center
Note: Data from 2017 is not included to avoid the impact of new construction projects on this analysis.

Ramp meters increase throughput and speeds, decrease congestion duration on JBLM corridor

April 2015 compared to April 2016; Tues-Thurs; Southbound I-5 at Berkeley Ave.; Speed in average miles per hour; Throughput in average vehicles per hour



Data source: WSDOT Olympic Region Traffic Management Center.
Note: Data from 2017 is not included to avoid the impact of new construction projects on this analysis.

Routine congestion and throughput improved at Berkeley Avenue

The average travel speed on I-5 at Berkeley Avenue increased, and improved up to 10 mph at 5 p.m. In other locations along the corridor, peak hour speeds increased between 5 and 20 mph. The duration of peak hour congestion decreased. The traffic congestion at Berkeley Avenue during evening peak hours shortened by 15 minutes. Other locations along the JBLM corridor saw congestion durations shortened by up to 60 minutes. In addition, traffic volumes increased during all hours of the day without negatively affecting the travel speeds. On I-5 at Berkeley Avenue, traffic volumes increased up to 25% at 5 p.m.

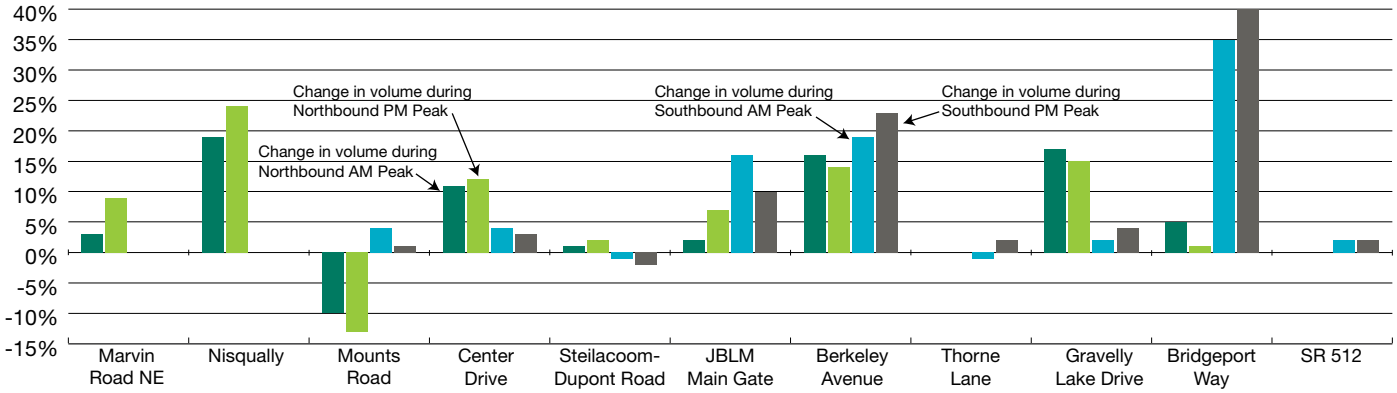
How do ramp meters relieve congestion?

Ramp meters reduce congestion caused by busy on-ramps by creating timed gaps between vehicles entering the freeway, allowing for safer and more efficient merging. Better merging conditions at each ramp ultimately improve the traffic flow for the entire corridor as the automatic metering process helps balance the demands of vehicles entering the freeway with those already on it.

Ramp meters lead to increased throughput on I-5

Peak hour volume increased at most locations on I-5 JBLM corridor

Percent change in volume during peak hour on I-5 from April 2015 to April 2016; Tues-Thurs



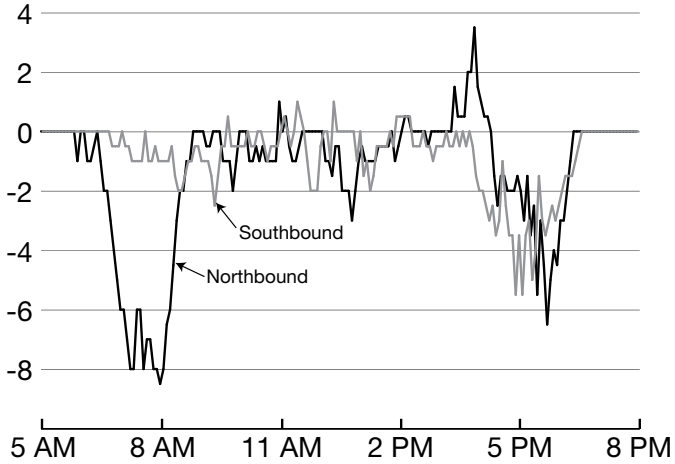
Data source: WSDOT Olympic Region Traffic Management Center.

Notes: If there is no bar for a certain location or time, there was no ramp meter at that location. Data from 2017 is not included to avoid the impact of new construction projects on this analysis.

The graph above shows the percent change in volumes between 6-9 a.m. and 2-6 p.m. (which includes peak hours) when ramp meters were active. There is no data plotted for certain locations as some locations only have ramp meters in either southbound or northbound direction, but not both. The percent change ranges from -13% to +40%. Overall, throughput has increased by 7% on the JBLM corridor.

Peak travel times improve on I-5 JBLM corridor with active ramp meters

April 2015 compared to April 2016; Tues-Thurs; Change in travel times (in minutes) for northbound I-5 from Marvin Rd to SR 512, southbound I-5 from SR 512 to Martin Way



Data source: WSDOT Olympic Region Traffic Management Center

Note: Data from 2017 is not included to avoid the impact of new construction projects on this analysis.

Travel times improved on the JBLM corridor

Drivers traveling northbound from SR 510 in Lacey to SR 512 in Lakewood saw the 15-mile morning commute shortened by eight minutes in 2016. Southbound travelers between the two cities saw their 17-mile peak commute decrease by six minutes (see graph below left). Five collisions in April 2016 resulted in blocked lanes and an increase in average travel time during the early evening northbound commute (3-5 p.m.). Overall, travel times decreased most during the peak hours when ramp meters were active.

Further improvements to JBLM corridor underway

While ramp meter operations have successfully improved travel time, travel speed and throughput volume, the JBLM corridor continues to face challenges. Geographically limited by Puget Sound and Joint Base Lewis-McChord, the JBLM area lacks viable alternate routes to serve the increasing population of Thurston and Pierce counties.

WSDOT has several projects underway to further improve travel on the JBLM corridor. WSDOT plans to add one lane in each direction on I-5 and enhance several interchanges in the corridor (see wsdot.wa.gov/Projects/I5/MountsRdThorneLn for more information). During the projects, drivers may experience traffic performance below the numbers listed in this analysis. Ramp meters will continue to operate in the JBLM corridor during and after these projects, and help minimize the traffic impacts from roadwork and construction in the area.

Spokane Region I-90 Corridor Capacity Analysis

Visit bit.ly/agolCCR17Spokanemap for this article's interactive map.

Annual person miles traveled
2014 vs. 2016
221.8 vs. 242.1
in millions of miles
9.2%

Annual vehicle delay[1,5]
2014 vs. 2016
8.9 vs. 24.3
in thousands of hours
173%

Annual GHG emissions
2014 vs. 2016
176.2 vs. 182.8
in millions of pounds of CO_2 equivalents
3.7%

Annual passenger miles traveled on transit
2014 vs. 2016
1.9 vs. 1.6
in millions of miles
15.8%

Capacity savings due to transit
2014 vs. 2016
0.09 vs. 0.08
in number of lanes
11%

Percent transit seats occupied
2014 vs. 2016
57% vs. 50%
on average during peak periods
7%

Percent park and ride[5] spaces occupied
2014 vs. 2016
83% vs. 65%
on average during peak periods
18%

Commute travel times

2014 and 2016 during the morning (7-10 a.m.) and evening (3-6 p.m.) peak periods; Weekday travel times in minutes at the 5-minute peak including average and reliable[2] travel times for single occupant vehicle (GP) and planned, average and reliable transit[3] travel times.

Average GP · Reliable GP · Average transit · Reliable transit · Planned transit[6]

Argonne Rd. to Division St.

Morning; 7:50 a.m.; Trip length 7.5 miles

GP
2014 9 12
2016 11 16

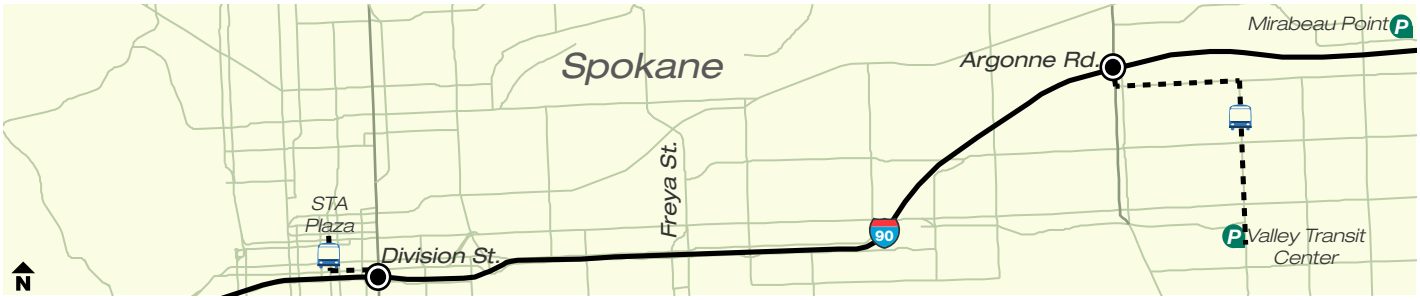
Transit
2014[3] 15
2016 17 21

Division St. to Argonne Rd.

Evening; 5:20 p.m.; Trip length 7.5 miles

GP
2014 9 11
2016 11 15

Transit
2014[3] 24
2016 13 16



Transit system use

2014 and 2016; For typical weekday morning (6-9 a.m.) and evening (3-6 p.m.) transit[3] peak periods; Ridership and percent of available seats occupied on select commutes

By commute

	Daily peak period riders		Percent of seats occupied	
	2014	2016	2014	2016
Morning (6-9 a.m.)				
Argonne to Division	614	501	58%	50%
Evening (3-6 p.m.)				
Division to Argonne	458	365	57%	51%

Park and ride capacity

2014 and 2016; Average percent occupied for select park and rides (see map for locations)[4]

Argonne-Division commute

Park and ride (spaces)	2014 percent occupied	2016 percent occupied
Mirabeau Point (198)	84%	64%
Liberty Lake (204)	92%	70%
Valley Transit Center (236)	73%	61%

See Appendix pp. 38-40 for more commute routes

Data sources and analysis: WSDOT Eastern Region Traffic Office, Spokane Transit Authority and WSDOT Office of Strategic Assessment and Performance Analysis.

