National Capital Region Transportation Planning Board

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MEMORANDUM

ITEM # 6

TO: MOITS Subcommittee

FROM: Daivamani Sivasailam
Erin Morrow
Department of Transportation Planning

DATE: September 10, 2013

SUBJECT: Status Report on the Arterial Highway Congestion Monitoring Program

Background

The National Capital Region Transportation Planning Board has had a congestion monitoring program of its freeway and arterial highways system for more than 30 years. The program has evolved over the years adapting to changes in the technology used to monitor the performance of the highways. In the 1980's travel time data was collected using a stopwatch and clipboard by a technician who was a passenger in a probe vehicle. In the early 1990's staff experimented with global position system (GPS) equipment and adopted it for use in lieu of the stopwatch and the technician. GPS provided speed data at 2 second intervals and a number of detailed analyses could be performed from the data. Use of the technology also enabled us to substantially increase the number of highways which were monitored. From 1999 until 2011 the region monitored most of the arterial highways in the national highway system using a GPS equipped vehicle driving with the traffic and measuring the system performance in terms of average travel speed and travel times and reported it as Arterial Travel Time (ATT) Survey Report. With the introduction of Bluetooth and other smartphone technologies, travel time and speed data are being marketed commercially by a number of firms. These data were initially available for freeways and the coverage has expanded to include arterial highways.

Since 2008 TPB has been using the probe vehicle data in analyzing the performance of the freeway system. In FY 2013, staff embarked on a project to use the probe vehicle data for arterial highway congestion monitoring. This memorandum discusses the approach, the validation of the data by comparing it with the GPS data, advantages in using the commercially available probe vehicle data, additional performance measures developed using the data and the outlook for the arterial highway congestion monitoring program.

Probe Vehicle Data for Freeway Applications

The I-95 Corridor Coalition, a consortium of state departments of transportation and metropolitan planning organizations (MPO's) along the I-95 corridor, has been purchasing probe vehicle data also known as vehicle probe project (VPP) data from INRIX a commercial supplier of such data and as part of the purchase agreement the data is available to member agencies (TPB is a member agency). The corridor coalition has also examined the validity of the data using independent data source and found the freeway data to be reliable for use. TPB staff has obtained archived data on all the freeway corridors in the Washington region and have developed a number of performance measures such as the Travel Time Index, Planning Time Index, and

freeway delay per traveler findings have been reported in the Congestion Management Process Technical Report (www.mwcog.org/cmp).

Probe Vehicle Data for Arterial Highway Applications

In FY 2013 staff obtained 2012 archived data on all the major arterial highway corridors and systematically analyzed them under the arterial highway congestion monitoring work element of the UPWP replacing the traditional GPS based travel time study which was suspended in 2011.

Arterial Highways Routes

The routes that were studied using the INRIX probe vehicle data were the same corridors that were chosen in 1999 as part of the arterial highway congestion monitoring program. Table 1 shows the routes, the route limits and the centerline miles of the routes in the program. The following paragraphs describe the analysis and the discussion of the results.

Validation of INRIX data in Arterial Highway Applications

In March 2013, the I-95 Corridor Coalition released a report entitled "Vehicle Probe Project: Probe Data for Arterial Performance Measures, A Case Study on US-1 in Virginia." In the report, the author, Stanley Young of the University of Maryland, discussed the differences between using VPP data for freeways and arterials noting that "the stop and go nature of signalized operations on arterials create complex travel time distributions that are not well summarized with any single central-tendency measure as with freeways" and "the performance measures and validations procedures developed for freeways often fail on arterials due to these complex travel time distributions." Additionally, "the amount of probe data acquired on arterials is less than that for freeways due in part to lower volumes." The report "summarizes fundamental methodologies established to describe the traffic flow on arterials, and to eventually serve as the computational basis for assessing performance and validating data." The two main principles are to (1) group individual data samples as the sample sizes on arterials are too small to be sufficient for analysis and (2) use percentile statistics to summarize the patterns in the data. The author uses a Cumulative Frequency Diagram (CFD) to visualize the variation in travel time in a given time period (i.e. hourly, daily) with travel time on the x-axis and the cumulative probability of the travel time on the y-axis.

There are several findings from this report that could be relevant to the TPB's arterial highway analysis as we proceed with using VPP data for congestion monitoring analysis.

