

Better Performance Measures are Needed for Decision-Making

Citizens, businesses and public officials in Washington want to know that the state is doing everything it can to alleviate congestion on freeways and highways.

Like many other state transportation agencies, the Washington State Department of Transportation (WSDOT) is faced with addressing public need while coping with stagnant or diminishing levels of funding. In response, WSDOT has developed three distinct strategies:

- Manage traffic breakdowns more aggressively and significantly expand incident response programs.
- Encourage more efficient travel behavior by providing system users with enhanced traffic information.
- Plan system investments with measurable benefits for congestion.

As transportation agencies further develop operations-based approaches to congestion management and carefully weigh system investments in operations as well as capital improvements, new types of performance information and communication are clearly needed. Traditional congestion measurements are based on modeled speed estimates generated from volume and capacity information. They are difficult to communicate, fail to capture subtle changes in real-world system performance, and are inadequate for evaluating impacts on congestion patterns and conditions from specific operational or capital investments.

In May 2002, WSDOT decided to take performance measurement for congestion – how the highways are doing and how WSDOT is doing – in a new direction, and implemented specific congestion measurement principles (see the box, top right). WSDOT seeks congestion measures that can communicate with the public as well as assist the department in developing capital and operational strategies that address congestion. Its congestion measurements track the effectiveness of con-

WSDOT's Congestion Measurement Principles:

- Use real time measurements (rather than computer models) whenever possible.
- Measure congestion due to incidents as distinct from congestion due to inadequate capacity.
- Show whether reducing congestion from incidents will improve the travel time reliability.
- Demonstrate both long-term trends and short-to-intermediate term results.
- Communicate about possible congestion fixes using an “apples-to-apples” comparison with the current situation (for example, if the trip takes 20 minutes today, how many minutes shorter will it be if we improve the interchange?)
- Use plain English to describe measurements.

From the Gray Notebook for the quarter ending March 31, 2002, available at www.wsdot.wa.gov/accountability/archives/GrayNotebookMar-02.pdf#page=6

gestion relief investments, with a focus on measuring travel time, distinguishing between congestion caused by incidents (“non-recurrent” congestion) and congestion caused by inadequate capacity (“recurrent” congestion), and measuring travel time reliability.



Incident-caused congestion; Southbound Interstate 5 in Seattle (WSDOT Incident Response truck working at the scene).

Congestion measurement focus:

- Real-Time Travel Times
- Recurrent and Non-Recurrent Congestion
- Travel Time Reliability



Non-incident-related congestion; Northbound Interstate 405 near Seattle.

Measures Your Neighbor Can Understand: Travel Times

In May of 2002, as a first step, WSDOT launched a web site-based travel time report (www.wsdot.wa.gov/pugetsoundtraffic/traveltimes). These active, real travel times are updated every 5 minutes to provide the public up-to-the-minute information for 11 of the most congested corridors in the Puget Sound region. Another route was added in 2003 for a total of 12.

The collection and analysis of real-time travel time information was the critical element in WSDOT's congestion measurement development. It was also important to develop measurements that were easy to communicate to the public. System performance information in terms of travel times (time to travel from Point A to Point B) is a tool the public and every traveler can relate to and understand.

The popular service is now widely used by commuters, either directly from WSDOT's web sites or indirectly through media that link to WSDOT's information. WSDOT's Travel Times web site had 254,676 page views in June 2003. Television and radio stations use the information daily in their own traffic reports — television news programs scroll the travel times along the bottom of the screen. Newspaper, radio, and television web sites publish the information as well, taking a live feed direct from WSDOT's servers.

Distinguishing Between Recurrent and Non-Recurrent Congestion

The ability to identify and measure different types of congestion is key to developing appropriate responses. WSDOT's immediate need to measure the effectiveness of its newly expanded incident response program led to an effort to develop distinct measures of incident-related (non-recurring) and non-incident-related (recurring) congestion.

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Two Times Free Flow: A Temporary Approach

The lack of incident data sets that could be correlated with the archived travel time data required an interim measurement solution. As a first step, WSDOT, in coordination with the University of Washington's Transportation Center (TRAC), developed baseline statistics for travel times on the 11 commute corridors described above for incident and non-incident conditions and analyzed travel time distributions for all monitored trips. Based on the examination of the real-time travel data for 2001 and sample incident data, the study recommended that, until complete incident data

The screenshot shows the 'COMMUTE AND TRAVEL' section of the WSDOT website. It displays a table titled 'Central Puget Sound Travel Times' with columns for 'State Route/Interstate', 'Route Description', 'Distance (miles)', 'Average Travel Time (minutes)', and 'Current Travel Time (minutes)'. The table lists 11 routes with their respective travel times and current status (e.g., '405' route from Tacoma to Everett shows a current travel time of 45 minutes).

