Research Note

Incident Response Evaluation Phase III

From the WSDOT Research Office
February 2011

WSDOT responds to causes of congestion

National studies determined that congestion results from a combination of seven factors: incidents, inclement weather, work zones, special events, traffic control device timing, demand fluctuations, and inadequate base capacity. As part of its Moving Washington campaign, the Washington State Department of Transportation (WSDOT) is addressing these seven factors to cost-effectively reduce congestion on state highways. WSDOT is developing programs that, add capacity where it makes sense, detect and respond to incidents, respond to bad weather to quickly restore roadways to desired operating condition, manage work zones to limit impact on traffic flow, improve traffic control systems, and more effectively manage travel demand in coordination with local agencies.

Washington State
Department of Transportation

A better understanding was needed

To more effectively manage its limited resources, WSDOT requires a better understanding of the amount of congestion that each of these factors causes. In addition, it needs to understand the effectiveness of the programs it has developed to respond to congestion. By better understanding the amount of congestion caused by each factor, the effectiveness of its response actions, and the cost of those actions, the Department can manage its congestion fighting resources more effectively.

Relationship of incidents to delay

This project investigated the basic relationship of incidents to delay on Puget Sound area freeways. The intent was to determine both the amount of delay caused by incidents and the benefits obtained from WSDOT's incident response actions.

Researchers divided the regional roadway performance data into 42 roadway segments (21 segments with two directions). The performances of the HOV and reversible lanes were not analyzed. The study defined delay as any travel at less than the speed limit over the length of each study segment during each 5-minute time period of the year. Vehicle delay was computed by multiplying that time delay by the average volume in the segment during the time interval examined.

There was much the researchers learned

For the 2006 study year, a conservative estimate is that crashes and other traffic incidents (including disabled vehicles, debris, and other events requiring WSDOT intervention to remove hazards) caused 5,300,000 vehicle-hours of delay, in addition to typical congestion delay, on the Puget Sound region's freeway system[1].

That is roughly 30 percent of the total delay caused by all factors on these roadways. Approximately 11 percent of the total delay (1,950,000 vehicle-hours) was the result of reported vehicle crashes.

Incidents, including crashes, do not, in and of themselves, cause measureable delay. They cause delay only when the disruption they create causes functional capacity to fall below actual demand. Therefore, the impact of any given incident is not constant but is a function of where it occurs, when it occurs, and the traffic demand relative to functional roadway capacity at the time it occurs.

Consequently, no simple relationship defines the amount of delay caused by a generic "incident" or how much delay could be saved if that incident was shortened. The delay characteristics change with the details of each specific incident. However, for planning and programming purposes, it is important to understand how changing the length of a generic incident affects the total delay the public experiences. This project determined the following:

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

These statistics represent the added delay that would not have occurred if those incidents had not happened. They do not include the fact that incidents often shift delay from one portion of a corridor to another. That is, during peak periods that already experience some routine congestion, incidents not only add delay, they geographically shift where "normal delay" occurs. This causes some travelers who would not have been delayed had the incident not occurred to be delayed, while other travelers

[1] The study area included I-5 from SR 526 in the north to S. 320th in Federal Way in the south; all of I-90 west of milepost 19.5, which is east of Front Street in Issaquah; all of I-405; SR 167 from I-405 to SR 18; and all of SR 520.

