SR 520 EASTBOUND MORNING RAMP METERING THREE MONTH STUDY

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Paul Neel, FLOW Engineer

Jason Gibbens, FLOW Engineer

Washington State Department of Transportation

Northwest Region
Traffic Systems Management Center
(206) 440-4790

BACKGROUND

The ramp meters on the onramps from Montlake and Lake Washington Boulevards to eastbound SR 520 have operated during the evening commute since 1986. Until recently, however, these meters were not active during the morning commute or at any time before 2:30 pm each day. In an effort to address changing traffic conditions, alleviate increasingly heavy morning congestion, reduce merge-related accidents, and decrease cut-through traffic the decision was made to lift the time restrictions for the operation of these meters. Since August 6, 2001, these ramp meters have operated during weekday morning commute times.

This report is an examination of the morning metering operation at these two onramps. Four weeks of Tuesday, Wednesday, Thursday data from both before and after the inception of morning ramp metering were collected and used to determine average weekday figures. The morning operation study dates (October 23 – November 15, 2001) were compared with the same four-week period of the previous year (October 24 – November 16, 2000) in an effort to eliminate seasonal variation.

Embedded loop detectors were used to collect mainline and ramp volumes as well as to determine mainline congestion. To supplement these measurements, we performed a queue length study at Lake Washington Boulevard and a drive time study for the approach to the Montlake Boulevard onramp. Figures and tables for these performance measures are included where appropriate in the text.

RESULTS

Congestion

A reduction in highway traffic congestion is one of the primary goals of ramp metering. Because vehicles merge individually at metered ramps rather than in groups, mainline traffic at the merge point is less disrupted than at unregulated ramps. This smoothing of traffic flow results in reduced congestion in the vicinity of freeway onramps. Congestion is often quantified using a measurement called loop occupancy. Loop occupancy, the percentage of time that a loop detector is activated (or occupied) by vehicles traveling over it, was used to generate average congestion graphs for our study dates (Figures 1 and 2). As expected, both the severity and duration of eastbound SR 520 morning congestion decreased following the introduction of AM ramp metering.

On average, the onset of "heavy" conditions now occurs about 15 minutes later than it did prior to morning metering. More significantly, the duration of "stop-and-go" conditions has been dramatically reduced. During the pre-metering study dates, stop-and-go congestion typically extended from the floating bridge to the I-5 interchange for about one and a half hours, from 7:30 to 9:00 am. Following ramp meter activation, the period of heaviest congestion has been cut by two-thirds. Although stop-and-go congestion still extends from the bridge to I-5, the duration of that condition is now only half an hour. Stop-and-go conditions at Lake Washington Boulevard now typically ease up approximately 45 minutes earlier than a year ago.

There was hope that the improvements to traffic flow on SR 520 would have positive effects for the I-5 southbound congestion on the Ship Canal Bridge. Slower metering rates used when the meters where first activated in the morning produced drastic improvements on SR 520 mainline congestion and initial data showed a corresponding decrease in I-5 southbound congestion. In the course of balancing the congestion on the mainline with the waits at the ramps, the benefits to the SR 520 mainline, while still significant, were not as drastic as that experienced just after metering began. Looking at Figures 3 and 4 we actually see a slight increase in stop-and-go conditions for I-5. A couple of key factors are the likely cause. During the 2000 study dates, only 2 blocking incidents affected the morning commute in the southbound I-5 corridor, blocking mainline lanes for a total of 14 minutes. However in the 2001 study period, 5 incidents resulted in 97 minutes of blocked lanes during the morning commute. It is also worth noting that 9 out of the12 study dates for 2001 were rain days as compared with 5 out of 12 for the 2000 study dates. Blocking incidents and adverse weather conditions both result in significant congestion, and both occurred far more often during the 2001 study dates than during the 2000 period. It would be worthwhile to examine I-5 congestion again with a larger sample size for the one-year study. Sample size for the 3-month study was limited by significant tuning of the meters that was ongoing until just before the study period and the holiday season starting just after.

