



# I-95 Corridor Coalition

Validation of INRIX Data:  
Two-Year Summary Report  
July 2008 – June 2010



*September 2010*

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# **VALIDATION OF INRIX DATA: TWO- YEAR SUMMARY REPORT JULY 2008 - JUNE 2010**

## *Summary Report*

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*Acknowledgements:*

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*September 2010*



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## Executive Summary

Since July 2008, the I-95 Corridor Coalition has facilitated a groundbreaking Vehicle Probe Project (VPP) involving the public and private sectors as well as academia to collect, archive, use and evaluate speed data in several states. Presently, 5,100 miles of freeways in NJ, DE, PA, MD, DC, VA, NC, SC and FL are monitored by the project as shown in Figure 1.

The University of Maryland is responsible for evaluating the quality of the VPP data. As such, monthly validation efforts have been completed in each state comparing INRIX data to ground truth (Bluetooth data). Please see <http://tinyurl.com/VPP-database> (under the “Highlights” tab scroll down to the heading “Data Validation”) to access the data validation reports completed to date. Each month, road segments in a particular state are selected for study in concert with the relevant Department of Transportation. This overview report summarizes the results found to date. The results of the data validation process in each state ties directly to the required payment.

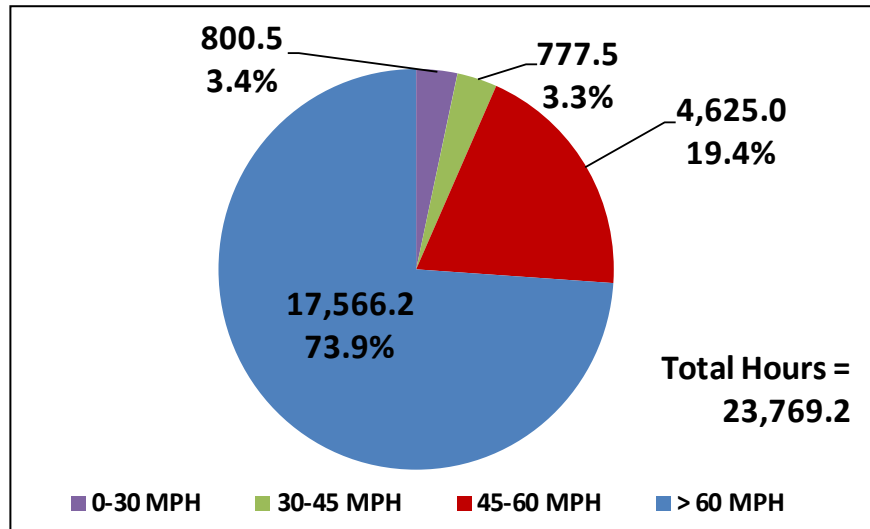


**Figure 1 - Coverage Area Map**

Since the initiation of the project, nearly 24,000 hours of data were collected through completion of 22 individual validation events across approximately 390 miles. Figure 2 presents the distribution of volume of data collected in each of the four speed ranges (speed bins): 0-30 mph, 30-45 mph, 45-60 mph and > 60 mph.



The validation process targets roadways and segments likely to have above average congestion, this was not always achievable. In fact, it is notable that the least amount of data was available in the lower two speed bins that represent congestion (the 0-30 mph and 30-45 mph speed bins); approximately 1,600 hours or 6.7% of the total volume of data collected is in the lower two speed bins.



**Figure 2 - Cumulative Hours of Data Collected Per Speed Bin**

The cumulative data collected in all states at all speed ranges meets the contract specifications for average absolute speed error (AASE) specification, and speed error bias (SEB). Table 1 presents the cumulative validation results.

**Table 1 – Cumulative Validation Results for All States**

Speed Bin	Average Absolute Speed Error (<10mph)	Speed Error Bias (<5mph)	Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with SEM Band		
0-30 MPH	5.3	2.7	800.5	3.4%
30-45 MPH	6.3	2.1	777.5	3.3%
45-60 MPH	2.4	0.0	4,625.0	19.4%
> 60 MPH	2.6	-2.3	17,566.2	73.9%
All Speeds	2.8	-1.5	23,769.2	100.0%

Figure 3 presents the speed data collected for each data validation effort in each speed range. As shown, on a monthly basis, more congestion events were captured in late 2009 and 2010. Early validation efforts focused on roadways of interest. These were not always segments with congestion.