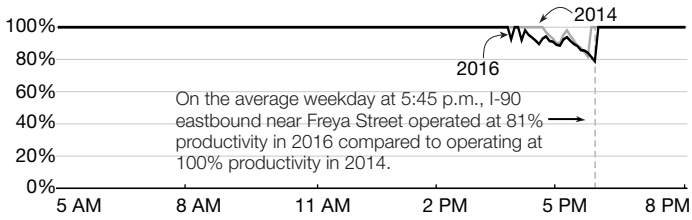
Notes: Measures at the top of the page are for general purpose (GP) trips only on the I-90 corridor in the Spokane area. **1** WSDOT defines delay as when average speeds are slower than 85% of the posted speed limit. **2** Reliable travel time will get a commuter to their destination on time or early 19 out of 20 weekdays (95% of the time). **3** Transit travel times by bus in the Spokane region include some off-highway travel past the Division St. and Argonne Rd. exits on I-90 (see dotted lines on map) and thus are not directly comparable to GP times which are highway only. Transit travel times are calculated using a representative trip that occurs as close as possible to the 5-minute peak. **4** Liberty Lake park and ride not shown in map extent. **5** Annual vehicle delay numbers were recalculated due to the change in the data source. **6** Planned travel time is defined as the pre-determined travel time scheduled for the transit to reach the destination.

Interstate 90 (I-90) in the Spokane region is one of the area's key commute and economic corridors. Approximately 242.1 million person miles were traveled on I-90 between Division Street and Argonne Road in 2016, an increase of 9.2% since 2014. Traffic at specific locations on the corridor worsened from 2014 to 2016, with morning and evening weekday commutes experiencing light to moderate congestion on a daily basis. Delay increased 173% (changes in small total quantities result in drastic changes in percentage) on the corridor between 2014 and 2016, mostly due to increased traffic volumes on a corridor that was already nearing capacity in the peak periods.

Spokane routine congestion expands by three miles

Throughput productivity on eastbound I-90 near Freya Street

2014 and 2016; Based on the highest observed 5-minute flow rate; Eastbound = 1,680 vehicles per hour per lane = 100%



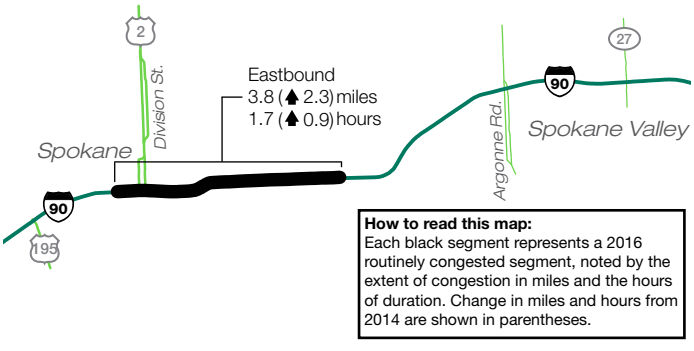
Data sources and analysis: WSDOT Eastern Region Traffic Office and WSDOT Office of Strategic Assessment and Performance Analysis.

Highway productivity: As traffic increases and speeds drop below maximum throughput, congested roads carry fewer vehicles, resulting in a drop in throughput productivity. In order to gauge the lost productivity on I-90 in the Spokane region, WSDOT analyzed vehicle throughput at several locations between Division Street and Argonne Road. In 2014 and 2016, productivity at these locations ranged from 71% to 100% at their most congested. The graph above shows how productivity varies by time of day near Freya Street. For example, at 5:45 p.m., 19% of the corridor's capacity was unavailable due to congestion on eastbound I-90 near Freya Street.

Routinely congested segments of I-90

2016; For weekday evening peak period (3-6 p.m.); Length of backup in miles; Daily duration of congestion in hours (compared to 2014)

Evening commute



Data sources and analysis: WSDOT Eastern Region Traffic Office and WSDOT Office of Strategic Assessment and Performance Analysis.

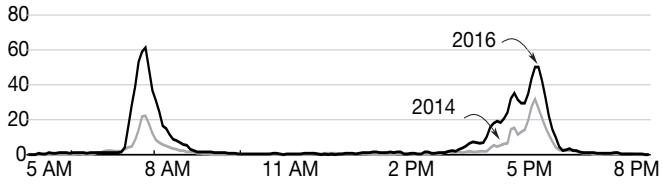
Notes: There was no routine morning congestion over the 50-minute threshold. See p. 39 in the Appendix for all Spokane region routinely congested segment data.

Routinely congested segments: In 2016, the eastbound I-90 evening commute experienced nearly four miles of congestion lasting nearly two hours between Division Street and Custer Road. This is a significant increase in routine congestion over 2014 in terms of both length (2.3 miles longer) and duration (about an hour longer). The morning routine congestion on westbound I-90 expanded by 2.3 miles, while the duration increased by 30 minutes from 2014 to 2016.

A focus on hot spots: The commute routes on I-90 through the Spokane region occasionally experienced congestion in 2016. The westbound commute had a 61% chance of experiencing congestion during both morning and afternoon peak commute periods on an average weekday. Similarly, eastbound commutes had a 77% chance of experiencing congestion during peak commute periods. The Spokane region experienced some severe congestion (average speeds slower than 36 mph) as well, ranging from a 28% chance in the westbound direction to a nearly 41% chance in the eastbound direction.

Congestion on the Spokane I-90 commute

2014 and 2016; Westbound; Percent of days the average speed was slower than 45 mph



Data sources and analysis: WSDOT Eastern Region Traffic Office and WSDOT Office of Strategic Assessment and Performance Analysis.

How do ramp meters relieve congestion?

Ramp metering is an urban congestion mitigation strategy that helps reduce congestion on freeways. The Eastern Region Traffic Office has hired a consultant to analyze ramp metering at various on-ramps in the Spokane area. Ramp meters use a stop-and-go signal system to control the frequency of vehicles entering I-90 from the on-ramps. This strategy to operate the freeway system efficiently has proved to be effective in improving the overall performance of the corridor in other parts of the state and the nation.

Lower park and ride use reflects drop in transit ridership

What does congestion mean for travel times on the corridor?

Between 2014 and 2016, average travel times increased by two minutes. In 2016, average and reliable transit travel times were 17 and 21 minutes, respectively, for the highway portion of the morning westbound commute. Similarly, the average and reliable transit travel times were 13 and 16 minutes, respectively, for the eastbound evening commute.

Transit ridership and GHG emissions avoided: Transit moved nearly 900 people on the corridor during the morning and evening peak periods on an average weekday in 2016. Transit ridership means fewer cars on the road, which helps alleviate traffic congestion by making the most efficient use of available highway capacity. Peak period transit ridership on the Spokane region I-90 corridor was equal to about a 11% of an extra lane of capacity in 2016 (when compared to the peak efficiency of the roadway, which is a conservative approach to this measurement).

Transit routes on the I-90 corridor were operating at about 50% of their seating capacity during the morning and 51% during evening peak periods in 2016. Combined morning and evening ridership declined by approximately 19% in 2016 compared to 2014. Similarly the amount of greenhouse gas emissions avoided declined by approximately 27%. Transit use during peak periods avoided roughly 2,400 pounds of GHG emissions per day on the I-90 Spokane region corridor in 2016.

Spokane Transit Authority has received grant funding to coordinate with WSDOT and regional partners to begin designing improved connections with routes outside of the corridor, upgrade passenger amenities, enhance operations, improve reliability and expand park and ride (P&R) facilities. These improvements are expected to encourage additional ridership and accommodate growth in demand for P&R spaces.

Park and ride: Along the I-90 corridor in the Spokane region in 2016, P&R utilization rates ranged from 61% to 70% depending on location. The Mirabeau Point P&R, east of Argonne Road, saw an average utilization rate of 65%. Any P&R lot that has 85% or more utilization is identified as operating at capacity. Spokane Transit Authority has seen transit use around Spokane slightly decline with the sustained drop in fuel prices (see pp. 9-10), which appears to have affected P&R utilization at a higher rate than overall ridership. Also contributing to the utilization decrease was an addition of 39 spaces to the frequently full Liberty Lake P&R in late 2014, decreasing the utilization percentages. P&R locations are essential parts of the transit service network and need to consistently have enough available spaces for transit riders. To be considered effective, P&R lots must also have high utilization rates.

Visit bit.ly/agolCCR17-Vancouvermap for this article's interactive map.

Vancouver Region I-5, I-205 & SR-14 Corridor Capacity Analysis

Annual person miles traveled[1]

2014	vs.	2016
708.8		749.0

in millions of miles — ▲ 5.7%

Annual vehicle delay[2]

2014	vs.	2016
303.8		555.7

in thousands of hours — ▲ 83%

Annual GHG emissions

2014	vs.	2016
570.5		570.1

in millions of pounds of CO_2 equivalents — ▼ 0.1%

Annual passenger miles traveled on transit

2014	vs.	2016
2.1		1.8

in millions of miles — ▼ 14%

Capacity savings due to transit

2014	vs.	2016
0.2		0.1

in number of lanes — ▼ 50%

Percent transit seats occupied

2014	vs.	2016
55%		43%

on average during peak periods — ▼ 12%

Percent park and ride spaces occupied

2014	vs.	2016
62%		65%

on average during peak periods — ▲ 3%

Commute travel times

2014 and 2016 during the morning (6-9 a.m.) and evening (3-6 p.m.) peak periods; Weekday travel times[3] in minutes at the 5-minute peak including average and reliable[4] travel times for general purpose (GP) travel times.