Figure 1: SR-520 Eastbound Morning Congestion, I-5 to Lake Washington Blvd
Average Weekday October 24 - November 16, 2000

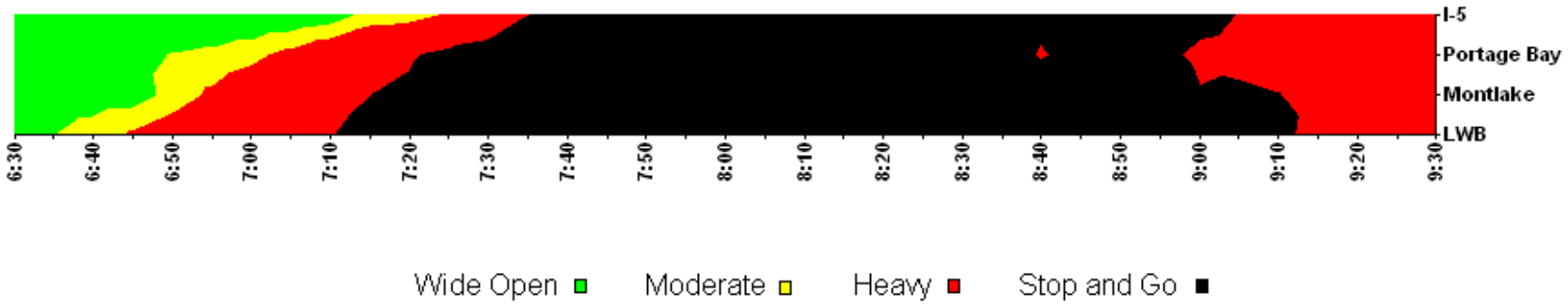


Figure 2: SR-520 Eastbound Morning Congestion, I-5 to Lake Washington Blvd
Average Weekday October 23 - November 15, 2001

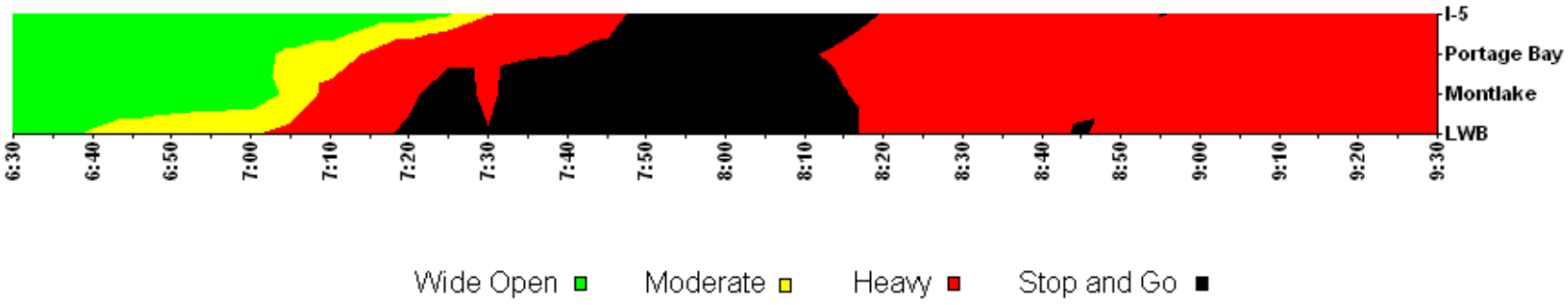


Figure 3: I-5 Southbound Morning Congestion, Ravenna Blvd to SR 520
Average Weekday, October 24 - November 16, 2000