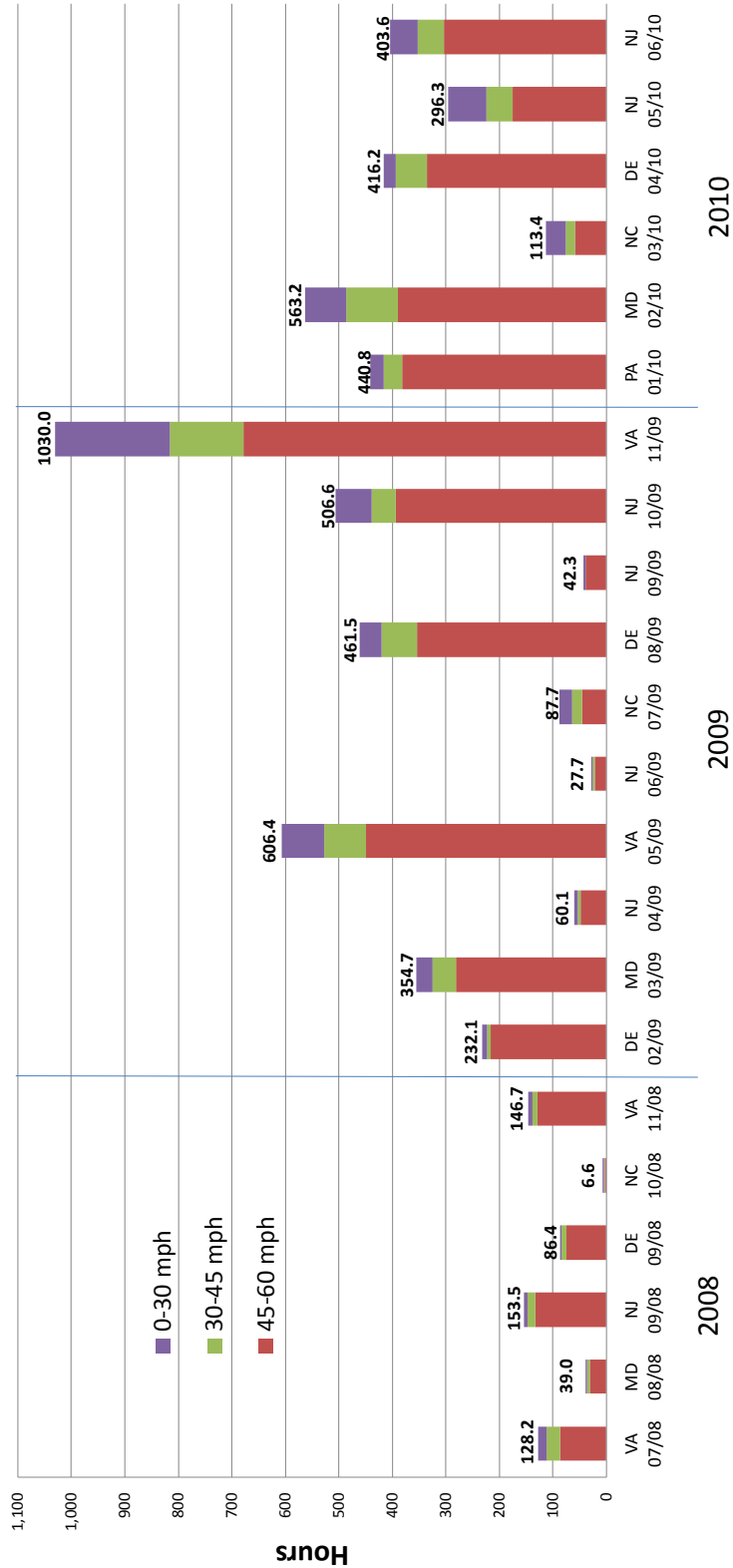


Figure 3 - Hours of Data Collected (Excluding >60 mph Speed Bin) Per Event



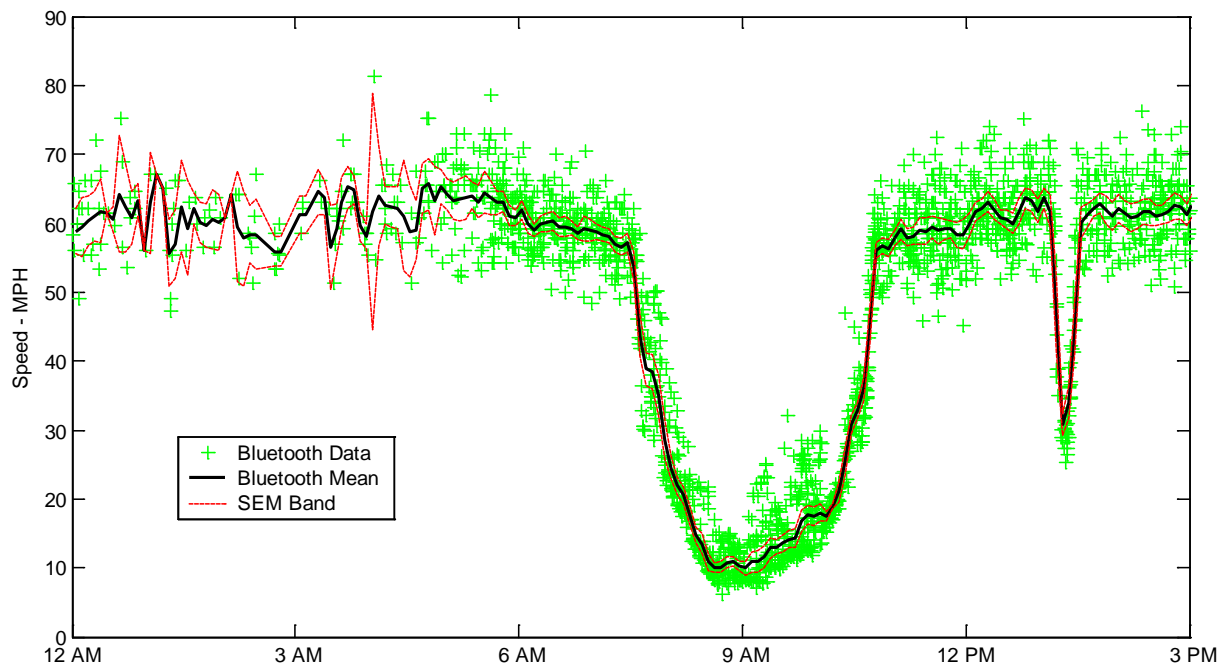


## Introduction and Methodology

This summary report presents the data validation findings from project inception in July 2008 to June 2010. During that time, 22 data validation events were completed. Each event studying six to ten road segments over a period of seven to fourteen days. The INRIX travel time and freeway speed data collected in the states of New Jersey, Pennsylvania, Delaware, Maryland, Virginia and North Carolina were compared to Bluetooth ground truth data to ensure satisfaction of the contract accuracy specifications (average absolute speed error less than 10 mph and speed error bias less than 5 mph).

### Contract Requirements –AASE and SEB

On any roadway section, there are significant speed and travel time variations depending on driver, vehicle and roadway characteristics. For this reason, in addition to reporting the mean ground truth travel time and speed, a confidence band was defined that represents the uncertainty existing in the definition of the ground truth speeds and travel times. The uncertainty measure presented is termed the standard error of the mean (SEM).<sup>1</sup> An example of the SEM band is shown in Figure 4. As shown, the band narrows to represent a higher confidence of the ground truth data and widens when there is less confidence. In essence, the SEM band is a surrogate for the 95 percent confidence interval of ground truth.



**Figure 4 - Example of Standard Error of Mean (SEM) Band**

A statistical analysis of the data was conducted for four defined speed ranges: 0 to 30 mph, 30 to 45 mph, 45 to 60 mph and greater than 60 mph, as defined in the contract. The speed ranges denoting congested

<sup>1</sup> Standard Error of the Mean (SEM) is calculated as the standard deviation (S) of the calculated error (the difference between the Bluetooth data and the INRIX GPS) divided by the square root of the number of Bluetooth data points (N) taken for a given time. In other words,  $SEM = S/(N)^{1/2}$



conditions are found in the 0-30 mph and 30-45 mph speed bins. The amount of congestion, and, therefore, data in the lower speed ranges, changes by location.

The ground truth SEM band and mean were calculated for these speed ranges as well as two other basic measures of error used to evaluate the accuracy of the INRIX data. The two measures are: 1) average absolute speed error (AASE)<sup>2</sup>, which compares INRIX data to ground truth and, 2) the speed error bias (SEB)<sup>3</sup> to identify bias (consistent differences) between INRIX data and ground truth. The contract specified allowable maximum AASE and SEB are 10 mph and 5 mph, respectively, as applied to the SEM Band. Detailed comparisons of the AASE and SEB to the mean, as well as the SEM band, are provided in [Appendix B](#).

This report provides a graphical presentation of the performance metrics, AASE and SEB compared to the SEM band, as well as the data collected by speed range to give the reader an understanding of the level of congestion captured in the data collection efforts.

## Individual State Validation Results

As part of the data validation effort, data collection and validation tasks were completed monthly in each of the following six states: New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and North Carolina. To date, 22 validations have been completed. The following narrative summarizes the results of the validation efforts for each state and presents both individual event and cumulative results.

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<sup>2</sup> The average absolute speed error (AASE) is calculated in the following manner. For each INRIX data point, take the absolute value of the difference between the data point and the Bluetooth data at the same time, and then average those absolute differences over the study period. In this way, positive and negative errors do not cancel each other.

<sup>3</sup> The speed error bias is calculated using the same procedure as the absolute speed error, except that the absolute value is not taken.



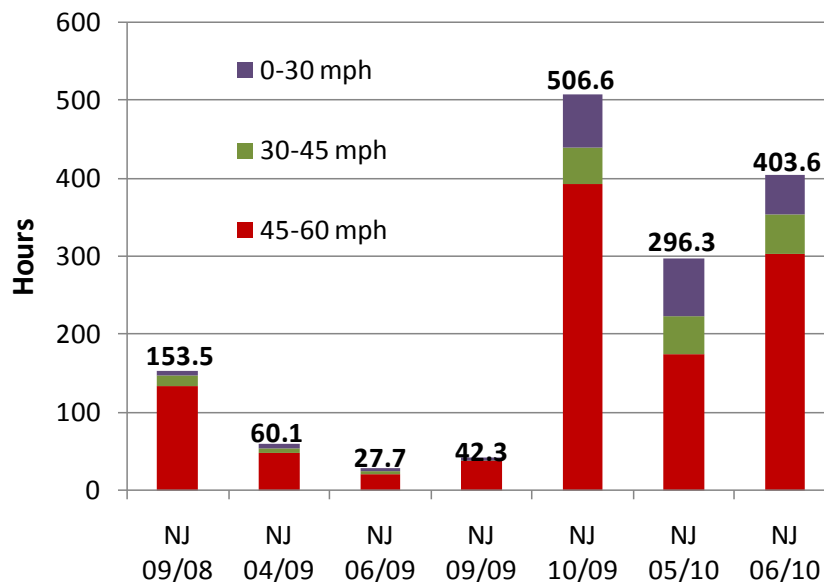
## New Jersey

There have been seven data validation efforts in New Jersey, as listed in Table 2.