See Appendix pp. 41-49 for more commute routes

Average GP | Reliable GP

Interstate 5 commutes

I-205 to I-5 bridge

Morning; 6:40 a.m.; Trip length 7 miles

	Average GP	Reliable GP
2014	16	31
2016	21	35

I-5 bridge to I-205

Evening; 5:15 p.m.; Trip length 8 miles

	Average GP	Reliable GP
2014	8	9
2016	8	9

Interstate 205 commutes

I-5 to I-205 bridge

Morning; 7:30 a.m.; Trip length 10 miles

	Average GP	Reliable GP
2014	13	24
2016	17	34

I-205 bridge to I-5

Evening; 5:25 p.m.; Trip length 10 miles

	Average GP	Reliable GP
2014	12	17
2016	13	17

State Route 14 commutes

Camas to I-205

Morning; 7:05 a.m.; Trip length 4 miles

	Average GP	Reliable GP
2014	10	23
2016	11	26

I-205 to Camas

Evening; 5:30 p.m.; Trip length 5 miles

	Average GP	Reliable GP
2014	7	13
2016	7	14

Transit system use

2014 and 2016; For typical weekday morning (6-9 a.m.) and evening (3-6 p.m.) transit[5] peak periods; Ridership and percent of available seats occupied on select commutes

By commute	Daily peak period riders		Percent of seats occupied	
Morning (6-9 a.m.)	2014	2016	2014	2016
I-5: I-205 to I-5 bridge	633	574	53%	45%
I-205: SR 500 to I-205 bridge	496	405	64%	54%
SR-14: Camas to I-205	N/A	37	N/A	16%
Evening (3-6 p.m.)				
I-5: I-5 bridge to I-205	608	414	52%	33%
I-5: I-5 bridge to SR 500[7]	109	115	52%	74%
SR-14: I-205 to Camas	N/A	50	N/A	25%

Park and ride capacity

2014 and 2016; Average percent occupied for select park and rides (see map for locations)[6]

Interstate 5 commute route

Park and ride (spaces)	2014 percent occupied	2016 percent occupied
Andresen (100)	51%	96%
99th Street Transit Ctr. (609)	65%	65%
Salmon Creek (472)	55%	52%

Interstate 205 commute route

Park and ride (spaces)	2014 percent occupied	2016 percent occupied
Fisher's Landing Transit Ctr. (563)	89%	93%
Evergreen Transit Ctr. (267)	12%	14%

Data sources and analysis: WSDOT Southwest Region Planning Office, Southwest Washington Regional Transportation Council, C-TRAN, National Performance Management Research Data Set and WSDOT Office of Strategic Assessment and Performance Analysis.

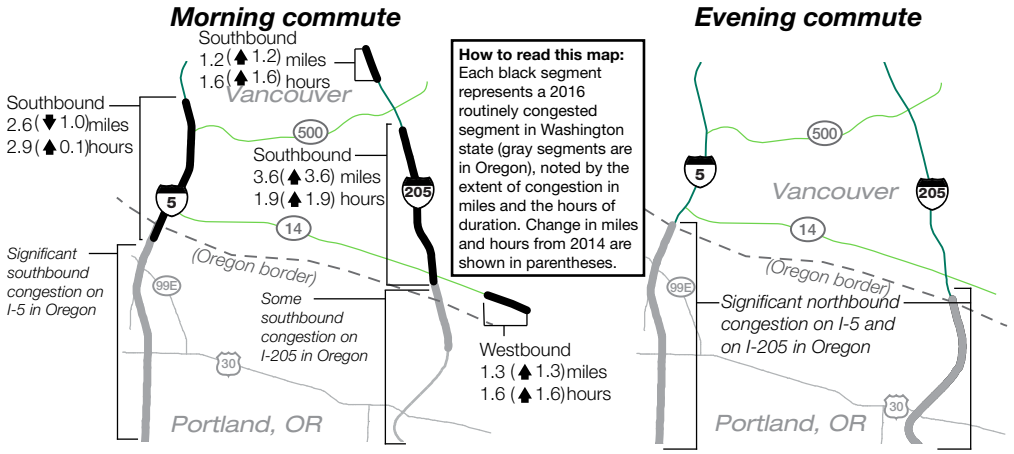
Notes: Measures at the top of the page are for general purpose (GP) trips only on the I-5, I-205 and SR 14 corridors in the Vancouver area. **1** Due to limited data availability, measurements for annual person miles traveled (PMT) are not comparable to previous editions of the *Corridor Capacity Report*. WSDOT recommends that the percent change in PMT be used as an indicator of a general trend for the region. **2** WSDOT defines delay as when average speeds are slower than 85% of the posted speed limit. This measure now has a better data source (provided by the Federal Highway Administration), so trends might not line up with previous years. **3** Due to constrained sample sizes, transit travel time data for I-5, I-205 and SR 14 were not published for 2014 and 2016. **4** Reliable travel time will get a commuter to their destination on time or early 19 out of 20 weekdays (95% of the time). **5** WSDOT attempts to match transit trips as closely as is practical to GP/HOV. **6** The Bonneville Power Administration park and ride was shut down before 2015 and is not included in this report. **7** The 2014 number in the 2015 *Corridor Capacity Report* will not match this figure because C-Tran has updated the criteria used to assign buses to commute routes. The updated criteria were used for both 2014 and 2016 transit data analysis.

Congestion on Vancouver corridors on the rise in 2016

Interstate 5 (I-5), Interstate 205 (I-205) and State Route 14 9 (SR 14) in the Vancouver region are three of the region's key commute and economic corridors. General trends for these corridors combined indicate a 5.7% increase between 2014 and 2016 in annual person miles traveled. The I-5 and I-205 corridors are analyzed for the Vancouver urban area from the I-5/I-205 split to the respective bridges that cross the Washington/Oregon border. The SR 14 corridor analysis is new to this year's report, and includes the sections of highway between Camas and the SR 14/I-5 and SR 14/I-205 interchanges.

Routinely congested segments of I-5 and I-205 in the Vancouver area

2016; For weekday morning (6-9 a.m.) and evening (3-6 p.m.) peak periods; Length of backup in miles; Daily duration of congestion in hours (compared to 2014)

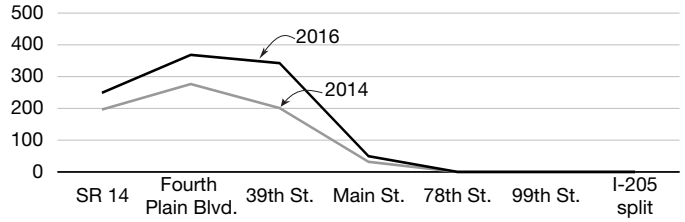


Data sources and analysis: National Performance Measurement Research Data Set, WSDOT Southwest Region Planning Office, WSDOT Office of Strategic Assessment and Performance Analysis, and endorsed by Oregon Department of Transportation.
Note: See pp. 48-49 in the Appendix for all Vancouver and Portland region routinely congested segment data. Generalized Portland routinely congested segments are shown in the map above in light gray.

Traffic at specific locations on the corridors worsened from 2014 to 2016, with morning and evening weekday commutes experiencing moderate to heavy congestion on a daily basis. Delay increased 83% throughout the corridors between 2014 and 2016. (See heatmap graphs for I-5 and I-205 on p. 52). In addition to delaying commuters, this congestion directly impacts the movement of goods in Washington; in 2016, trucks accounted for 7% of the total daily traffic volume on I-5, 6% on I-205 and 5% on SR 14.

Delay along the I-5 corridor

2014 and 2016; Average daily vehicle hours of delay by milepost

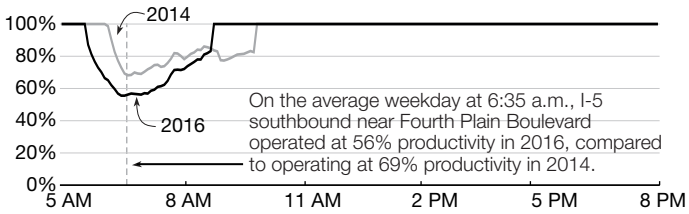


Data sources and analysis: National Performance Management Research Data Set and WSDOT Office of Strategic Assessment and Performance Analysis.

Highway productivity: As traffic increases and speeds drop below maximum throughput speed, congested roads carry fewer vehicles, resulting in a drop in throughput productivity. In order to gauge the lost productivity on I-5, I-205 and SR 14 in the Vancouver region, WSDOT analyzed vehicle throughput at three locations: near Fourth Plain Boulevard on I-5, near 10th Street on I-205, and near S Lieser Road on SR 14. In 2016, productivity at these locations ranged from 56% to 100%. Throughput productivity varies by direction of travel, location and time of day. For example, in 2016, on southbound I-5 near Fourth Plain Boulevard, nearly one-half of the corridor's capacity was unavailable due to congestion during part of the morning peak period. The graph below shows that productivity loss increased in intensity between 2014 and 2016. The graph also shows that the periods of productivity loss were longer in 2014 than in 2016.

Throughput productivity on southbound I-5 near Fourth Plain Boulevard

2014 and 2016; Based on the highest observed 5-minute flow rate; Southbound = 1,470 vehicles per hour per lane = 100%



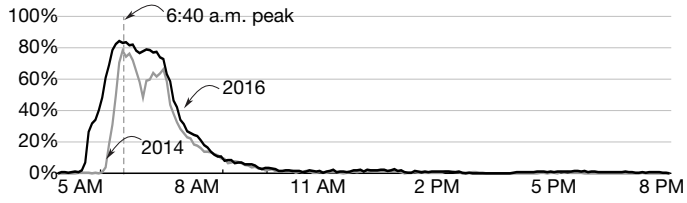
Data sources and analysis: WSDOT Southwest Region Planning Office and WSDOT Office of Strategic Assessment and Performance Analysis.

Routinely congested segments: Of the 64 miles on the I-5, I-205, and SR 14 corridors (both directions), the segments between SR 500 and the state line in the southbound direction experienced the most routine congestion, mostly during the morning commute. I-5 morning congestion often extends to 78th Street in Vancouver. Combined routine congestion on the I-5, I-205, and SR 14 corridors in the Vancouver area increased

I-5 morning commute into Oregon severely congested

from nearly three hours in 2014 to 11 hours in 2016. I-5 saw a 3% increase in daily congestion between 2014 (two hours and 50 minutes) and 2016 (two hours and 55 minutes). Additionally, there was six and a half hours of daily congestion on I-205 in 2016 and none in 2014. Similarly, on SR 14 the morning commute in the westbound direction saw daily congestion of one hour and 35 minutes in 2016, while that commute had no congestion at all in 2014. As shown in the maps on p. 50, significant congestion occurred in the Portland area on the I-5 and I-205 corridors heading into Washington during the evening commute. Refer to Appendix p. 49 for more details on Portland-area congestion.