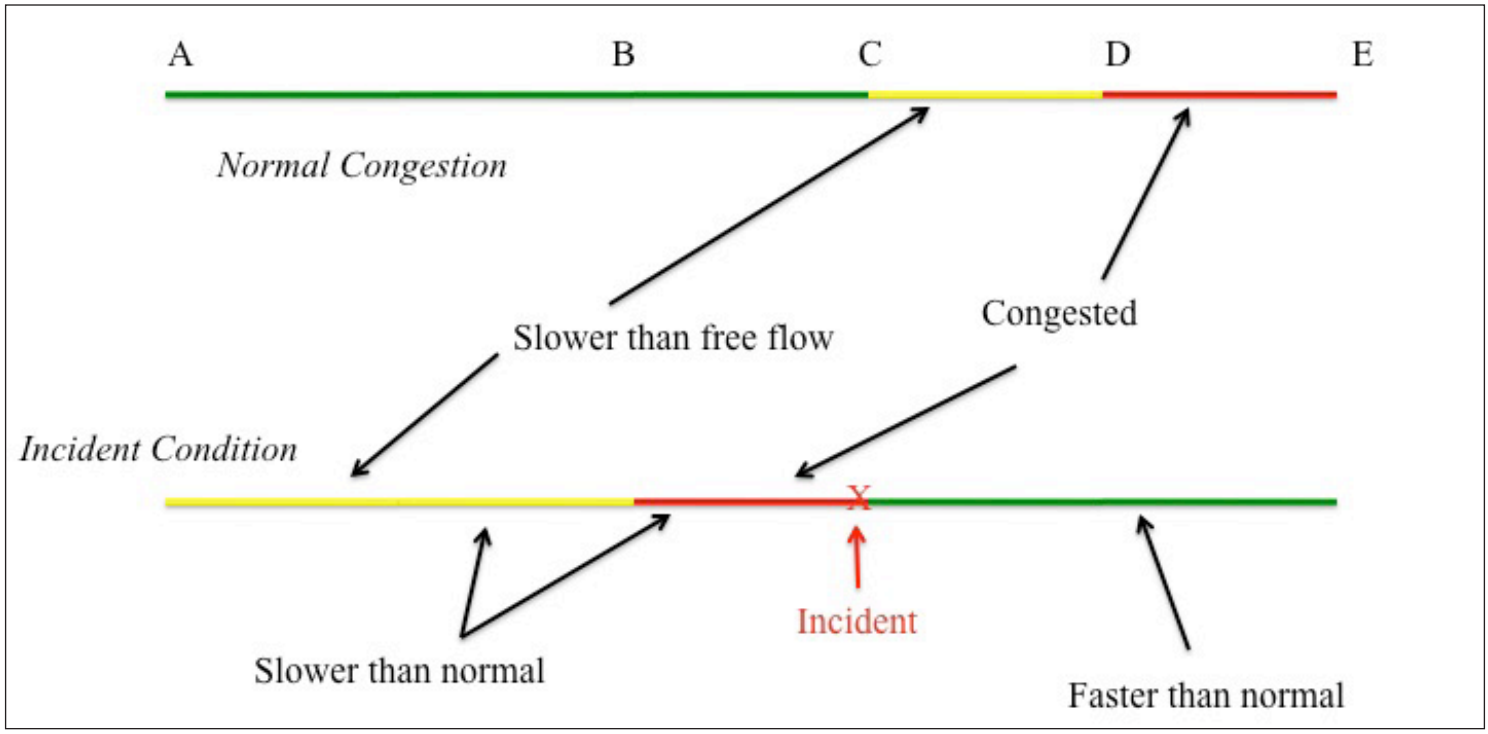

Figure 1: Shift of Delay from One Group of Travelers to Another Under Incident Conditions

entering the freeway downstream of the incident location incur less delay than they would have faced had the incident not created a bottleneck upstream of their entrance ramp. This is illustrated in Figure 1, which shows that travelers entering at point C or D on the example freeway section travel faster than normal under incident conditions. Conversely, travelers using the roadway section from A to C experience unusually long delay under those same incident conditions, while travelers going from A to E experience moderate time increases. (The incident delay they experience upstream of the incident is somewhat balanced by faster travel downstream of the incident.) Within the Puget Sound freeway system, this effect can be seen when a crash southbound on I-5 at Northgate allows traffic at the Ship Canal Bridge to flow more smoothly than normal during the morning commute.