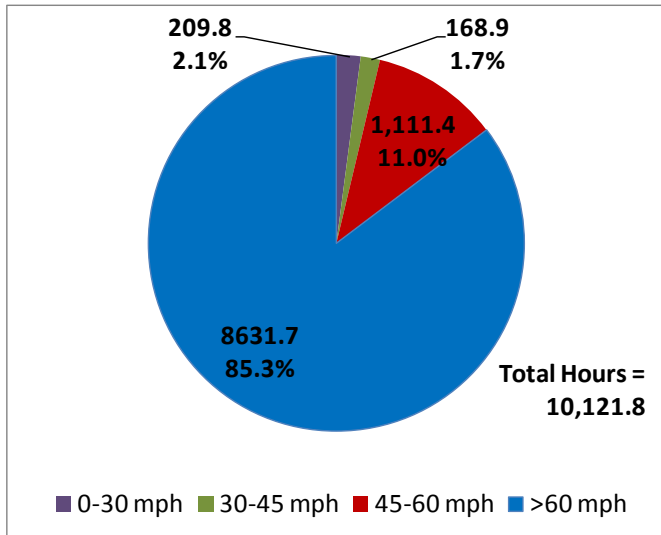
**Table 2 – Data Validation Efforts in New Jersey**

Data Collection Period	Roadway/County
September/October 2008	I-295/ Camden County NJ Turnpike/ Burlington and Mercer Counties I-80/Passaic, Essex and Morris Counties I-95/ Middlesex County Garden State Parkway/ Union County I-76/ Camden County
April 2009	I-78/Somerset County I-287/Somerset and Middlesex Counties
June 2009	NJ Turnpike/Gloucester, Camden, Burlington and Salem Counties
September 2009	NJ-55/Gloucester County
October 2009	NJ-42/Gloucester and Camden Counties
May 2010	I-78/Somerset County I-287/Somerset and Middlesex Counties
June 2010	I-295/Camden County NJ-42/Gloucester and Camden Counties I-76/Camden County

Figure 5 presents the volume of data collected for speeds less than 60 mph for each of the above events.



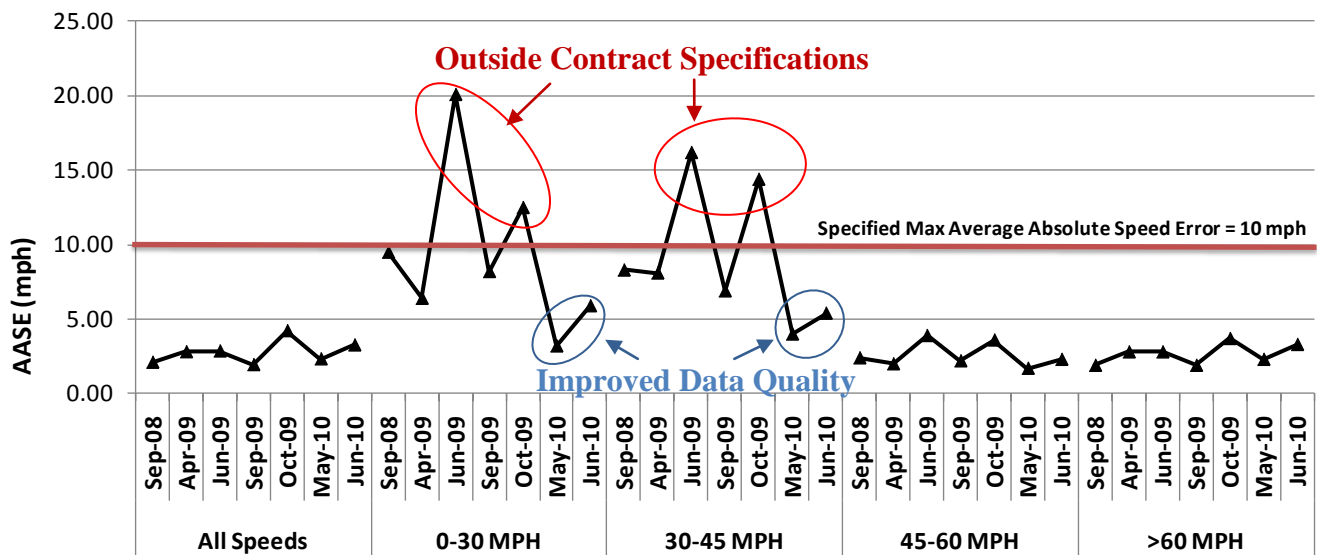
**Figure 5 - Hours of Data Collected  
(Excluding >60 Speed Bin) in New Jersey**



**Figure 6 – Total Hours of Data Collected By Speed Range in New Jersey**

Figure 6 presents the cumulative volume of data collected by speed range, including the greater than 60 mph speed bin. The seven data validation efforts gathered approximately 10,125 hours of traffic data. Less than five percent of the total volume of data collected in New Jersey fell within the congested speed ranges.

Figure 7 presents the average absolute speed error for each validation event by speed range. As shown in Figure 7, in June and October of 2009, the data collected in the lower two speed bins did not meet the contract specifications for AASE. Efforts in May and June of 2010 provided improved data quality in the lower two speed ranges.



**Figure 7 - Average Absolute Speed Error (AASE) Per Validation Event in New Jersey**



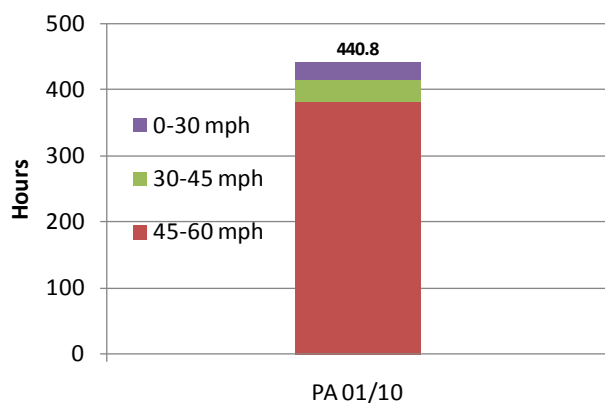
Table 3 presents the cumulative results comprising the seven data validation efforts. In general, the data quality is good in the non-congested speed ranges. As shown, the data set meets the AASE contract specifications in all speed bin categories. The SEB contract specification is also satisfied for all the speed bins except in the 30-mph range.