Severe congestion on the I-5 Vancouver to Portland commute (I-205 interchange to I-5 bridge)
2014 and 2016; Southbound; Percent of days the average speed was slower than 36 mph



Data sources and analysis: National Performance Management Research Data Set and WSDOT Office of Strategic Assessment and Performance Analysis.

A focus on hot spots: Morning commuters driving on I-5 between the I-205 interchange and the I-5 bridge at the state line traveled in severely congested conditions (36 mph or less) slightly more often in 2016 than in 2014. For example, at 6:40 a.m. the southbound I-5 commute was severely congested on 88% of weekdays in 2016 compared to only 79% in 2014 (see graph above). Similarly, the southbound sub-commute on I-5 from SR 500 to the I-5 bridge experienced severe congestion on almost all weekdays in both 2014 and 2016 (see graph below). For example, at around 6:35 a.m. speeds were below 36 mph on 95% of weekdays in 2016 and on 97% of weekdays in 2014. Severe congestion on southbound I-5 during the morning commute lasted longer in 2016 than it did in 2014 (see graphs below left).

Severe congestion on the I-5 Vancouver to Portland commute (SR 500 to I-5 bridge)
2014 and 2016; Southbound; Percent of days the average speed was slower than 36 mph

Data sources and analysis: National Performance Management Research Data Set and WSDOT Office of Strategic Assessment and Performance Analysis.

What does severe congestion mean for travel times on the corridor?

General purpose lane trips: Between 2014 and 2016, average travel times for I-5 morning commutes in the Vancouver region increased by five minutes or less, while reliable travel times increased by as much as four minutes. Average and reliable travel times for the I-5 evening commute remained relatively steady between 2014 and 2016. On I-205 commutes average travel times increased by no more than four minutes, while the reliable travel time increased by up to ten minutes. Most of the I-205 travel time increases are for the morning commutes in the southbound direction heading into Portland. Westbound morning commute from Camas to I-5 interchange, average travel time improved by three minutes while the reliable travel time improved by two minutes. Other commute travel times on SR 14 saw moderate changes.

In 2016, 11 out of 12 Vancouver commutes on I-5, I-205, and SR 14 had a maximum throughput travel time index (MT3I) greater than one. The southbound I-5 morning commute from SR 500 to the I-5 bridge exhibited the highest MT3I (4.41), which means the trip took over four times longer than it would at maximum throughput speed. Peak period speeds on this commute were 14 mph on average. This two-mile segment of stop-and-go traffic up to the Washington state line is the state's most congested segment based on MT3I.

Transit ridership and GHG emissions avoided (excludes SR 14 commutes): On an average weekday in 2016, transit moved nearly 1,650 people on both the corridors during the morning and evening peak periods, a 19% decrease from 2014 (2,025 riders). This decrease may be due to dropping gas prices and better economic conditions (see pp. 9-10). Riding transit helps alleviate traffic congestion by making the most efficient use of available highway capacity. In 2016, peak period transit ridership on the I-5 and I-205 Vancouver region corridors was equal to 14% of a lane of capacity (when compared to the peak efficiency of the roadway, which is a conservative approach to this measurement).

Fisher's Landing P&R expands by 200 spaces in 2016

Approximately 43% of available transit seats on I-5 and I-205 commutes in the Vancouver region were occupied during the morning and evening peak periods (in the peak directions of travel) in 2016, a 12 percentage point reduction from 2014. Transit use during peak periods avoided approximately 2,500 pounds of greenhouse gas emissions per day on the I-5 and I-205 corridors in 2016, 28% less than in 2014 (3,450 pounds).

Park and ride: Along the I-5 corridor in the Vancouver region in 2016, park and ride (P&R) utilization rates ranged from 52% to 96%. The Andresen P&R had the highest average utilization rate (96%), due in part to the closure of the nearby Bonneville Power Administration P&R, which likely shifted users to the Andresen P&R. On I-205, the Evergreen Transit Center P&R had a utilization rate of 14% in 2016, and the Fisher's Landing Transit Center P&R had a utilization rate of 93%. Although parking capacity at Fisher's Landing increased by nearly 200 spaces during 2016, its 2016 utilization rate was calculated using the number of spaces that were available at the beginning of the year.

P&R locations are essential parts of the transit service network and need to consistently have enough available spaces for transit riders and carpoolers. To be considered effective, P&R lots must also have high utilization rates. Any P&R lot that has 85% or more utilization is identified as operating at capacity.

One of the primary focuses of C-TRAN, the Vancouver region's main transit provider, is improving ridership; C-TRAN uses strategies ranging from increased public outreach to changes in service routes. For example, "The Vine" is the C-Tran's first bus rapid transit system which uses larger buses, level boarding platforms and other features to reduce travel times, improve reliability and control costs. For more details, see www.thevine.c-tran.com. Targeted outreach efforts from transit agencies as well as employer initiatives to encourage participation in a Commute Trip Reduction program help address regional highway capacity issues.

How much is congestion costing you?

In 2016, drivers on the 7.5-mile southbound morning commute on I-5 from the I-205 split near the Clark County fairgrounds to the Columbia River experienced the region's highest costs due to congestion (measured in wasted time and gas for travel below maximum throughput speed)—about $725 per passenger vehicle annually. The return trip congestion is on the Oregon side of the river, and is not accounted for in this report's cost calculations.

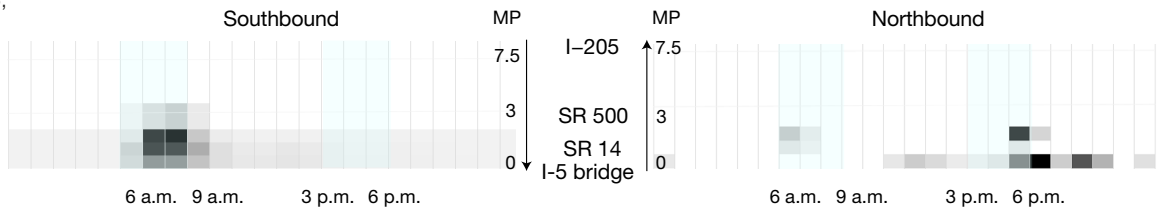
Additional congestion in the Vancouver region

Vancouver area commuters regularly experience delays on other major arterials including SR 500 and Padden Parkway. Because data collection infrastructure is not in place to reliably quantify this congestion, information for these corridors is not provided in this report. For additional information on Clark County traffic trends, refer to Southwest Washington Regional Transportation Council's 2016 Congestion Management Process Summary Report at http://rtc.wa.gov/reports/cmp/CMsum16.pdf.

I-5 delay between the I-5 bridge and the I-205 interchange

2016; Vehicle hours of delay; Weekdays only; By milepost (MP); Shading represents intensity of delay; Highlighted sections represent peak periods

In 2016 on northbound I-5, delay lasted from 2:30 to 7:30 p.m. around the I-5 bridge. On southbound I-5, morning delay extended from before State Route 500 to the I-5 bridge. Delay around the I-5 bridge lasted all day.

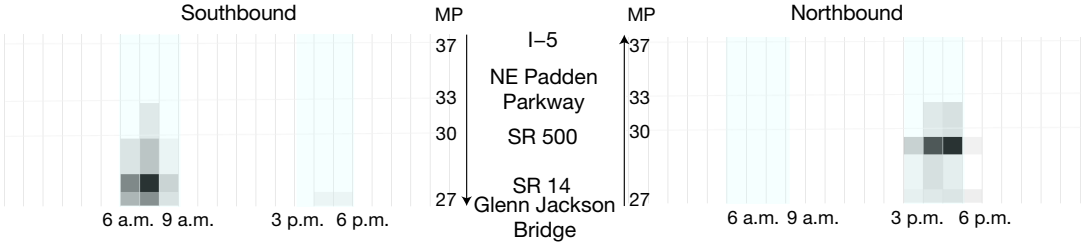


Data sources and analysis: National Performance Management Research Data Set and WSDOT Office of Strategic Assessment and Performance Analysis.

I-205 delay between Glenn Jackson Bridge and the I-5 interchange

2016; Vehicle hours of delay; Weekdays only; By milepost (MP); Shading represents intensity of delay; Highlighted sections represent peak periods

In 2016 on northbound I-205, delay occurred during the evening peak period, with pockets of delay from the Glenn Jackson Bridge to Northeast Padden Parkway. On I-205 southbound, delay lasted from 6-8:30 a.m., and extended from the I-5 interchange to the Glenn Jackson Bridge.



Data sources and analysis: National Performance Management Research Data Set and WSDOT Office of Strategic Assessment and Performance Analysis.

Tri-Cities US 395 Corridor Capacity Analysis

Annual person miles traveled

2014	vs.	2016
70.8		73.1

in millions of miles

3.3%

Annual vehicle delay[1,2,4]

2014	vs.	2016
0.8		1.6

in thousands of hours

100%

Annual GHG emissions

2014	vs.	2016
140.4		138.5

in millions of pounds of CO_2 equivalents

1.3%

Commute travel times

2014 and 2016 during the morning (6-8 a.m.) and evening (3-6 p.m.) peak periods; Weekday travel times in minutes during peak periods including average and reliable[3] travel times for general purpose (GP) trips.