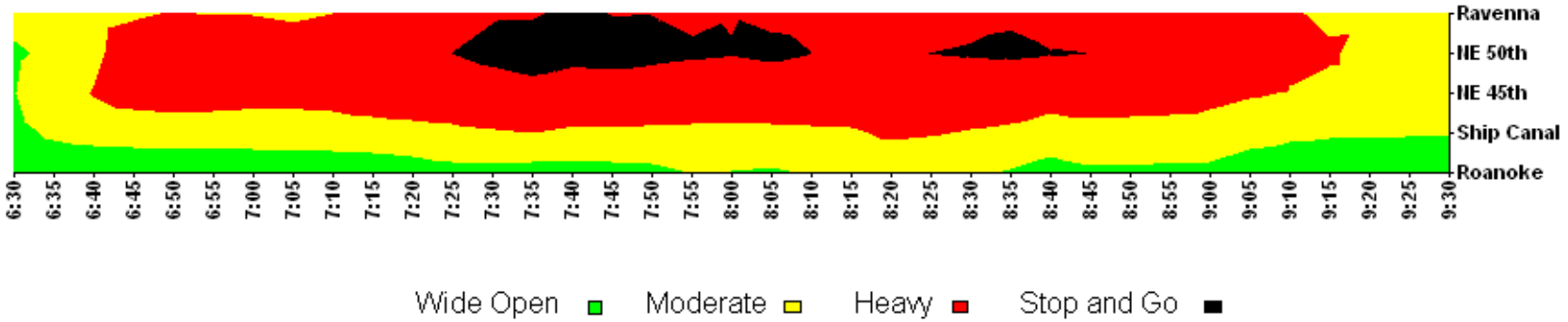
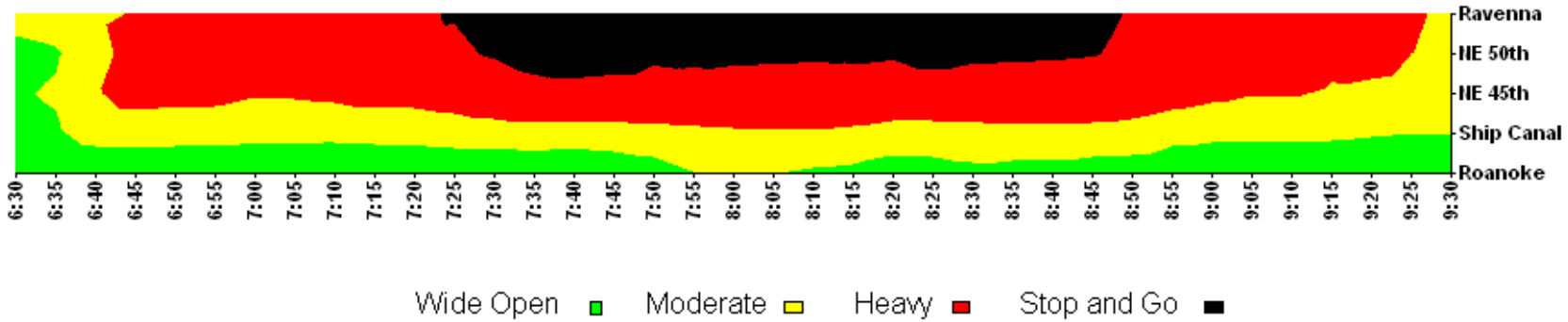


Figure 4: I-5 Southbound Morning Congestion, Ravenna Blvd to SR 520
Average Weekday, October 23 - November 15, 2001



Mainline Throughput

Because heavy congestion restricts the speed and flow of vehicles, a congested highway can carry fewer vehicles per hour than an uncongested one. With the congestion reductions detailed above, it is not surprising that eastbound SR 520 throughput increased following the inception of morning ramp metering. As Table 1 illustrates, freeway volumes increased by 14% for the most congested period of the morning commute (7:00 to 9:00 am). During the period when these meters typically operate (6:45 – 10:00 am), the total throughput increased by 980 vehicles. In other words, eastbound SR 520 carries 10% more vehicles during the course of the morning commute after the introduction of morning metering.

Table 1: SR 520 Eastbound Throughput at Portage Bay
(vehicles per hour)

	10/24 - 11/16/2000	10/23 - 11/15/2001	Percent change
6:00 - 7:00 am	2975	2813	-5%
7:00 - 8:00 am	2915	3322	14%
8:00 - 9:00 am	2662	3030	14%
9:00 - 10:00 am	3014	3165	5%

Ramp Volumes

In addition to easing congestion and improving safety, reducing cut-through traffic was one of the goals of morning ramp metering. Cut-through traffic occurs when motorists bypass portions of congested freeways with shortcuts through city and neighborhood streets. The Lake Washington Boulevard ramp is particularly attractive as a cut-through route because it is the last entrance prior to the floating bridge. Since morning ramp metering began at this ramp, cut-through traffic has diminished considerably. As Table 2 shows, the Lake Washington Boulevard onramp volumes have decreased by approximately 40% during the 7:00 and 8:00 o'clock hours.

Because of its often-lengthy queues and its proximity to the Lake Washington Boulevard ramp, the Montlake Boulevard entrance attracted much less cut-through traffic than the neighboring onramp prior to morning metering. In light of this, it is not surprising that the Montlake Boulevard ramp volumes changed much less significantly than those of Lake Washington Boulevard. Although the volumes for the Montlake ramp's general-purpose lane decreased somewhat, the total ramp volume actually rose slightly (between 2% and 8%) due to the large increase in carpool lane volume.

The relatively small volume changes at the Montlake Boulevard ramp are partly a reflection of its intentionally high meter rate. The algorithm controlling that ramp meter has been programmed to release 12 vehicles per minute (720 per hour) when both the freeway and onramp are at or near capacity. Since this release rate is so similar to the unmetered volumes, the Montlake Boulevard ramp would have comparable queues whether or not the ramp meter was activated.