**Table 3 – Overall Data Validation Results in New Jersey**

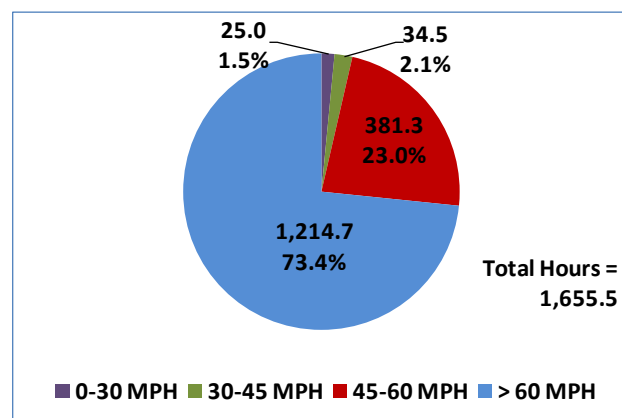
Speed Bin	Average Absolute Speed Error (<10mph)	Speed Error Bias (<5mph)	Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with SEM Band		
0-30 MPH	7.4	5.3	209.8	2.1%
30-45 MPH	8.0	4.8	168.9	1.7%
45-60 MPH	2.7	0.6	1111.4	19.4%
> 60 MPH	2.8	-2.5	8631.7	85.3%
All Speeds	3.0	-1.9	10121.8	100.0%

**Pennsylvania**

To date, only one validation has been conducted in Pennsylvania. In January 2010, approximately 1,650 hours of data were collected on I-95 and U.S. 322 in Delaware County. The data was found to meet contract specifications for both the AASE and SEB. Figures 8 and 9 illustrate the total hours of data collected. Table 4 presents the data validation results.



**Figure 8 – Hours of Data Collected (Excluding >60 Speed Bin) in Pennsylvania**



**Figure 9 – Total Hours of Data Collected By Speed Range in Pennsylvania**



**Table 4 – Overall Data Validation Results in Pennsylvania**

Speed Bin	Average Absolute Speed Error (<10mph)	Speed Error Bias (<5mph)	Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with SEM Band		
0-30 MPH	6.5	2.5	25.0	1.5%
30-45 MPH	7.0	1.1	34.5	2.1%
45-60 MPH	2.3	-0.3	381.3	19.4%
> 60 MPH	3.3	-3.2	1214.7	73.4%
All Speeds	3.2	-2.4	1655.5	100.0%

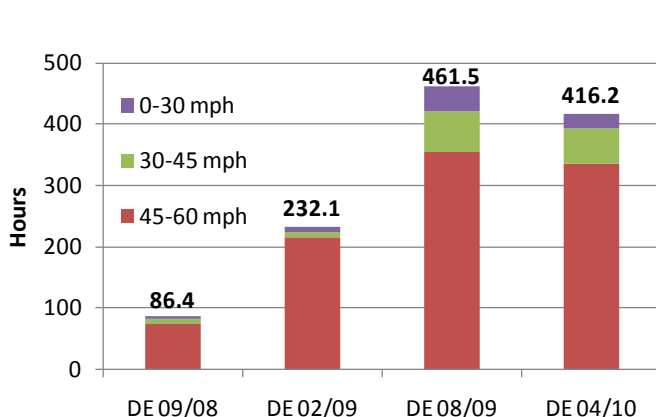
**Delaware**

Four data validation events were conducted in Delaware as listed in Table 5 below.

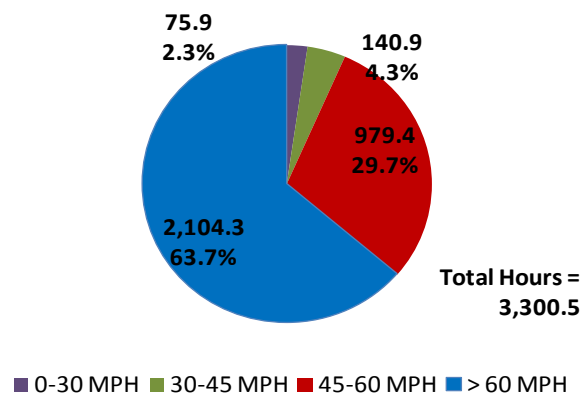
**Table 5 – Data Validation Efforts in Delaware**

Data Collection Period	Roadway/County
September 2008	I-95/ New Castle County
February 2009	I-95, I-295, I-495/New Castle County
August 2009	I-95, I-295, I-495/New Castle County
April/May 2010	DE 1, DE 7, I-95, I-295/ New Castle County

The above efforts yielded approximately 3,300 hours of data as presented in Figures 10 and 11. The most recent data validation events have greater amounts of data collected in the 0-30 mph and 30-45 mph speed ranges, the speed ranges which denote congested conditions. To date, the total volume of this “congested” data is less than seven percent of the total volume of data collected in Delaware.



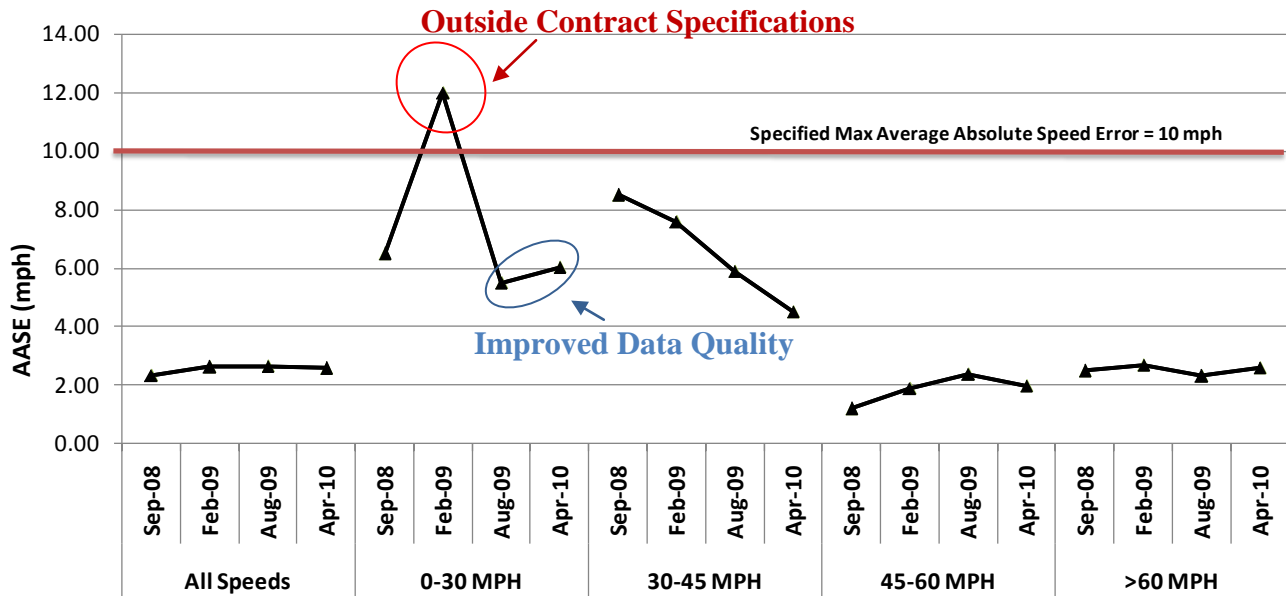
**Figure 10 - Hours of Data Collected (Excluding >60 mph Speed Bin) in Delaware**



**Figure 11 – Total Hours of Data Collected By Speed Range in Delaware**



Figure 12 presents the average absolute speed error for each validation event by speed range. As shown, data quality improves, particularly in the 0-30 mph speed bin, through late 2009 and 2010. This improvement is likely due to the increased amount of data collected in those lower speed ranges (as shown in Figure 10).