1. Validation of the VPP arterial data can be challenging because the segments may not align with other existing data sources. The report found this to be the case on US-1 in Virginia.
2. "VPP data provides speed and travel time samples once per minute, regardless of volume." In this report, the confidence score in the INRIX data was used to throw out some of the data before analysis.
3. "VPP data is recorded to the nearest whole mph and then converted to travel time." In this report, a method was developed to accommodate this.
4. The author developed CFDs to illustrate the VPP data because of the differences in operational characteristics between freeways and arterials and difference in the quantity of data collected.

Table1. List of Routes Analyzed

State	Route	From	To	Distance (mi)
Maryland	MD Route 4	Alabama	Old Crain	11.5
	MD Route 144	Waverly	Monocacy	4.2
	MD Route 450	Landover	Crain Hwy	12.8
	MD Route 586	1st St	University Blvd	5.4
	MD 210 (Indian Head Hwy)	Southern Av	Livingston Rd (Accokeek)	11
	MD 97 (Georgia Avenue)	Eastern Avenue	MD 28	9.7
	MD 5	Suitland Parkway	Accokeek Road	11.9
	MD 28	Viers Mill Road	New Hampshire Avenue	9
	MD 193 (University Boulevard)	Connecticut Avenue	US 29	4.2
	Randolph Road	MD 355	Columbia Pike / US 29	9.1
	MD 355	Western Ave.	Montgomery Village Ave.	15.3
	MD 117	Muddy Branch Rd	Clarksburg Rd	6.8
	MD 198	MD 650	Old Gunpowder Rd	5
	MD 197	MD 198	US 301	14.7
Virginia	US 50	Henry Bacon Dr.	Centerview Drive	23
	US 15	VA 7	Lovettsville Road	12.5
	VA 123	Kirby Road	Horner Road	27.7
	Fairfax Co. Parkway	Sunrise Valley Road	Rolling Road	19.7
	US 1	20th Street	VA 123	18.8
	US 29	M Street NW	Bull Run PO Road	21
	VA 7	Menokin/Van Dorn	Cochran Mill - 653	29.3
	VA 234	Hoadly	Hoadly	22.6
	VA 28	Compton	VA - 7	17
	VA Route 120	Mt Vernon	Chain Bridge	8.1
D.C	Georgia Ave	New Hampshire	Eastern	3.3
	Georgia Ave/7th St	Independence	New Hampshire	3.4
	Louisiana/Constitution Ave	North Capital	21st St NE	2.4
	Pennsylvania/Branch Ave	Independence	Southern	3.7
	Canal/M St	30th St NW	Chain Bridge	3.7
	14th Street NW	Independence Avenue	K Street NW	1
	16th Street NW	K Street NW	Eastern Avenue	6.1
	Connecticut Avenue NW	K Street NW	Nebraska Avenue	4
	K Street NW / New York Avenue	21st Street NW	Bladensburg Road	4.2
	Military Road / Nebraska Avenue	Connecticut Avenue	Georgia Avenue	2.5
	Pennsylvania Avenue NW	15th Street NW	Constitution Avenue	0.8
	L Street NW	Pennsylvania Avenue	14th Street NW	1.1
	Wisconsin Avenue	M Street	Western Avenue	4.1
	Pennsylvania Avenue	M Street	17th Street, N.W.	1.1
	17th Street	Pennsylvania Ave.	Independence Avenue	0.7
	Independence Avenue	17th Street, S.W.	2nd Street, S.E.	1.9
	I Street	14th Street, N.W.	Pennsylvania Avenue	0.8
	H Street	Pennsylvania Ave.	14th Street, N.W.	0.6
	15th Street	Independence Ave	E Street, N.W.	0.7