Average GP Reliable GP

Kennewick to Pasco

Morning; 6-8 a.m.; Trip length 6.9 miles

GP
2014 12 14
2016 12 14

Pasco to Kennewick

Evening; 3-6 p.m.; Trip length 7.0 miles

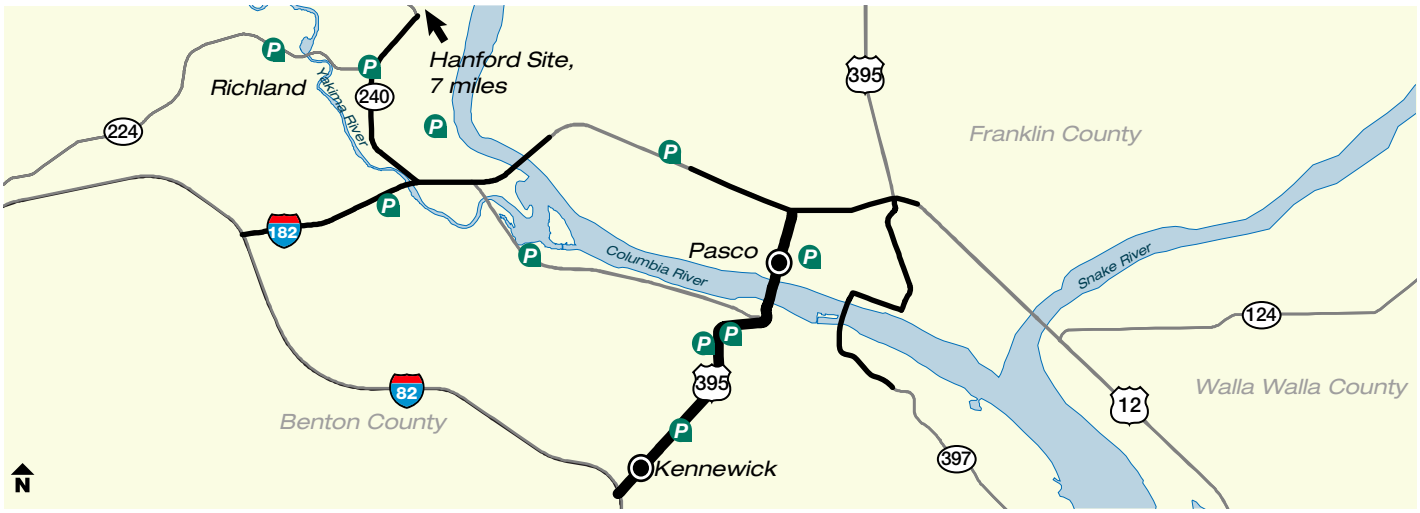
GP
2014 14 17
2016 14 18

Park and ride capacity

2016; Average percent occupied for select park and rides (see map for locations)

Kennewick-Pasco commute

Park and ride (spaces)	2014 percent occupied	2016 percent occupied
Union Street & 27th Avenue (50)	72%	45%
Ed Frost (Huntington) Transit Center (96)	41%	51%
U.S. 395 & Yelm Street (39)	47%	42%
Pasco - North 22nd Avenue Transit (50)	43%	12%



Data sources and analysis: WSDOT South Central Region Planning Office, National Performance Management Research Data Set, WSDOT Multimodal Planning Division and WSDOT Office of Strategic Assessment and Performance Analysis.

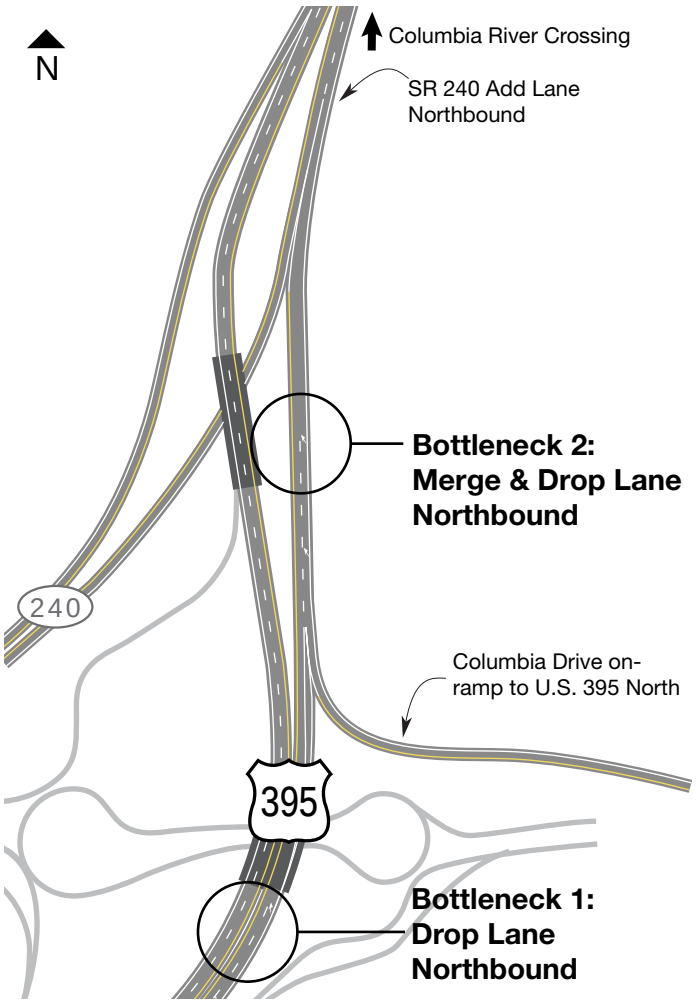
Notes: Measures at the top of the page are for the US 395 corridor in the Tri-Cities area for GP trips only. **1** WSDOT defines delay as when average speeds are lower than 85% of the posted speed limit. **2** Annual vehicle delay for the U.S. 395 arterial corridor is calculated for peak periods only. **3** Reliable travel time will get commuters to their destination on time 19 out of 20 weekdays (95% of the time). **4** New methodology is being used to calculate delay.

U.S. 395 is one of the key commute and economic corridors in the Tri-Cities region. Unlike other urban corridors discussed in the report, U.S. 395 is partly an arterial; it has a five-mile signalized section in Kennewick with eight traffic signals, a two-mile freeway segment mostly in Pasco and a small freeway segment in Kennewick. More than 73 million weekday person miles were traveled between Kennewick and Pasco in 2016, a 3.3% increase over 2014.

Travel delay at specific locations on the corridor worsened from 2014 to 2016, with morning and evening weekday commutes experiencing moderate congestion on a daily basis. Delay increased 100% on the corridor with signalized sections of the roadway contributing to the increase in 2016 compared to 2014. In addition to delaying commuters, this congestion directly impacts the movement of goods in Washington as trucks accounted for 11% of the total daily traffic volume on the corridor in 2016. There is some variability in the travel time data from year to year that WSDOT will continue to monitor.

A focus on hot spots: The U.S. 395/SR 240 interchange at the south end of the Columbia River Bridge is a key chokepoint where traffic volumes peak. There are two bottlenecks created by a complicated series of merges, weaves and lane reductions (see graphic on p.54). In the northbound direction, two lanes of traffic are restricted to one lane (bottleneck 1), followed by traffic merging from the Columbia Drive on-ramp into one lane (bottleneck 2). Shortly after, traffic merges from the SR 240 on-ramp.

Travel times fairly consistent in the Tri-Cities region



These capacity issues cause significant congestion as the corridor crosses the Columbia River. The U.S. 395 Columbia River crossing and the I-182 crossing had similar traffic volumes in 2016, averaging 64,000 vehicles per day. Comparatively, the I-182 river crossing did not experience as much delay due to the lack of bottlenecks and complicated traffic patterns in close proximity to the bridge.

Routinely congested segments: Routinely congested intersections on the arterial section include Yelm Street, Clearwater Avenue, Kennewick Avenue, and 10th Avenue. In the freeway section of the corridor in Pasco, the Lewis Street Interchange at the north end of the Columbia River Bridge and the I-182 Interchange at the north end of the corridor experience regular congestion. Specific data for these routinely congested locations were not available. More detailed data are expected to be available in the future from the National Performance Management Research Data Set (NPMRDS) provided by the Federal Highway Administration (FHWA).

What does congestion mean for travel times on the corridor?

The average travel times for the U.S. 395 morning commute from Kennewick to Pasco remained steady at just under 12 minutes, and reliable travel times remained steady at approximately 14 minutes from 2014 to 2016. The peak direction evening commute from Pasco to Kennewick remained the same from 2014 to 2016, and reliable travel times worsened by one minute (7.5%) between the same years.

Park and ride: In 2016, park and ride (P&R) utilization rates ranged from 12% to 51% along the U.S. 395 corridor. Three of the four P&R lots saw lower utilization rates in 2016 than in 2014, and the overall utilization rate went down more than 16% over the same period. The largest P&R on the corridor—Ed Frost (Huntington) Transit Center—had a drop in the average number of spaces used, but the utilization rate rose because the total number of spaces available decreased. P&R locations are essential parts of the transit service network and need to consistently have enough available spaces for transit riders and carpoolers.

Transit measures will be discussed in future Tri-Cities region analyses depending on data availability.

Future corridor analysis for I-182 and SR 397

In addition to U.S. 395 and SR 240, I-182 and SR 397 are important commute and freight corridors in the Tri-Cities area. I-182 has two known congested segments. One is in Richland from Queensgate Drive to George Washington Way. In 2016, 28.5 million weekday person miles traveled on this segment, an increase of 13.3% over 2014. The other segment is in Pasco from U.S. 395/20th Avenue to SR 397. In 2016, 46.6 million weekday person miles traveled on it, an increase of 13.2% over 2014. When data become available, the congestion level on I-182 will be analyzed. Traffic data are collected on I-182, but not in the congested locations. WSDOT is looking at ways to acquire traffic data for these I-182 segments.

SR 397 provides access to the Port of Pasco and is an important freight route. It also serves as a secondary Columbia River crossing. SR 397 traffic data were only available for 2016. There were 18.8 million weekday person miles traveled on the corridor in 2016, an increase of 3.9% from 2014. The delay shows only modest congestion levels through the corridor.

Tri-Cities SR 240 Corridor Capacity Analysis

Annual person miles traveled

2014	vs.	2016	
45.7		47.9	4.8%
in millions of miles			

Annual vehicle delay[1,2]

2014	vs.	2016	
N/A		140.7	N/A[4]
thousands of hours			

Annual GHG emissions

2014	vs.	2016	
N/A		60.7	N/A[4]
in millions of pounds of CO_2 equivalents			

Commute travel times

2014 and 2016 during the morning (6-8 a.m.) and evening (3-6 p.m.) peak periods; Weekday travel times in minutes during peak periods including average and reliable[3] travel times for general purpose (GP) trips.

Average GP Reliable GP

I-182 to Stevens Drive

Morning; 6-8 a.m.; Trip length 4.24 miles

Stevens Drive to I-182

Evening; 3-6 p.m.; Trip length 4.24 miles

Park and ride capacity

2016; Average percent occupied for select park and rides

Stevens Drive - I-182 commute

Park and ride (spaces)	2014 percent occupied	2016 percent occupied
SR 240 & SR 224 (89-2014, 80-2016)	51%	26%
SR 224 - Flattop Park (154)	44%	44%
Stevens Drive & Spengler Rd (686)	14%	14%
Columbia Park Trail & Tulip Ln (139)	3%	10%

Data sources and analysis: WSDOT South Central Region Planning Office, National Performance Management Research Data Set, WSDOT Multimodal Planning Division and WSDOT Office of Strategic Assessment and Performance Analysis.