**Figure 12 – Average Absolute Speed Error (AASE) Per Validation Event in Delaware**

Table 6 presents the overall data validation results in Delaware. Both the AASE and SEB contract specifications are met.

**Table 6 – Overall Data Validation Results in Delaware**

Speed Bin	Average Absolute Speed Error (<10mph)	Speed Error Bias (<5mph)	Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with SEM Band		
0-30 MPH	6.0	3.7	75.9	2.3%
30-45 MPH	4.5	1.5	140.9	4.3%
45-60 MPH	2.0	-0.6	979.4	19.4%
> 60 MPH	2.6	-2.4	2104.3	63.8%
All Speeds	2.6	-1.6	3300.5	100.0%



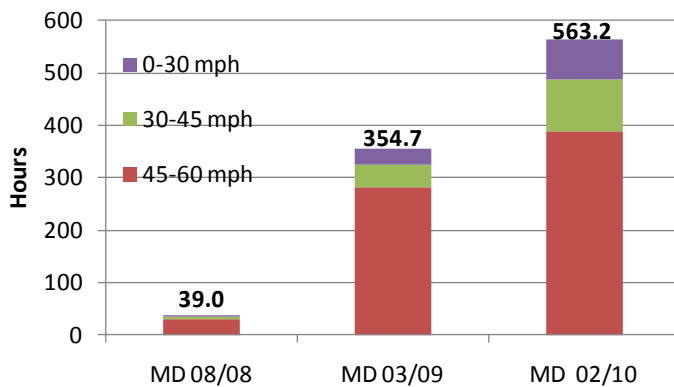
## Maryland

There have been three data validation efforts in Maryland. These efforts yielded a total of approximately 1,935 hours of data. The data collection periods are presented in Table 7 below.

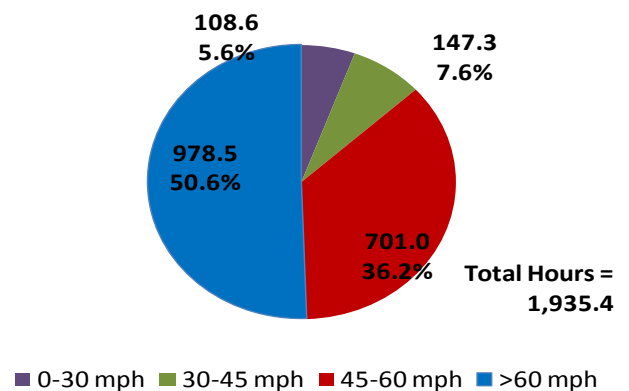
**Table 7 – Data Validation Efforts in Maryland**

Data Collection Period	Roadway/County
July/August 2008	MD 295/Prince George’s County I-495/Prince George’s County I-695/Baltimore County I-70/Howard and Baltimore Counties I-95/ Howard and Baltimore Counties I-97 Anne Arundel County US 29/Howard County
March 2009	I-95/Howard and Prince George’s Counties I-495/Prince George’s and Montgomery Counties
February 2010	I-495/Prince George’s and Montgomery Counties MD 355/ Montgomery County

Figures 13 and 14 present the breakdown of data collected by speed bin for the individual and cumulative efforts, respectively. As shown, more than 13 percent of the data collected represents congestion speed ranges.



**Figure 13 – Hours of Data Collected (Excluding >60 mph Speed Bin) in Maryland**



**Figure 14 – Total Hours of Data Collected Per Speed Range in Maryland**

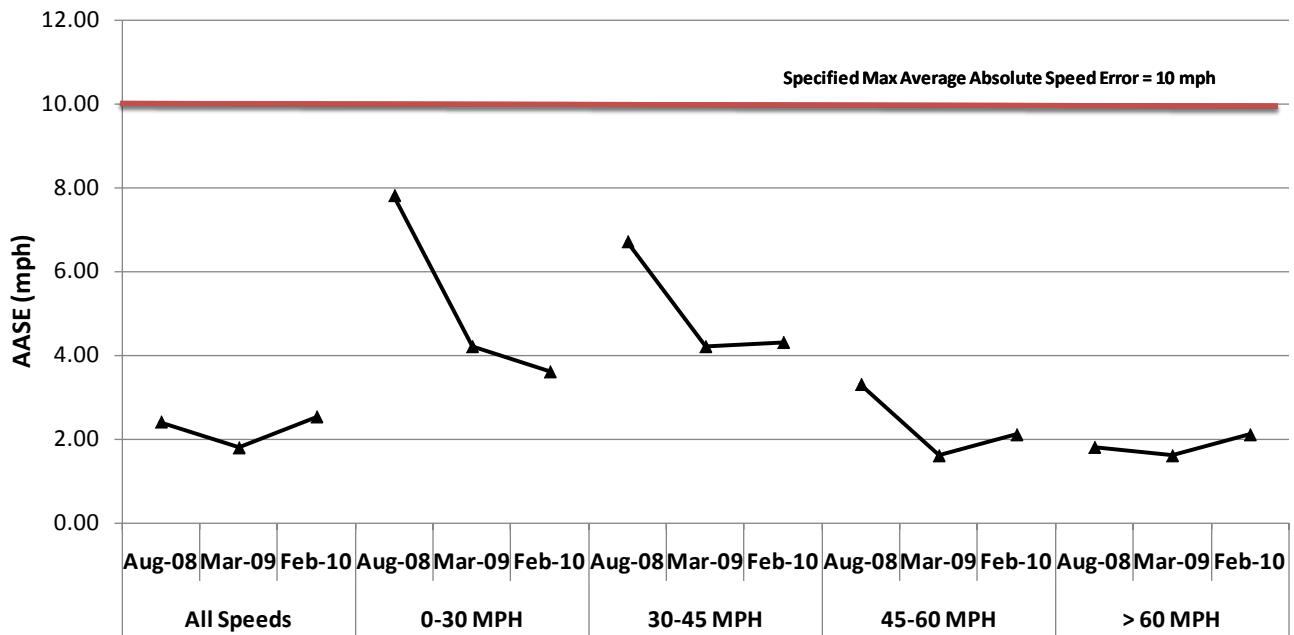
The overall data quality in Maryland met both standards for AASE and SEB, for all speed categories, as shown in Table 8 and Figure 15.





**Table 8 – Overall Data Validation Results in Maryland**

Speed Bin	Average Absolute Speed Error (<10mph)	Speed Error Bias (<5mph)	Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with SEM Band		
0-30 MPH	3.9	1.4	108.6	5.6%
30-45 MPH	4.4	1.7	147.3	7.6%
45-60 MPH	2.0	0.0	701.0	19.4%
> 60 MPH	1.7	-1.5	978.5	50.6%
All Speeds	2.1	-0.5	1935.4	100.0%



**Figure 15 – Average Absolute Speed Error (AASE) Per Validation Event in Maryland**



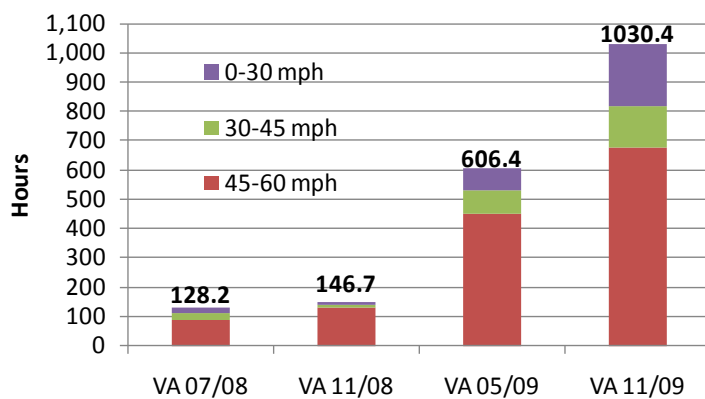
## Virginia

The four data collection events completed in Virginia yielded approximately 4,033 hours. The validation efforts are listed below in Table 9.