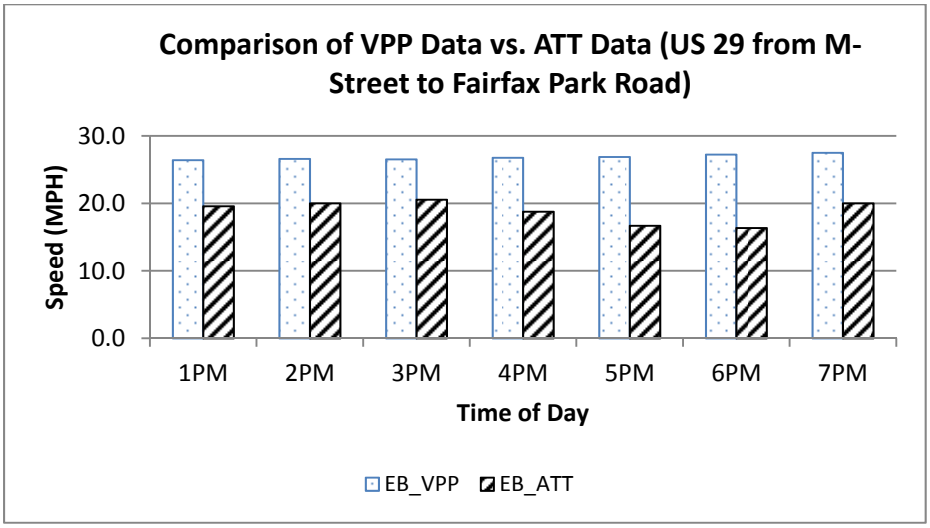
The report states that "common travel time and reliability measures…can be derived directly from knowledge of the percentile distribution" thus still providing the ability to report measures, such as travel time index and planning time index.

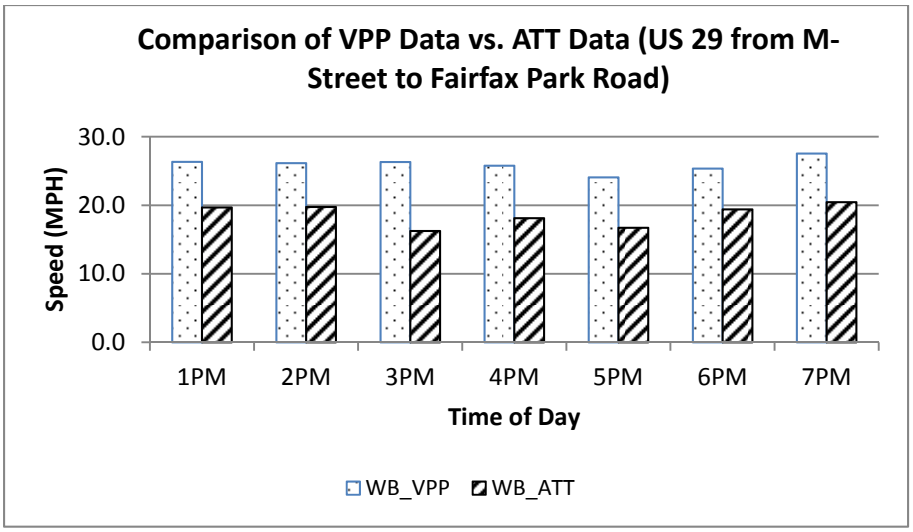
Comparison of INRIX (VPP) data and GPS based speed data from Arterial Travel Time/Speed (ATT) studies

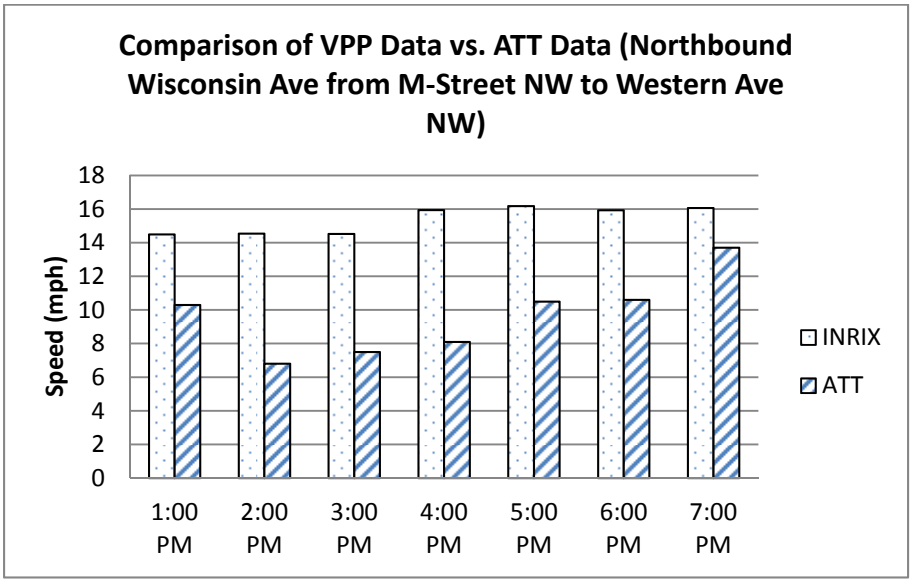
Traffic Message Channel (TMC) coding is the smallest link at which INRIX data is reported. The segment between major signalized intersections is the smallest link in the arterial travel time survey report even though raw data is available in 2 second intervals. Very few of the INRIX TMC links matched with the links defined in the arterial travel time/speed studies. Therefore, meaningful comparison of data could be carried out only at the route level as noted in the University of Maryland Study of INRIX data.