The project team believes that using the above delay statistics to determine the value of incident response is very conservative. There are two reasons for this opinion. First, because our methodology measures the change in delay, the "normal" delay travelers experience (i.e., the delay on road segment AE in Figure 1) is not attributed to incidents. Second, our method assumes that the value of time saved when people travel faster than normal (e.g., the benefit in terms of the value per minute of time saved occurring in sections CD and DE under the incident conditions) is equal to the value per minute of time lost to unexpected congestion (e.g., sections AB and BC under incident conditions). However, studies on the value of travel time reliability have shown that travelers value time lost to unexpected delay at considerably higher rates than the time gained when delays are not as bad as expected. (That is, getting to the airport 10 minutes early is not as "good" as getting to the airport 10 minutes late is "bad.") Because our process weights the value of these times equally, it makes our estimates of the value of incident delay conservative.

The study also determined that crash rates increase substantially when delays caused in part by incidents are present. While the effect of incident-caused congestion on accident rates varies from corridor to corridor and by time of day, a simple summary of the available data indicates that crash rates essentially double in corridors when unexpected incident-related queuing exists. Consequently, since reducing the duration of incidents results in faster clearance of incident-related queuing, timely incident clearance will also have a significant safety benefit, as measured in a reduced crash rate.

Deployment of incident response teams

Given the conditions under which incidents cause congestion and the fact that WSDOT response actions reduce the time during which congestion forms, from a cost-effectiveness basis, this project recommends that incident response teams be located

- on roadway segments 5 to 7 miles long that produce roughly 45 crashes per year in one direction of travel, and
- where roadway volumes exceed a volume/capacity ratio of 0.6 on two-lane (in one direction) roadways or 0.7 on three-lane or larger roads.

Some modification of this basic recommendation will need to be considered for specific local conditions. For example, in some locations across the state, short duration commute peaks (less than two hours) may create labor utilization issues that are not effectively accounted for in the benefit/cost analyses performed for this project. Similarly, in other locations, incident response deployment should be associated with recreational traffic movements (for example, incident response deployed during peak weekend travel movements on I-5 through Centralia/Chehalis during many Thursday and Friday evenings and on Sundays during major three-day holiday weekends). There too, additional analysis of the cost of providing incident response service will be needed to understand the expected benefit/cost ratio.

The research results will be used for ongoing evaluation

WSDOT will use these results as part of its ongoing evaluation of the deployment of its incident response team resources.

Contact Information
Incident Response Evaluation Phase III
WA-RD 761.1
http://www.wsdot.wa.gov/research/reports/fullreports/756.1.pdf

Researcher
Mark Hallenbeck, Director
Transportation Research Center (TRAC)
University of Washington
tracmark@uw.edu

Technical Monitor
Bill Legg
WSDOT ITS Engineer
LeggB@wsdot.wa.gov

Project Funding
$60,000 State
$15,000 Federal

Research Manager
Doug Brodin
WSDOT Research Office
BrodinD@wsdot.wa.gov

Americans with Disabilities Act (ADA) Information: Materials can be provided in alternative formats: large print, Braille, cassette tape, or on computer disk for people with disabilities by calling the Office of Equal Opportunity (OEO) at (360) 705-7097. Persons who are deaf or hard of hearing may contact OEO through the Washington Relay Service at 7-1-1.

Title VI Statement to Public: It is the Washington State Department of Transportation's (WSDOT) policy to assure that no person shall, on the grounds of race, color, national origin and sex, as provided by Title VI of the Civil Rights Act of 1964, be excluded from participation in, be denied the benefits of, or be otherwise discriminated against under any of its federally funded programs and activities. Any person who believes his/her Title VI protection has been violated, may file a complaint with WSDOT's Office of Equal Opportunity (OEO). For Title VI complaint forms and advice, please contact OEO's Title VI Coordinator at (360) 705-7098.

11-02-0465