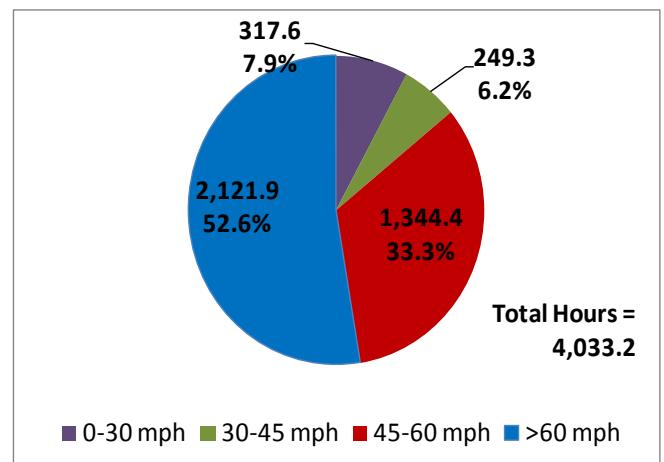
**Table 9 – Data Validation Efforts in Virginia**

Data Collection Period	Roadway/County
July 2008	I-395/Alexandria and Fairfax Counties I-495/Fairfax and Alexandria Counties I-66/Fairfax County I-95/Prince William, Fairfax, and Stafford Counties
November 2008	I-64/Henrico County and the City of Richmond I-295/Henrico County I-64 & I-95/City of Richmond I-95/City of Richmond and Chesterfield, Henrico, and Petersburg Counties I-295/Hanover County
May 2009	I-495/Fairfax and Alexandria Counties I-66/Fairfax County I-95/Fairfax and Alexandria Counties
November 2009	I-66, VA 7/Fairfax County

Figures 16 and 17 present the data collected as a result of the above data validation efforts. More than 14 percent of the total data collected was in the congested ranges, less than 45 mph.



**Figure 16 – Hours of Data Collected (Excluding >60 mph Speed Bin) in Virginia**



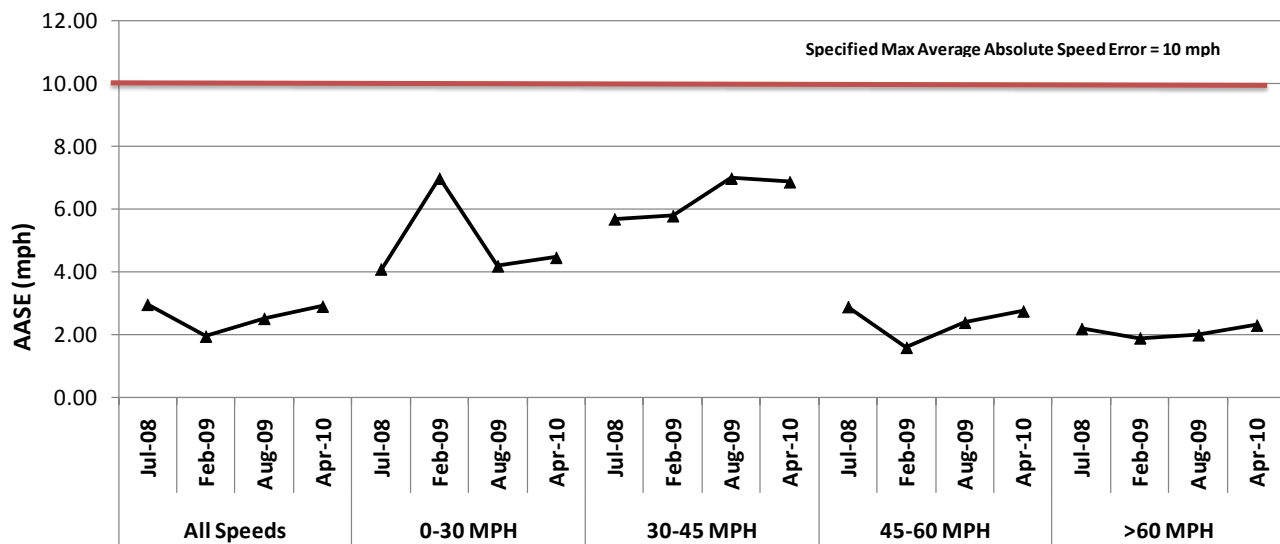
**Figure 17 – Total Hours of Data Collected Per Speed Range in Virginia**



Data quality based upon the study of more than 4000 hours of data is consistently within the contract specifications. The cumulative results are shown in Table 10 and Figure 18.

**Table 10 – Overall Data Validation Results in Virginia**

Speed Bin	Average Absolute Speed Error (<10mph)	Speed Error Bias (<5mph)	Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with SEM Band		
0-30 MPH	4.5	1.2	317.6	7.9%
30-45 MPH	6.9	1.1	249.3	6.2%
45-60 MPH	2.8	-0.1	1344.4	33.3%
> 60 MPH	2.3	-1.8	2121.9	52.6%
All Speeds	2.9	-0.8	4033.2	100.0%



**Figure 18 – Average Absolute Speed Error (AASE) Per Validation Event in Virginia**



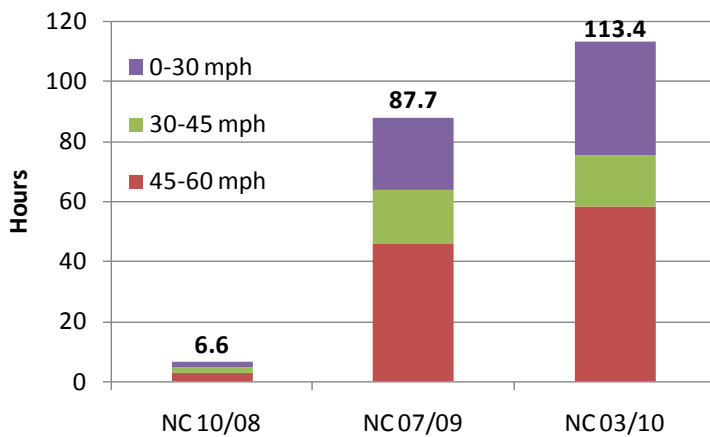
## North Carolina

There have been three data validation efforts, as listed below in Table 11, in North Carolina collecting approximately 2,725 hours of data.