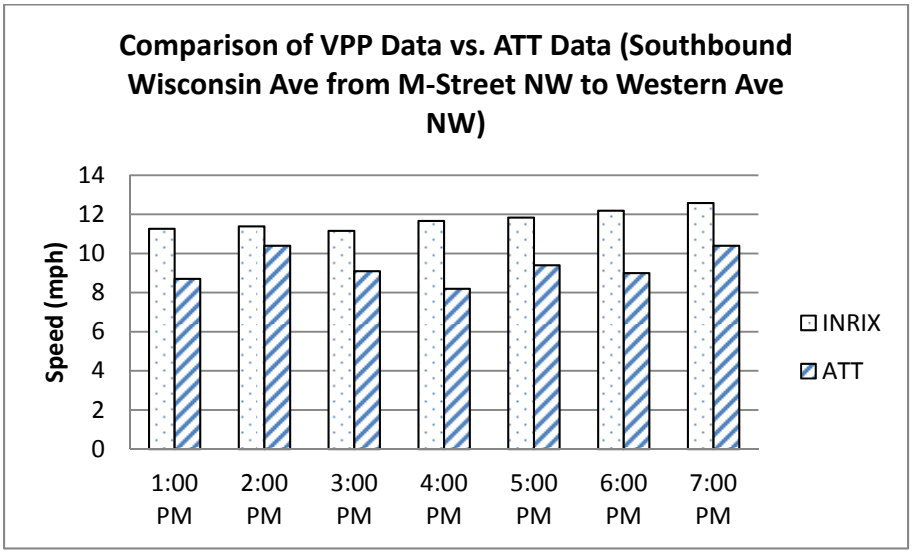
ATT data on the routes used in the comparison were collected over a three-year period from 2009 through 2011 and the average speed was based on a single day of data collection for each route. Data was collected on a Tuesday, Wednesday or a Thursday between the months of November through April. The VPP data used in the analysis represents calendar year 2012 and the annual average speed data was estimated using Tuesday, Wednesday or Thursday data excluding major holidays. The other difference between the two sets of data include suspension of ATT data collection on bad weather and major incident days whereas, VPP data includes all days as there is no method available to exclude bad weather and incident impacted data.

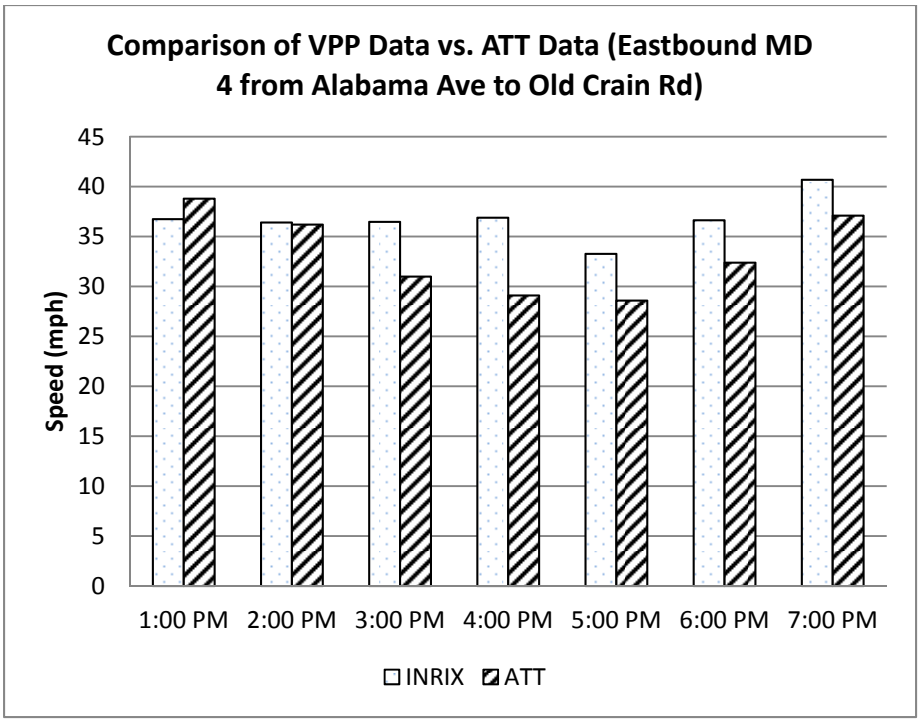
Hourly comparison of speed data between VPP and ATT data was performed from 1 PM through 8 PM. The results of the comparison for a sample of routes are shown on charts in the following page. Except for WB MD 4 VPP seems to indicate higher speeds compared to the ATT data based on the sample of routes studied so far.