Notes: Measures at the top of the page are for the SR 240 corridor in the Tri-Cities area for GP trips only. **1** WSDOT defines delay as when average speeds are slower than 85% of the posted speed limit. **2** Annual vehicle delay for SR 240 arterial corridor is calculated for peak periods only. **3** Reliable travel time will get commuters to their destiniation on time 19 out of 20 weekdays (95% of the time). **4** Detailed traffic data were not available for 2014. More complete analysis can be conducted in future reports now that historical data exist.

SR 240 is an important commute and freight corridor in Richland connecting the Tri-Cities to the U.S. Department of Energy Hanford Site to the north. The segment of SR 240 known as the Bypass Highway extends from Stevens Drive/Jadwin Avenue to the I-182 interchange. The Bypass Highway experiences frequent and persistent delay during commute peak periods. The commute to the Hanford Site experiences a significant amount of delay, which is reflected in longer evening peak period travel times. In 2016, there were 47.9 million weekday person miles traveled on the corridor, a 4.8% increase over 2014. Detailed traffic data were not available for 2014 to compute other metrics. However, more complete congestion analysis can be conducted in future reports, once that historical data becomes available.

The morning and evening weekday commutes experienced congestion on a daily basis. In addition to delaying commuters, this congestion negatively impacts the movement of goods as trucks accounted for 7% of the total daily traffic volume on the corridor in 2016.

The City of Richland is constructing a bridge across the Yakima River to connect two segments of Duportail Street. The new crossing could degrade travel on SR 240, but will improve travel on I-182. The bridge is expected to open in 2020.

A focus on hot spots: Traffic volumes on the Bypass Highway peak at the Aaron Drive/westbound I-182 on-ramp intersection. Delay at the Aaron Drive/ westbound I-182 on-ramp intersection can create queues that extend past intersections upstream. The SR 224/Van Giesen Street intersection is another hot spot with the junction of two state highways. The intersection experiences significant delay.

Routinely congested segments: The entire SR 240 corridor is routinely congested. The Aaron Drive/ westbound I-182 on-ramp, the SR 224/Van Giesen Street intersection, the Swift Boulevard and Stevens Drive/ Jadwin Avenue intersections experience congestion daily. With the NPMRDS dataset provided by the FHWA, more detailed data might be available in the future.

What does congestion mean for travel times along the corridor?

The average travel times for the SR 240 morning commute from I-182 to Stevens Drive were around seven minutes while reliable travel times were approximately nine minutes in 2016. The afternoon commute from Stevens Drive to I-182 averaged about 11 minutes, and reliable travel times were approximately 22 minutes in 2016. Travel time data for 2014 were not available.

Park and ride: In 2016, park and ride (P&R) utilization rates in vicinity of SR 240 Bypass Highway ranged from 10% to 44%, down over 6% from 2014. The only lot with increased usage—at Columbia Park Trail and Tulip Lane—was recently paved. The number of spaces at the SR 240/SR 224 lot declined between 2014 and 2016, as did usage. The availability of P&R spaces within the transit service network provides essential access points to transit riders, vanpools, and carpools.

Washington State Ferries Corridor Capacity Analysis

Annual ridership[1]

2014 vs. 2016: 23.19 vs. 24.20 (▲ 4%)

in millions of passengers

Annual trip reliability[2]

2014 vs. 2016: 99.4% vs. 99.5% (▲ 0.1%)

of scheduled trips sailed

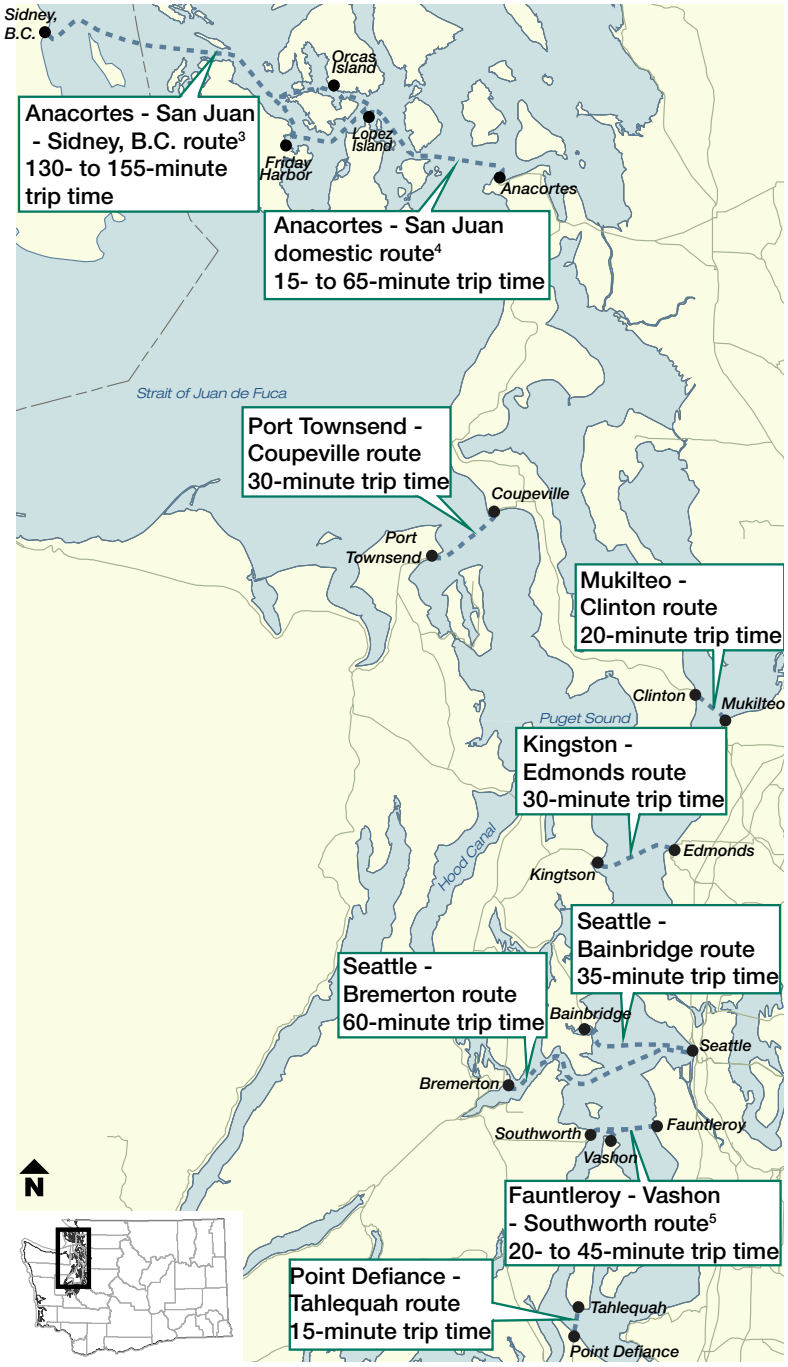
Annual fuel usage & use per service mile

2014 vs. 2016: 17.26 vs. 18.43 (▲ 6.7%)

in millions of gallons

2014 vs. 2016: 19.00 vs. 20.24 (▲ 6.5%)

in gallons per mile



Ferry capacity utilization

2014 and 2016; Vehicle utilization (driver + passenger utilization)

Ferry Route	2014	2016	Change (Δ)
Anacortes - San Juan domestic	56% (12%)	56% (11%)	0% (-1%)
Anacortes - San Juan - Sidney, B.C.	55% (18%)	52% (18%)	-3% (0%)
Edmonds - Kingston	66% (11%)	67% (11%)	1% (0%)
Fauntleroy - Vashon - Southworth	60% (9%)	55% (9%)	-5% (0%)
Mukilteo - Clinton	66% (12%)	67% (12%)	1% (0%)
Point Defiance - Tahlequah	50% (7%)	55% (8%)	5% (1%)
Port Townsend - Coupeville	66% (11%)	76% (13%)	10% (2%)
Seattle - Bainbridge	61% (15%)	60% (16%)	-1% (1%)
Seattle - Bremerton	45% (15%)	44% (14%)	-1% (-1%)
System-wide	**61% (12%)**	**60% (12%)**	**-1% (0%)**

Notes: Utilization data is based on the cumulative capacity (in terms of the number of vehicle spaces and room for passengers) on all vessels serving that route, and is measured for all sailings in a calendar year. Utilization for the San Juan domestic route is measured at Anacortes, and for the Fauntleroy - Vashon - Southworth "triangle route" at Fauntleroy. See Appendix p.50 for number of trips data.

On-time performance by route

2014 and 2016; Annual percent of trips that departed on time

Ferry Route	2014	2016	Change (Δ)
Anacortes - San Juan domestic	90.3%	89.4%	-0.9%
Anacortes - San Juan - Sidney, B.C.	90.1%	90.9%	+0.8%
Edmonds - Kingston	98.6%	97.5%	-1.1%
Fauntleroy - Vashon - Southworth	92.3%	91.5%	-0.8%
Mukilteo - Clinton	97.5%	96.1%	-1.4%
Point Defiance - Tahlequah	99.6%	98.9%	-0.7%
Port Townsend - Coupeville	95.3%	94.9%	-0.4%
Seattle - Bainbridge	94.2%	92.9%	-1.3%
Seattle - Bremerton	98.1%	97.9%	-0.2%
System-wide	**94.8%**	**93.9%**	**-0.9%**

Notes: A vessel is considered on time if it departs within 10 minutes of its scheduled departure. WSDOT's annual goal is for 95% of trips to depart on time.

Ridership by route

2014 and 2016; Annual ridership in thousands

Ferry Route	2014	2016	%Change (Δ)
Anacortes - San Juan domestic	1,911	2,009	5%
Anacortes - San Juan - Sidney, B.C.	140	146	4%
Edmonds - Kingston	4,003	4,114	3%
Fauntleroy - Vashon - Southworth	2,919	3,060	5%
Mukilteo - Clinton	3,950	4,074	3%
Point Defiance - Tahlequah	705	813	15%
Port Townsend - Coupeville	723	819	13%
Seattle - Bainbridge	6,321	6,430	2%
Seattle - Bremerton	2,523	2,740	9%
System-wide	**23,194**	**24,205**	**4%**

See Appendix p. 50 for more information

Data source and analysis: WSDOT Ferries Division.