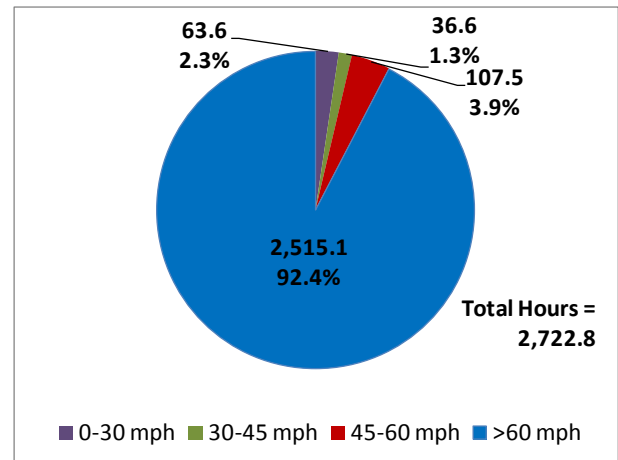
**Table 11 – Data Validation Efforts in North Carolina**

Data Collection Period	Roadway/County
October 2008	I-95/Halifax, Robeson and Johnston Counties
July 2009	I-95/Halifax and Nash Counties
March 2010	I-440/Wake County I-40/Wake and Durham Counties

Figures 19 and 20 present the data collected by speed range. As shown, less than five percent of the data collected was in the 45 mph or lower range.



**Figure 19 – Hours of Data Collected (Excluding >60 mph Speed Bin) in North Carolina**



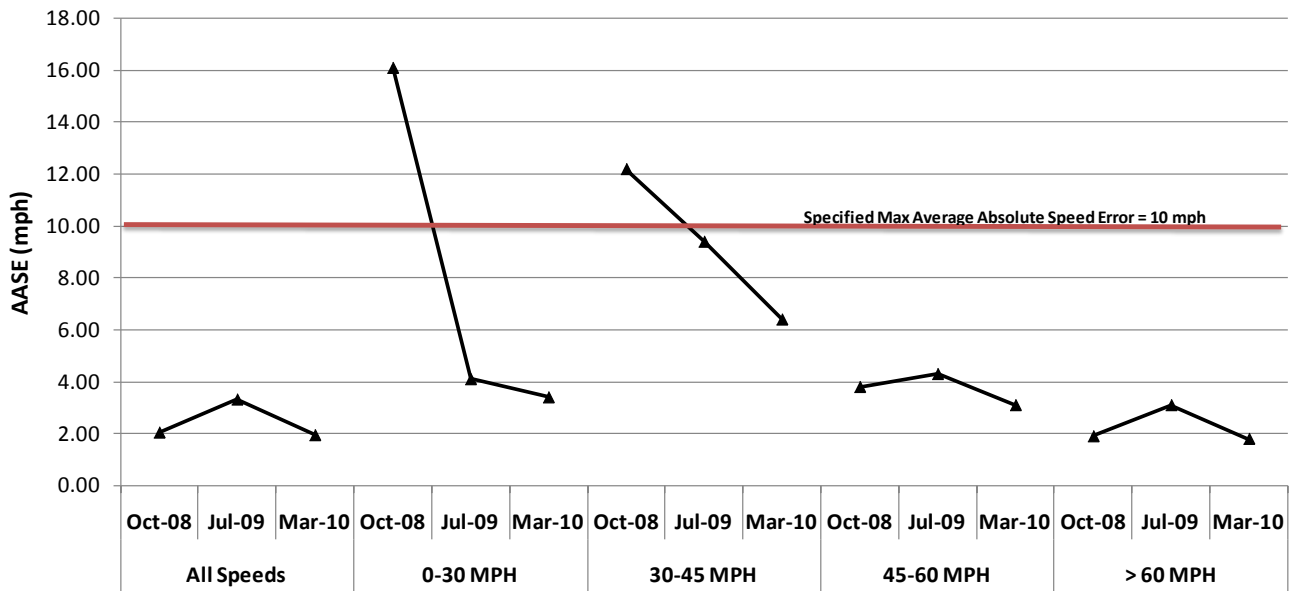
**Figure 20 – Total Hours of Data Collected By Speed Range in North Carolina**

The cumulative results are presented in Table 12. All data satisfied the contract requirements. Figure 21 presents the AASE data results.



**Table 12 – Overall Data Validation Results in North Carolina**

Speed Bin	Average Absolute Speed Error (<10mph)	Speed Error Bias (<5mph)	Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with SEM Band		
0-30 MPH	4.0	2.3	63.6	2.3%
30-45 MPH	8.1	0.9	36.6	1.3%
45-60 MPH	3.6	1.0	107.5	3.9%
> 60 MPH	2.2	-1.9	2515.1	92.4%
All Speeds	2.4	-1.6	2722.8	100.0%



**Figure 21 – Average Absolute Speed Error (AASE) Per Validation Event in North Carolina**



## Conclusion

Between July 2008 and June 2010, data was collected on an almost monthly basis from each of the core states producing a total of nearly 24,000 hours of data across approximately 390 miles. In general, the data satisfied the contract specifications. Accordingly, it has become apparent that as the amount of data acquired by INRIX increases, the data quality improves.



## Appendix A – Summary of Validation Events

The University of Maryland team collected data and completed data validation analyses on a rotating monthly schedule. Below is a summary of the data validation efforts as of September 1, 2010. Data validation reports can be found at <http://www.i95coalition.net/i95/Projects/ProjectDatabase/tabid/120/agentType/View/PropertyID/107/Default.aspx> under the heading “Data Validation”.

**Table 1A – Data Validation Efforts to Date**

State	Data Collection Period	Validation Report Published
Virginia	July 2008	January 2009
Maryland	July/August 2008	
Delaware	September 2008	
New Jersey	September/October 2008	
North Carolina	October/November 2008	February 2009
Virginia	November/December 2008	February 2009
Delaware	February 2009	May 2009
Maryland	March 2009	May 2009
New Jersey	April 2009	May 2009
Virginia	May 2009	June 2009
New Jersey	June 2009	August 2009
North Carolina	July 2009	August 2009
Delaware	August 2009	September 2009
New Jersey	September 2009	October 2009
New Jersey	October 2009	April 2010
Virginia	November 2009	February 2010
Pennsylvania	January 2010	March 2010
Maryland	April 2010	April 2010
North Carolina	March/April 2010	June 2010
Delaware	April/May 2010	July 2010
New Jersey	May 2010	July 2010
New Jersey	June 2010	August 2010



## Appendix B – Cumulative State Data Validation Results

**Table 1B – Individual State Data Validation Overall and Cumulative Results**

Cumulative Total - All States (July 2008 - June 2010)					Miles Tested = 390.7	
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	5.3	6.6	2.7	3.0	800.5	3.4%
30-45 MPH	6.3	8.6	2.1	3.1	777.5	3.3%
45-60 MPH	2.4	4.6	0.0	0.4	4,625.0	19.4%
> 60 MPH	2.6	5.1	-2.3	-4.1	17,566.2	73.9%
All Speeds	2.8	5.1	-1.5	-2.8	23,769.2	100.0%

New Jersey (Overall)					Miles Tested = 162.7	
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	7.4	8.5	5.3	5.8	209.8	2.1%
30-45 MPH	8.0	10.4	4.8	6.0	168.9	1.7%
45-60 MPH	2.7	5.0	0.6	1.6	1111.4	19.4%
> 60 MPH	2.8	5.3	-2.5	-4.4	8631.7	85.3%
All Speeds	3.0	5.4	-1.9	-3.3	10121.8	100.0%

Pennsylvania (Overall)					Miles Tested = 16.3	
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	6.5	7.7	2.5	2.5	25.0	1.5%
30-45 MPH	7.0	8.6	1.1	1.4	34.5	2.1%
45-60 MPH	2.3	4.3	-0.3	0.0	381.3	19.4%
> 60 MPH	3.3	5.9	-3.2	-5.5	1214.7	73.4%
All Speeds	3.2	5.6	-2.4	-4.0	1655.5	100.0%