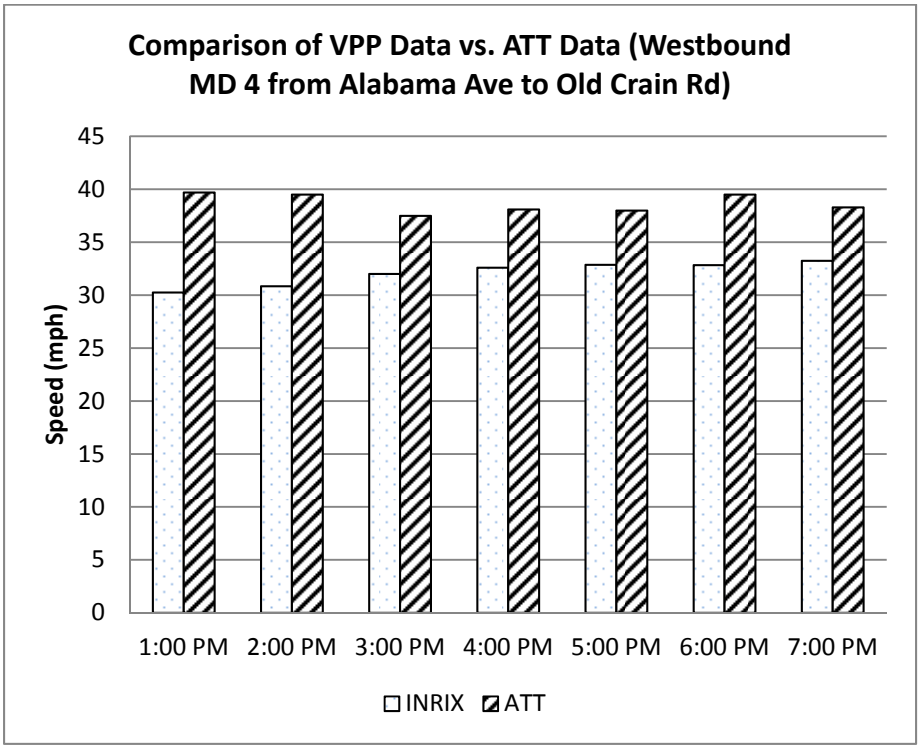



Comparison of VPP Data vs. ATT Data (US 29 from M-Street to Fairfax Park Road)
Speed (MPH)
30.0
20.0
10.0
0.0
1PM
2PM
3PM
4PM
5PM
6PM
7PM
Time of Day
WB_VPP
WB_ATT


Comparison of VPP Data vs. ATT Data (Northbound Wisconsin Ave from M-Street NW to Western Ave NW)
Speed (mph)
18
16
14
12
10
8
6
4
2
0
1:00 PM
2:00 PM
3:00 PM
4:00 PM
5:00 PM
6:00 PM
7:00 PM
INRIX
ATT


Comparison of VPP Data vs. ATT Data (Southbound Wisconsin Ave from M-Street NW to Western Ave NW)
Speed (mph)
14
12
10
8
6
4
2
0
1:00 PM
2:00 PM
3:00 PM
4:00 PM
5:00 PM
6:00 PM
7:00 PM
INRIX
ATT