State Route/Interstate	Route Description	Distance (miles)	Average Travel Time (minutes)	Current Travel Time (minutes)
405	Tacoma to Everett	29.2	37	45
5	Everett to Tacoma	29.6	29	26
5	Everett to Seattle	29.2	33	33
5	Via Southbound Express Lanes	N/A	N/A	N/A
5	Seattle to Everett	29.2	37	40
5	Via Northbound Express Lanes	29.2	33	35
5	SeaTac to Seattle	13.0	18	20
5	Seattle to SeaTac	13.0	20	15
405	Bellevue to Everett	9.7	12	11
405	Tacoma to Everett	9.7	17	26
405	Tacoma to Bellevue	13.6	19	16
405	Bellevue to Tacoma	13.6	24	29
167	Andover to Everett	9.8	12	12
167	Everett to Andover	9.8	23	22
5	Issaquah to Seattle	15.6	24	34
5	Seattle to Issaquah	15.7	21	25
5	Redmond to Seattle	14.8	29	41
5	Seattle to Redmond	14.7	26	31
480	Bellevue to Seattle	10.7	23	30
480	Via Westbound Express Lanes	N/A	N/A	N/A
480	Seattle to Bellevue	10.6	17	20

www.wsdot.wa.gov/pugetsoundtraffic/traveltimes

The average travel time is the average time for a trip starting at this time during the past few months, derived from WSDOT's archived loop detector data. The current travel time is refreshed at five-minute increments to reflect current conditions.

could be compiled and correlated, "incident-affected trips" could be defined as any trip that takes twice as long as a free-flow trip for that route. These trips have a Trip Time Factor of greater than 2.0 (Trip Time Factor = Actual Trip Time / Free Flow Trip Time).

Using this temporary approach, WSDOT examined archived data for 2001 and 2002 for the 11 routes and compared changes in travel

time performance for both recurrent and non-recurrent congestion (as defined by the two times free flow threshold) during peak times. More information is available at www.wsdot.wa.gov/accountability/peaktime.

Detailed Analysis

After development of the Washington Incident Tracking System (WITS), a database that logs every incident response, WSDOT and TRAC entered the second phase of development and correlated travel time data with actual incident data. The focus was to identify the causes of congestion on individual highway segments and during particular time periods. Data on incidents

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that resulted in congestion were drawn from the WITS database and the Transportation System Management Center (TSMC) incident log.

TRAC's 2003 study, "Measurement of Recurring Versus Non-Recurring Congestion," concludes that non-recurring delay generally ranges between 30 and 50 percent of all peak period delay and that lane blocking incidents generally account for 10 to 35 percent of all non-recurring delay. The study shows that the causes of congestion vary considerably from one location to another, and with respect to peak and off-peak periods. Correlating incidents with real travel time data also showed that some occurrences of extreme congestion were not related to recorded incidents, even though traffic flows behaved as if under incident conditions. Factors of non-recurring congestion include:

- Lane blocking accidents and disabled vehicles,
- Other lane blocking events, (e.g., debris)
- Construction lane closures,
- Significant roadside distractions that alter driver behavior (e.g., roadside construction, electronic signs, a fire beside the freeway),
- Inclement weather,
- Heavier than normal vehicle merging movements, and
- Significant increases in traffic volume in comparison to "normal" traffic volumes.

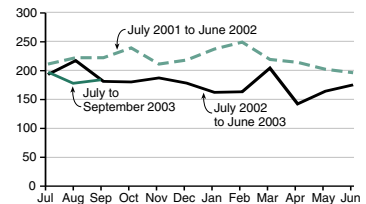
This congestion relationship and measurement is complex and requires further analysis. The effect of non-recurrent congestion on predictable, reliable highway travel is dramatic, and WSDOT continues to develop measurement tools for analyzing and communicating the reliability of highway corridors (see below).

Incident Response: Is It Worth It?

On February 13, 2002, WSDOT signed a Joint Operations Policy Statement (JOPS) with the Washington State Patrol (WSP) to integrate resources for responding to incidents and increasing security. JOPS established a target for WSDOT's Incident Response Team (IRT) that all incidents on highways be cleared within 90 minutes. The 2002 Washington Legislature funded an additional 19 incident response vehicles.



Average Clearance Time for Incidents Lasting Over 90 Minutes
3-Year Comparison: July 2001 to September 2003



Today, the IRT has 44 units that rove on 35 highway segments statewide during peak periods, with most of the units concentrated in the central Puget Sound region. Tracking changes in non-recurrent congestion and reliability will help the agency evaluate its investment in IRT.

WSDOT conducted a disabled vehicle case study on a section of I-405 where incident response vehicles were recently deployed in order to calculate the delay savings gained. Comparison with and without IR shows an average seven-minute reduction in clearance time.

Using a disabled vehicle incident that occurred on I-405 at milepost 13.5 (21.7 km), WSDOT calculated the savings to other motorists in fuel and other operating costs at \$5,800 per incident. Cost of time savings is even greater, at more than \$7,000 per incident. In order to calculate the savings, WSDOT applied volume information provided by loop detector data, and the volume of commercial truck traffic to other types of traffic, provided by HPMS data (for more information visit www.wsdot.wa.gov/accountability/GrayNotebookJun-03.pdf#page=48).