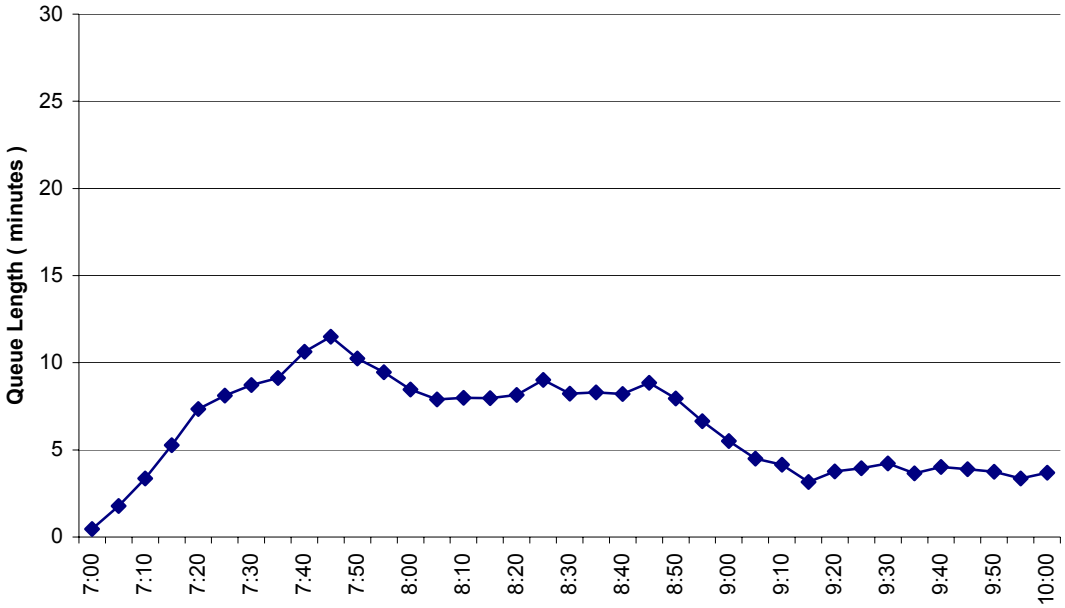
Table 2: Average Ramp Volumes (vehicles per hour)

	10/24 - 11/16/2000	10/23 - 11/15/2001	Percent change
	Montlake Blvd (general purpose lane)		
6:00 - 7:00 am	658	553	-16%
7:00 - 8:00 am	769	698	-9%
8:00 - 9:00 am	719	684	-5%
9:00 - 10:00 am	753	688	-9%
	Montlake Blvd (HOV bypass lane)		
6:00 - 7:00 am	24	63	167%
7:00 - 8:00 am	72	187	159%
8:00 - 9:00 am	81	180	122%
9:00 - 10:00 am	41	125	203%
	Lake Washington Blvd (general purpose lane)		
6:00 - 7:00 am	270	240	-11%
7:00 - 8:00 am	866	531	-39%
8:00 - 9:00 am	1037	564	-46%
9:00 - 10:00 am	612	460	-25%

Lake Washington Boulevard Queue Study

The queues at Lake Washington Boulevard were substantial during the first few weeks of morning ramp metering. Wait times were frequently between 10 and 20 minutes during this period. However as motorists have adjusted and WSDOT engineers have tweaked the metering algorithm, traffic patterns have stabilized with considerably reduced wait times. During the four-week study period, queue times very rarely exceeded 15 minutes and were typically between 5 and 10 minutes. Figure 5 shows the average queue times during the study period.

Figure 5: Lake Washington Boulevard Ramp Queue Times, Average Weekday 10/23 - 11/15/2001



Montlake Boulevard Drive Time Study

Because of Montlake Boulevard's signalized intersections, a queue study like the one performed at Lake Washington Boulevard would not be appropriate. A drive time study along Montlake Boulevard between 25th Ave NE and the beginning of the freeway onramp was performed instead (Figure 6). The drive times along this corridor vary widely depending on the time of day, in large part because of the street's proximity to the University of Washington and other large destination centers. It is important to note that much of the delay recorded in this study is caused by limitations of the traffic signals along the Montlake Boulevard corridor. In particular, traffic volumes often exceed the capacity of the intersection at NE Pacific St, creating delays that are largely independent of the ramp meter's operation. When evaluating this data it is important to keep in mind that it typically takes 3 to 4 minutes to travel from 25th Ave NE to the head of the ramp even when there is no congestion.

Before and after comparison of the Montlake corridor is difficult since the before data is limited to that provided by the loop detectors. This loop data shows that prior to morning metering, ramp traffic typically backed up past the last advance queue loop detector from 7:25 until 8:55 am. This northernmost detector is located just south of E. Hamlin St.; it is impossible to know how much farther the queue extended based on the loop detector data alone.

Figure 6: Montlake Boulevard Total Travel Time from 25th Ave NE to SR 520, Average Weekday 10/23 - 11/15/2001