Notes: **1** Passenger ridership includes vehicle drivers and passengers, as well as walk-on passengers and bicyclists. **2** Trip reliability is the ratio of actual sailings compared to the number of scheduled sailings. **3** The international route takes 130 minutes non-stop between Anacortes and Sidney, B.C., and 155 minutes if the trip stops at Friday Harbor. **4** Data for the San Juan inter-island route is combined with the San Juan domestic route. The 65-minute trip time is specifically for Anacortes to Friday Harbor with no stops, and the inter-island trips have shorter trip times. **5** Some trips are direct between two locations (with shorter trip times) and others serve all three locations.

Ferries ridership over 24 million with 99.5% reliability

Annual ridership on Washington State Ferries increased 4% from 2014 to 2016, with approximately 691,000 more passengers and 320,000 more vehicles traveling by ferry. Annual trip reliability increased slightly over the same period, going from 99.4% to 99.5% of scheduled sailings completed and continuing to meet the system-wide goal of at least 99% reliability. Between 2014 and 2016, total ferry vessel fuel use increased 6.3%, and fuel use per mile increased 6.5%. This increase is largely attributable to the addition of new, larger vessels to the fleet. Fuel use per mile is influenced by route characteristics as well as type and size of vessel; total fuel use is also affected by the number of sailings.

WSDOT's ferry service routes function as marine highway corridors in Washington state. They are integral links across the Puget Sound, connecting island and peninsula communities with the major employment centers in addition to facilitating leisure trips.

Ferry route analysis:

Ridership by route: Ridership changes ranged from 1.7% to 15.3% between 2014 and 2016. The largest ridership increase (15.3%) was on the Point Defiance – Tahlequah route, which experienced increases in frequent-user passes and truck traffic associated with construction projects on Vashon Island, with additional increases occurring in the discounted fares category.

Ferry route capacity: WSDOT owns and operates 23 ferry vessels—the newest in the fleet, Motor/Vessel *Samish*, was launched in June 2015. These vessels serve nine routes with stops at 19 ferry terminals in Washington and one stop in Sidney, British Columbia. Seven of the nine ferry routes are served by multiple vessels operating simultaneously in order to keep terminal wait times low. Route capacity is defined as the cumulative passenger and vehicle capacities for all sailings of each vessel serving a particular route, and may fluctuate depending on vessel size or crew availability for each trip. Read more in the 2014 *Corridor Capacity Report* (p. 42).

Capacity utilization: In 2016, the utilization of vehicle spaces on all ferry trips averaged 60%, one percentage point lower than in 2014. Vehicle space utilization on individual ferry routes ranged between 44% (Seattle – Bremerton) and 76% (Port Townsend – Coupeville) in 2016. The Port Townsend – Coupeville route saw the greatest increase in vehicle utilization, with a 10 percentage point change to 76% in 2016, which can be attributed to higher use by commercial trucks.

Ferry route utilization based on ridership and vessel capacity reflects utilization for all sailings over the entire day, not for peak periods as used to track capacity for most other transportation modes. Because ferry vessels can carry many more passengers than vehicles, the passenger utilization rates are lower, ranging from 8% (Point Defiance – Tahlequah) to 18% (between Canada and the U.S.) of the available capacity in 2016.

Passenger capacity utilization on ferries, which includes drivers of the onboard vehicles, fluctuated for different routes between 2014 and 2016 but did not significantly increase system-wide. The highest route increase—two percentage points—was observed on the Port Townsend – Coupeville route. Simultaneously, vehicle capacity utilization and ridership increased on this route. The Anacortes – San Juan Domestic and the Seattle – Bremerton routes both experienced slight declines (drops of less than 1%) in passenger capacity utilization.

On-time performance: There were more than 162,300 sailings in 2016, an average of 439 sailings every day of the year (see Appendix p. 50). In 2016, 93.9% of sailings departed within 10 minutes of their scheduled departure time, which is slightly below WSDOT's annual system wide goal of 95%. On-time performance improved on only one route—Anacortes – San Juan – Sidney, B.C., which improved by 0.8%—from 2014 to 2016. The other eight routes all saw declines of between 0.2% and 1.4% over that period, leading to a system-wide drop in on-time performance of 0.9%.

System-wide declines in on-time performance are mostly due to increased ridership, which increases the time vessels need to be at the dock for loading and unloading. Unplanned maintenance requiring less-than-ideal vessel assignments also negatively impacted on-time performance in 2016.

Trip reliability: Seven of the nine routes met the annual system-wide goal of completing at least 99% of scheduled sailings in 2016. System-wide, Ferries made 99.5% of its 163,224 scheduled trips in 2016, and had 897 net missed trips. The Port Townsend – Coupeville route (96.4%) and the Point Defiance – Tahlequah (98.0%) routes did not meet the annual goal in 2016. Reliability changed less than one percentage point from 2014 on all routes with the exception of the Anacortes – San Juan – Sidney, B.C. route, which improved from 98.2% in 2014 to 100% in 2016.

Amtrak CASCADES®

Corridor Capacity Analysis

Passenger miles traveled

2014 111.7 vs. 2016 117.1 (in millions of miles) — ▲ 4.8%

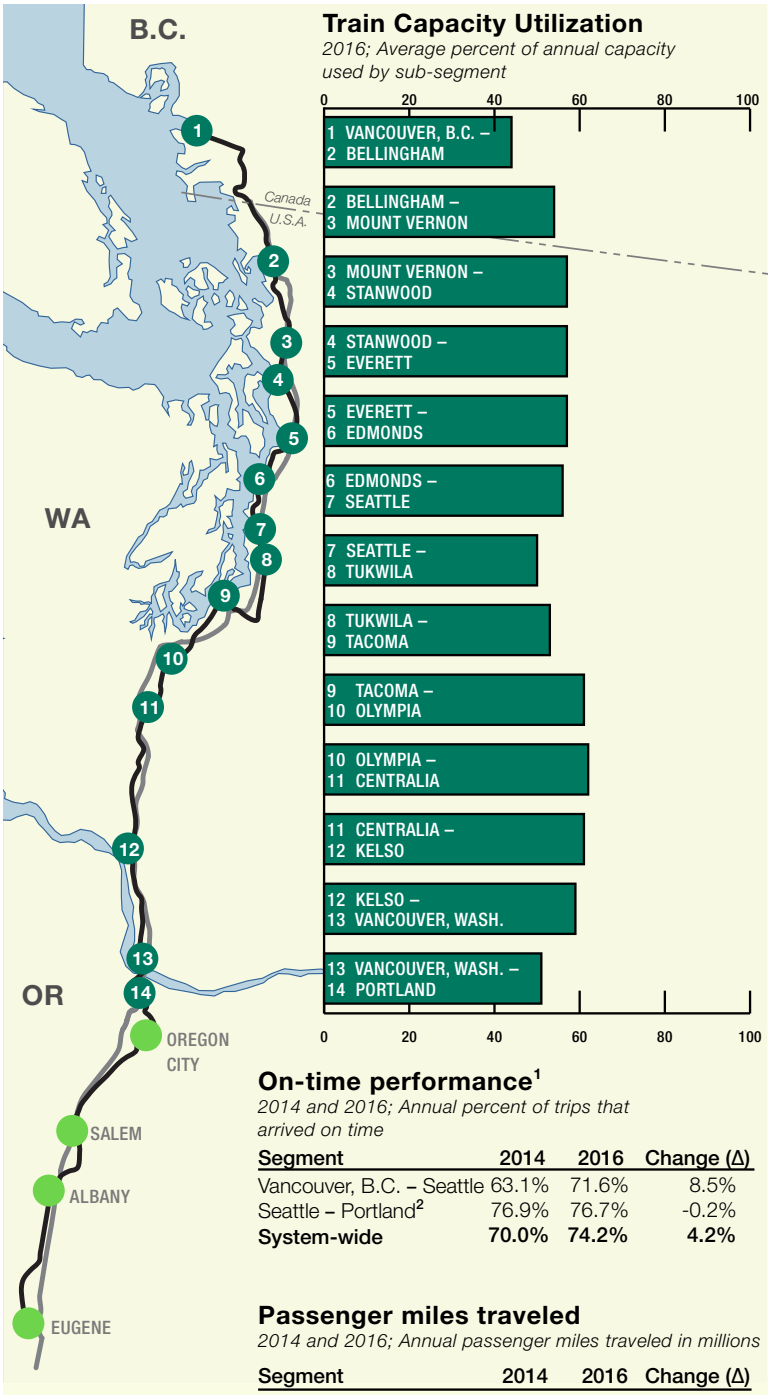
Annual on-time performance[1]

2014 70.0% vs. 2016 74.2% (of scheduled trips) — ▲ 4.2%

Annual capacity utilization + annual ridership

2014 60.4% vs. 2016 61.8% (for the peak sub-segment) — ▲ 1.4%

2014 700 vs. 2016 735 (in thousands of passengers) — ▲ 5.0%



Train Capacity Utilization

2016; Average percent of annual capacity used by sub-segment

On-time performance[1]

2014 and 2016; Annual percent of trips that arrived on time

Segment	2014	2016	Change (Δ)
Vancouver, B.C. – Seattle	63.1%	71.6%	8.5%
Seattle – Portland[2]	76.9%	76.7%	-0.2%
System-wide	**70.0%**	**74.2%**	**4.2%**

Passenger miles traveled

2014 and 2016; Annual passenger miles traveled in millions

Segment	2014	2016	Change (Δ)
Vancouver, B.C. – Seattle	27.6	30.5	10.5%
Seattle – Portland	84.1	86.6	3.0%
System-wide	**111.7**	**117.1**	**4.8%**

As population and economic activity grow and congestion worsens along the I-5 corridor, the importance of providing travel options that reduce reliance on singel occupant vehicles increases. Amtrak Cascades provides five daily intercity rail round trips for various segments of the Vancouver, British Columbia, to Eugene, Oregon, corridor, supporting the state's long-term goal of providing a sustainable multimodal transportation system and increasing person throughput. Beginning December 18, 2017, Amtrak Cascades will add two additional daily round trips between Seattle and Portland.

Passenger miles traveled: In 2016, Amtrak Cascades passengers rode 117.1 million passenger miles in Washington, an increase of 4.8% from 2014. Ridership increased by 5.0% over the same period, likely due to an enhanced marketing campaign and incentives created by the weakened Candadian dollar.