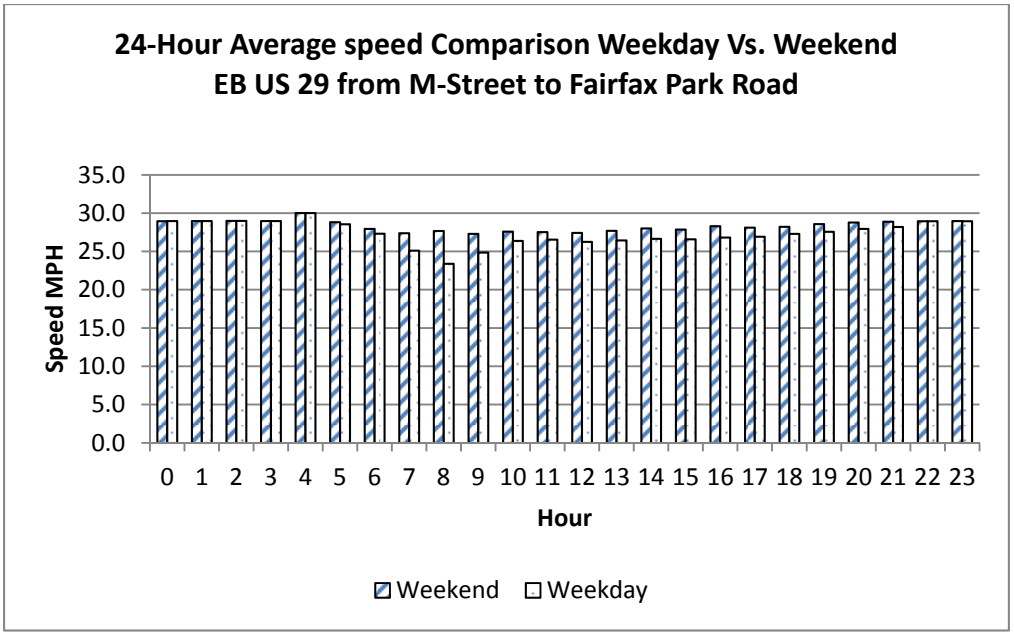

Comparison of VPP Data vs. ATT Data (Eastbound MD 4 from Alabama Ave to Old Crain Rd)
Speed (mph)
45
40
35
30
25
20
15
10
5
0
1:00 PM
2:00 PM
3:00 PM
4:00 PM
5:00 PM
6:00 PM
7:00 PM
INRIX
ATT


Comparison of VPP Data vs. ATT Data (Westbound MD 4 from Alabama Ave to Old Crain Rd)
Speed (mph)
45
40
35
30
25
20
15
10
5
0
1:00 PM
2:00 PM
3:00 PM
4:00 PM
5:00 PM
6:00 PM
7:00 PM
INRIX
ATT

Samples of Other Performance Measures

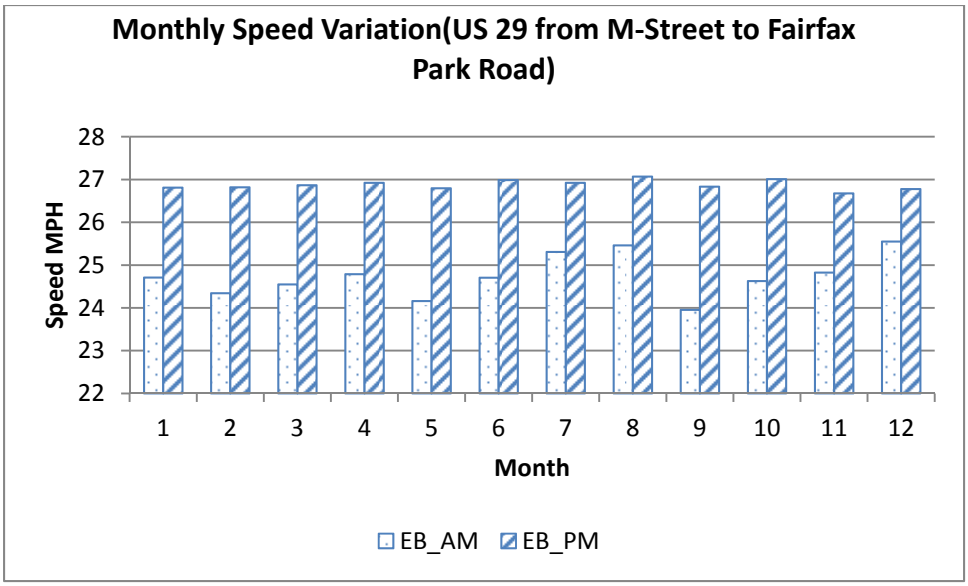
With the availability of vehicle probe data it became possible to develop a number of other performance measures. Some examples of the new performance measures are shown here.