Measuring What Matters: Travel Time Reliability

Route	Route Description	Miles	Peak Time	Avg. Travel Time Without Incidents	Avg. Travel Time With Incidents	95% Reliable Travel Time
I-5	Everett to Seattle	23.7	7:25 am	37 minutes	56 minutes	62 minutes
I-405	Tukwila to Bellevue	13.5	7:40 am	22 minutes	34 minutes	43 minutes
SR 167	Renton to Auburn	8.8	4:25 pm	15 minutes	26 minutes	39 minutes

If a commuter begins the route at the Peak Time, she can expect to be on time for work 19 out of 20 working days a month (or 95% of trips), if she allows for the 95% Reliable Travel Time. From www.wsdot.wa.gov/accountability/archives/graynotebookJun-02.pdf#page=11

Travel time reliability and predictability is of utmost importance to the public. Variability in travel times leads to frustrating and costly uncertainty for commuters and haulers.

WSDOT uses archived loop data to calculate a reasonable approximation of the "worst case" travel time scenario using the travel time at the 95th percentile (95 percent of the travel times are equal to or less than this marker) for a particular route.

In June 2003 WSDOT launched a new web page called "Calculate Your Commute" that provides

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a 95 percent reliable travel time for web users at www.wsdot.wa.gov/pugetsoundtraffic/traveltimes/reliability. Travelers using the service can choose one of 12 Puget Sound commute routes, the direction of travel and the time they plan to leave in 5-minute intervals from 6 a.m. to 7 p.m. The 95 percent reliable times presented on the web page are based on archived weekday travel time data for 2002.

Where the Data Comes From

In the Puget Sound region, operational data are collected from more than 4,000 induction loops embedded in the pavement of the state highway system. These loops are arrayed to gather data for each lane at roughly 360 highway locations.

Loops provide two measurements: vehicle count and the length of time each vehicle occupies the loop. This data is then used to estimate traffic volumes and speeds. Speed estimation using single loops is accurate to 5 or 10 mph (8 to 16.1 kph) in free-flow steady speed conditions. WSDOT has also installed "speed stations" (double loops) at about 100 locations in the freeway system. These stations provide accuracy to within 1 or 2 mph (1.6 to 3.2 kph) at ordinary driving speeds.

Data from the loop detectors are relayed to a centralized Transportation System Management Center (TSMC), where they are automatically converted into a color-coded map depicting traffic flow, as shown below. This digital traffic flow map is updated approximately once per minute, twenty-four hours per day. The map can be accessed on the Internet at



www.wsdot.wa.gov/pugetsoundtraffic/cameras. In addition, the measurements from the speed stations and single loop detectors are used to adjust freeway ramp meter timing and inform traffic managers about conditions on the freeway system. Travel times are calculated using speed and volume data from multiple loops in a series along the freeway.

At any given time, approximately eight percent of freeway

loops are flagged as out of reliable operation. The University of Washington's Transportation Center (TRAC) developed detailed quality control procedures that WSDOT uses to detect loop failures, exclude bad data, and support the level of accuracy that is needed for traffic management and reporting traffic conditions to the public.

Next Steps

The use of loop technology presents limitations and challenges. As an aging technology, loop detectors may become less cost effective or less accurate than emerging technologies, such as automatic vehicle locators (AVL). The system also requires regular investments in maintenance and replacement, as well as detailed quality control procedures to detect loop failures and exclude bad data.

WSDOT is exploring other ways to gather travel time information in areas where it is not feasible to expand loop infrastructure. WSDOT has begun to use roadside speed cameras (machine vision) to estimate traffic speeds on state highways in Pierce County, south of Seattle. The data is processed in essentially the same way as loop data, and displayed in the same format on a digital flow map of highways in the Tacoma area (see the flow map at right).



Another ITS data project focuses on correlating weather elements and congestion data to predict weather-related congestion and incidents.

For Future Research

Practitioners would benefit from further research in the mining, application, and interpretation of ITS data. Suggested research topics include:

- Applying travel times and reliability measures to planning and decision making,
- Forecasting travel times, delay, and reliability,
- Developing travel time measures for highway segments without ITS data, and
- Cost-benefit analysis of operational and capital strategies that improve reliability and travel times.

WSDOT also publishes annual travel time comparisons as part of its widely distributed quarterly performance report *Measures, Markers and Mileposts*, also referred to as the *Gray Notebook*. A comprehensive web based archive and index of the *Gray Notebook* allows easy public access to all current and previously published congestion related performance measures (www.wsdot.wa.gov/accountability/graybookindex.htm). The *Gray Notebook* editions can be electronically accessed at www.wsdot.wa.gov/accountability.



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