Fuel efficiency: In 2016, Washington trains used an estimated 1.2 gallons of fuel per mile traveled, resulting in an average of 126 passenger miles traveled per gallon of fuel used.

Capacity utilization: Riders utilized 61.8% of Amtrak Cascades train capacity in Washington on average in 2016 for the peak sub-segment (Olympia – Centralia), increasing from 60.4% in 2014. Utilization rates for the peak sub-segment can limit available capacity for the entire corridor. For example, if the Olympia – Centralia sub-segment was sold out, someone in Seattle could not buy a ticket to Portland. Average train capacity utilization fluctuates throughout the year, with trains selling out during weekends, holidays and the summer.

On-time performance: Trains in Washington achieved 74.2% on-time performance in 2016, up approximately 4.2 percentage points from 2014. The Seattle to Portland segment had the highest on-time performance, at 76.7%. The on-time performance goal is 80%, but inter-train congestion consistently causes corridor delays.

Data source and analysis: WSDOT Rail, Freight and Ports Division.

Notes: All "Washington" data is for trains between Portland, Oregon, and Vancouver, B.C. regardless of funding entity. See bit.ly/RailPerformance for more information. **1** A train is considered on time if it is within 10 minutes of scheduled arrival times for trains operating the Vancouver, B.C. – Seattle and Seattle – Portland segments; or 15 minutes of scheduled arrival times for trains operating the entire Vancouver, B.C. – Portland segment. **2** On-time performance for the Seattle-Portland segment for 2014 has been updated since 2015 *Corridor Capacity Report*.

WSDOT teams keep traffic moving at 58,235 incidents

Incident Response (IR), WSDOT's traffic incident management program, responded to 58,235 incidents in 2016, clearing scenes to keep traffic moving in an average of 12 minutes and 3 seconds from incident notification. WSDOT's assistance resulted in approximately $87.8 million in estimated economic benefit to travelers and businesses in Washington by reducing congestion caused by traffic incidents and helping prevent secondary incidents. WSDOT's annual IR budget was $6 million in 2016, meaning WSDOT provided an estimated $14.63 benefit for every dollar spent on traffic incident management.

Incident clearance times improve slightly in 2016

WSDOT's IR teams cleared incidents in an average of 12 minutes and 3 seconds in 2016. This was about nine seconds faster than 2014. The IR program's average incident clearance time has hovered between 12 and 13 minutes from 2012 through 2016. In general, faster clearance times mean less incident-induced congestion and fewer secondary incidents.

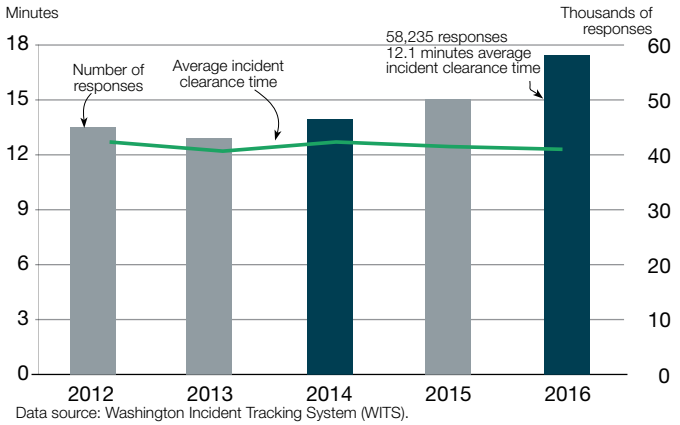
Traffic incident management is a key strategy for maximizing highway system performance

Traffic incidents such as collisions are responsible for nearly half of non-recurrent congestion (traffic congestion caused by one-time events). Non-recurrent congestion can also be caused by severe weather or large events. These events temporarily reduce the transportation system's ability to move people and goods. Traffic incident management is nationally recognized as a best practice for reducing or preventing non-recurrent congestion.

The WSDOT Incident Response program's mission is to clear traffic incidents safely and quickly, minimizing congestion and the risk of secondary collisions. The program is active in all six WSDOT regions with roughly 59 full-time equivalent positions and 69 dedicated vehicles. Teams patrol 1,300 centerline miles of state highway on major corridors during peak traffic hours and assist the Washington State Patrol in traffic emergencies at all hours.

Incident clearance times remain below 13 minutes, while responses increase by 25.4%

2012 through 2016; Clearance time in minutes; Number of incident responses in thousands



Data source: Washington Incident Tracking System (WITS).

Note: Data is only for incidents to which a WSDOT Incident Response team responded.

WSDOT prevents $87.8 million in delay and secondary collisions

WSDOT estimates that IR crews' proactive management of incident scenes provided an economic benefit of $87.8 million to travelers and businesses using Washington highways in 2016. These benefits are provided in two ways. First, by clearing incidents as quickly as possible, WSDOT crews reduce the time and fuel motorists wasted in incident-induced congestion. In 2016, WSDOT estimates that IR crews prevented about $49.5 million in incident-related congestion costs. Second, by proactively managing traffic at incident scenes, IR crews reduce the risk of secondary incidents caused by distracted driving or sudden changes in traffic conditions. WSDOT crews prevented an estimated 11,091 secondary incidents in 2016, resulting in $38.2 million of economic benefit. See WSDOT's *Handbook for Corridor Capacity Evaluation* pp. 45-47 for delay reduction benefit calculations as well as all other IR related metrics.

An Incident Response team responding to an incident.

WSDOT teams provide $87.8 million in benefit in 2016

WSDOT teams' performance at incidents in 2016 prevents $87.8 million in incident-related costs
2016; Incidents by duration; Time in minutes; Cost and economic benefit in dollars

		Blocking[1] incidents		All incidents	Economic impacts	
Incident duration	**Number of incidents[2]**	**Percent blocking**	**Average roadway clearance time**	**Average incident clearance time**	**Cost of incident-induced delay**	**Economic benefits[3] from IR program**
Less than 15 min.	45,189	15.0%	4.6	4.9	$55,419,624	$25,849,632
Between 15 and 90 min.	12,419	53.9%	25.2	30.0	$105,910,259	$46,442,939
Over 90 min.	627	88.2%	166.1	174.9	$36,784,164	$15,460,127
Total	**58,235**	**24.0%**	**21.0**	**12.1**	**$198,114,047**	**$87,752,698**
Percent change from 2014	**↑ 25.4%**	**↑ 1.1%**	**↓ -1.0%**	**↓ -1.2%**	**↑ 19.1%**	**↑ 18.4%**

Data sources: Washington Incident Tracking System, Washington State Patrol, WSDOT Traffic Office, and Washington State Transportation Center.
Notes: **1** An incident is defined as blocking when it closes down at least one lane of travel on the road. **2** WSDOT teams were unable to locate (UTL) 2,779 of the 58,235 incidents. UTL incidents are included in the total number of incidents but not figured into other performance measures. **3** Economic benefits include the sum of benefits from saved time, gas and secondary incidents avoided due to IR teams' proactive work. Numbers may not add due to rounding.

Incidents led to nearly $198 million in congestion-related costs

Traffic delay at the 58,235 incidents that WSDOT teams responded to in 2016 cost travelers on Washington highways an estimated $198.1 million. This is 19.1% more than the $166.3 million in costs that occurred in 2014. Without the work of WSDOT's IR crews, this cost would have been $285.9 million ($87.8 million in prevented delay and secondary collisions costs plus $198.1 million in actual delay costs).

Blocking incidents a quarter of all incidents, but over half of all delay

About 24.0% of the incidents that WSDOT's IR teams responded to in 2016 blocked at least one lane of traffic. These blocking incidents caused 60.4% of the incident-related congestion costs for the year.

Blocking incidents cause more congestion per minute than non-blocking incidents. Also, blocking incidents tend to last longer (compare the roadway clearance columns for blocking versus all incidents in the table above) as they are more complicated to clear.

Commercial vehicles involved in 6.8% of all incidents

Commercial vehicles, such as semi trucks, were involved in 3,764 incidents or about 6.8% of all incidents IR teams responded to in 2016 (not including unable to locate incidents; see notes in table above). On average these incidents took 18 minutes and 33 seconds to clear, about 6 minutes and 30 seconds longer than the overall average clearance time.

However, commercial vehicles were involved in a larger proportion of incidents lasting over 90 minutes, accounting for 28.0% of these incidents (175 out of 626). Furthermore, over-90-minute incidents involving a commercial vehicle took an average of 3 hours and 22 minutes to clear. This is roughly 27 minutes longer than all over-90-minute incidents including extraordinary incidents (those lasting longer than six hours).

Incidents involving commercial vehicles can be more complex to clear due to factors such as the size of the vehicle or any freight spilled due to the incident. These incidents can also require special towing equipment. Just like with other incidents, WSDOT's goal is quicker clearance times for less impact to the system.

Customer feedback: Incident Response program keeps traffic safe and moving

WSDOT drivers give comment cards to motorists who receive assistance. Below are some of the comments the program received in 2016.

- *Mark was so helpful. He was there before I could decide what steps to take for my flat tire accident.*
- *I was in the medical transport vehicle that broke down. I felt very unsafe sitting on a shoulder in a wheelchair. I felt safer when Glen pulled up behind us. He waited for us to be picked up. Thank you Glen.*

Corridor Capacity Report Credits

The *Corridor Capacity Report* is developed and produced by a small team of data scientists at the WSDOT Office of Strategic Assessment and Performance Analysis each year, with the help of dozens of individuals both at WSDOT and across the state's transportation community. WSDOT gratefully acknowledges their contributions.

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Behind the scenes of the *Corridor Capacity Report*

Beginning with the *2014 Corridor Capacity Report* WSDOT published detailed performance measure information as part of a data appendix along with a *Handbook for Corridor Capacity Evaluation*, which serves as a one-stop shop to help readers navigate the annual Corridor Capacity Report's multimodal analysis of transportation system performance. The handbook is a tool for technical professionals working to implement system performance measurement and reporting as part of their agency's accountability initiatives and/or the federal Moving Ahead for Progress in the 21st Century (MAP-21) requirements. WSDOT published a second edition of the document this year, which can be found at: www.wsdot.wa.gov/publications/fulltext/graynotebook/CCR_methodology_2nd_edition.pdf .

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WSDOT's 2017 *Corridor Capacity Report* is prepared by the
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