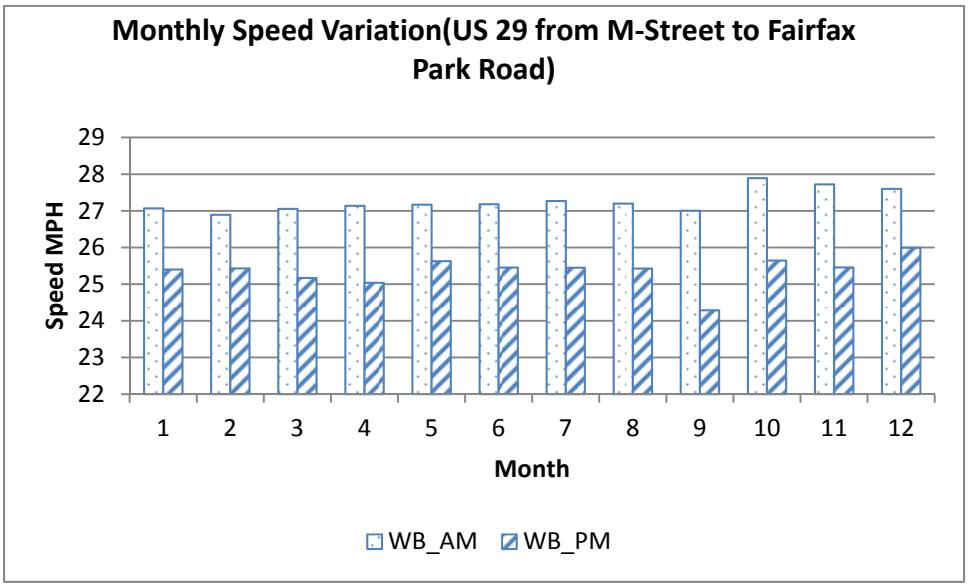
A number of arterial highways which serve as a gateway to activity centers with major retail have congestion issues during weekend hours. We compared the variation in speeds between weekdays and weekends over a 24-hour period.



The second performance measure we studied is the monthly speed variation. We performed a comparison of the speed variation during weekday peak period by month. This will help us identify the months when the route performance is the worst.

Another performance measure which has been developed but undergoing review is identifying the worst performing TMC's using the TTI as the ranking criteria. This will help us identify bottlenecks along routes which can be studied in detail.





Considerations and Future Outlook for Using INRIX Data for Arterial Highway Monitoring

Data is available for 365 days in a year enabling us to study monthly variation, weekday versus weekend comparison, seasonal variation, and time of day variation.

Even though the VPP (INRIX) arterial data has some known validation issues, comparison of speed data over time will be a useful approach to study changes to the system over time.

Due to differences in TMC definitions and the segments for which we have independent data, verification of the VPP (INRIX) data is an issue.

For the TPB's freeway analysis, no data is excluded. The US-1 Case Study report, however, used the confidence interval to exclude data that did not meet an average threshold of 25 (i.e. too much reliance on historic rather than current observed data).

We may want to consider a similar approach for analysis of arterial data and decide if we are willing to accept a lower confidence interval for overnight hours (10 pm to 5 am).

Given the differences in the use of VPP (INRIX) for freeway and arterial there are questions on how to proceed with reporting VPP data-based performance measures. Our initial approach was to replicate graphics from our previous arterial highway performance analyses, such as travel speed by hour of the day; however, in light of the findings of the US-1 Case Study report, staff will examine, in consultation with the University of Maryland, which approach the most appropriate. The US-1 Case Study report looked at smaller time periods (hourly, daily) whereas we would likely look at longer time periods (monthly, annually).

Future work on the arterial highway congestion monitoring program will be dependent on the probe vehicle data available to us. At this time, we are able to receive INRIX speed data gratis due to our relationship with the I-95 Corridor Coalition. In a webinar in August, FHWA announced that beginning in September, travel time data, differentiating between freight and passenger vehicles will be available to MPOs for the National Highway System. This is another data source that may be useful in pursuing the regional congestion monitoring program.

After meeting with the UMD staff, we will complete the activities outlined above and finalize the first arterial highway system performance report outline using VPP data. A status update will be presented at the next MOITS committee meeting as work is underway to complete the final report.