Delaware (Overall)					Miles Tested = 45.5	
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	6.0	7.8	3.7	4.6	75.9	2.3%
30-45 MPH	4.5	7.1	1.5	2.8	140.9	4.3%
45-60 MPH	2.0	4.3	-0.6	-1.0	979.4	19.4%
> 60 MPH	2.6	5.3	-2.4	-4.6	2104.3	63.8%
All Speeds	2.6	5.1	-1.6	-3.0	3300.5	100.0%





**Table 1B – Individual State Data Validation Overall and Cumulative Results (cont'd)**

<b>Maryland (Overall)</b>						<b>Miles Tested = 69.8</b>	
<b>Speed Bin</b>	<b>Average Absolute Speed Error (&lt;10mph)</b>		<b>Speed Error Bias (&lt;5mph)</b>		<b>Hours of Data Collection</b>	<b>Percent of Total Data</b>	
	<b>Comparison with SEM Band</b>	<b>Comparison with Mean</b>	<b>Comparison with SEM Band</b>	<b>Comparison with Mean</b>			
0-30 MPH	3.9	5.2	1.4	1.8	108.6	5.6%	
30-45 MPH	4.4	6.6	1.7	2.6	147.3	7.6%	
45-60 MPH	2.0	3.9	0.0	0.3	701.0	19.4%	
> 60 MPH	1.7	4.0	-1.5	-2.9	978.5	50.6%	
All Speeds	2.1	4.2	-0.5	-1.0	1935.4	100.0%	

<b>Virginia (Overall)</b>						<b>Miles Tested = 77.9</b>	
<b>Speed Bin</b>	<b>Average Absolute Speed Error (&lt;10mph)</b>		<b>Speed Error Bias (&lt;5mph)</b>		<b>Hours of Data Collection</b>	<b>Percent of Total Data</b>	
	<b>Comparison with SEM Band</b>	<b>Comparison with Mean</b>	<b>Comparison with SEM Band</b>	<b>Comparison with Mean</b>			
0-30 MPH	4.5	5.6	1.2	1.4	317.6	7.9%	
30-45 MPH	6.9	9.2	1.1	2.0	249.3	6.2%	
45-60 MPH	2.8	4.8	-0.1	0.5	1344.4	33.3%	
> 60 MPH	2.3	4.4	-1.8	-3.1	2121.9	52.6%	
All Speeds	2.9	4.9	-0.8	-1.2	4033.2	100.0%	

<b>North Carolina (Overall)</b>						<b>Miles Tested = 18.5</b>	
<b>Speed Bin</b>	<b>Average Absolute Speed Error (&lt;10mph)</b>		<b>Speed Error Bias (&lt;5mph)</b>		<b>Hours of Data Collection</b>	<b>Percent of Total Data</b>	
	<b>Comparison with SEM Band</b>	<b>Comparison with Mean</b>	<b>Comparison with SEM Band</b>	<b>Comparison with Mean</b>			
0-30 MPH	4.0	5.0	2.3	2.5	63.6	2.3%	
30-45 MPH	8.1	10.2	0.9	1.5	36.6	1.3%	
45-60 MPH	3.6	6.6	1.0	2.8	107.5	3.9%	
> 60 MPH	2.2	4.7	-1.9	-3.5	2515.1	92.4%	
All Speeds	2.4	4.8	-1.6	-3.0	2722.8	100.0%	



Total Hours of Data Collected

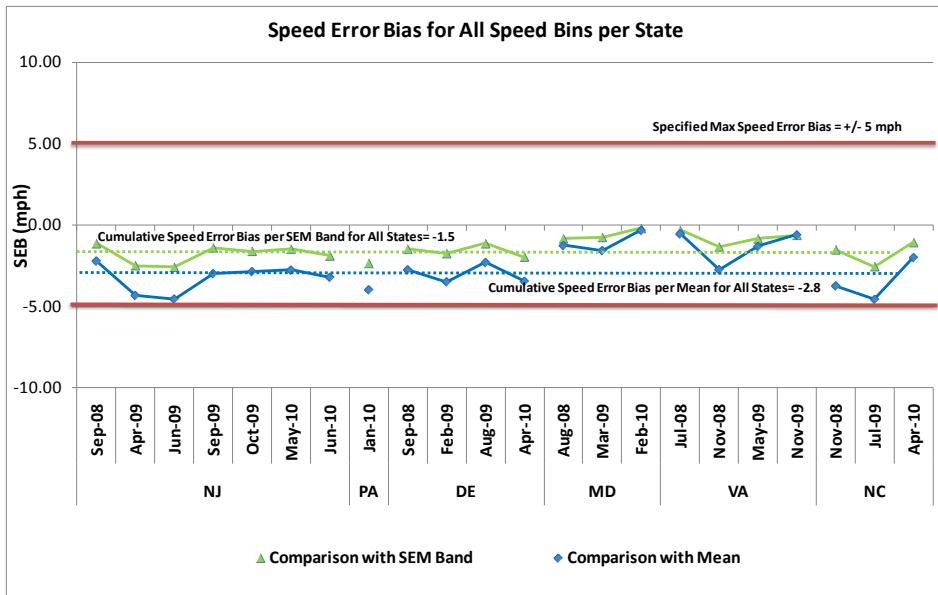
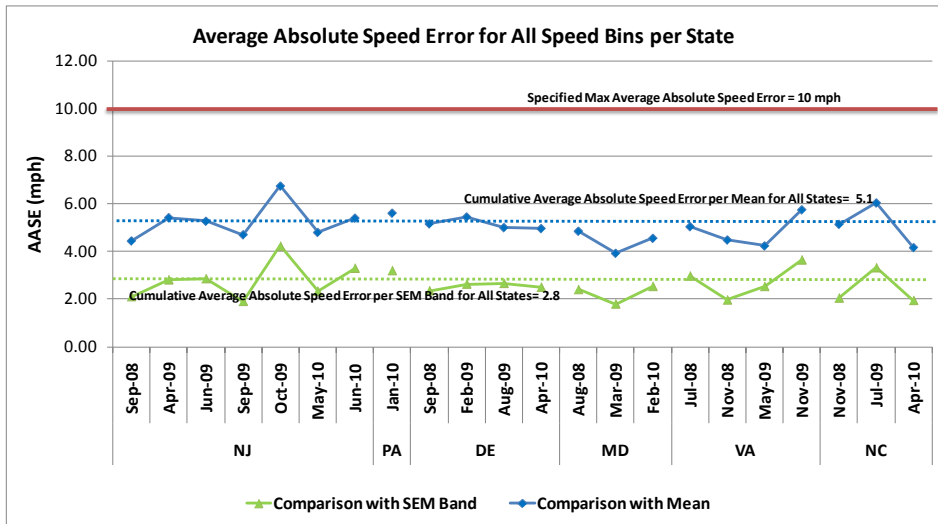
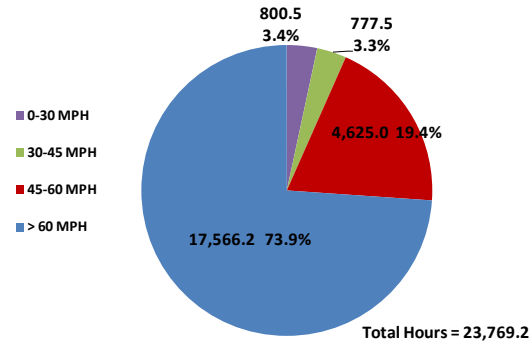


Figure 1B - Cumulative State Data Validation Results

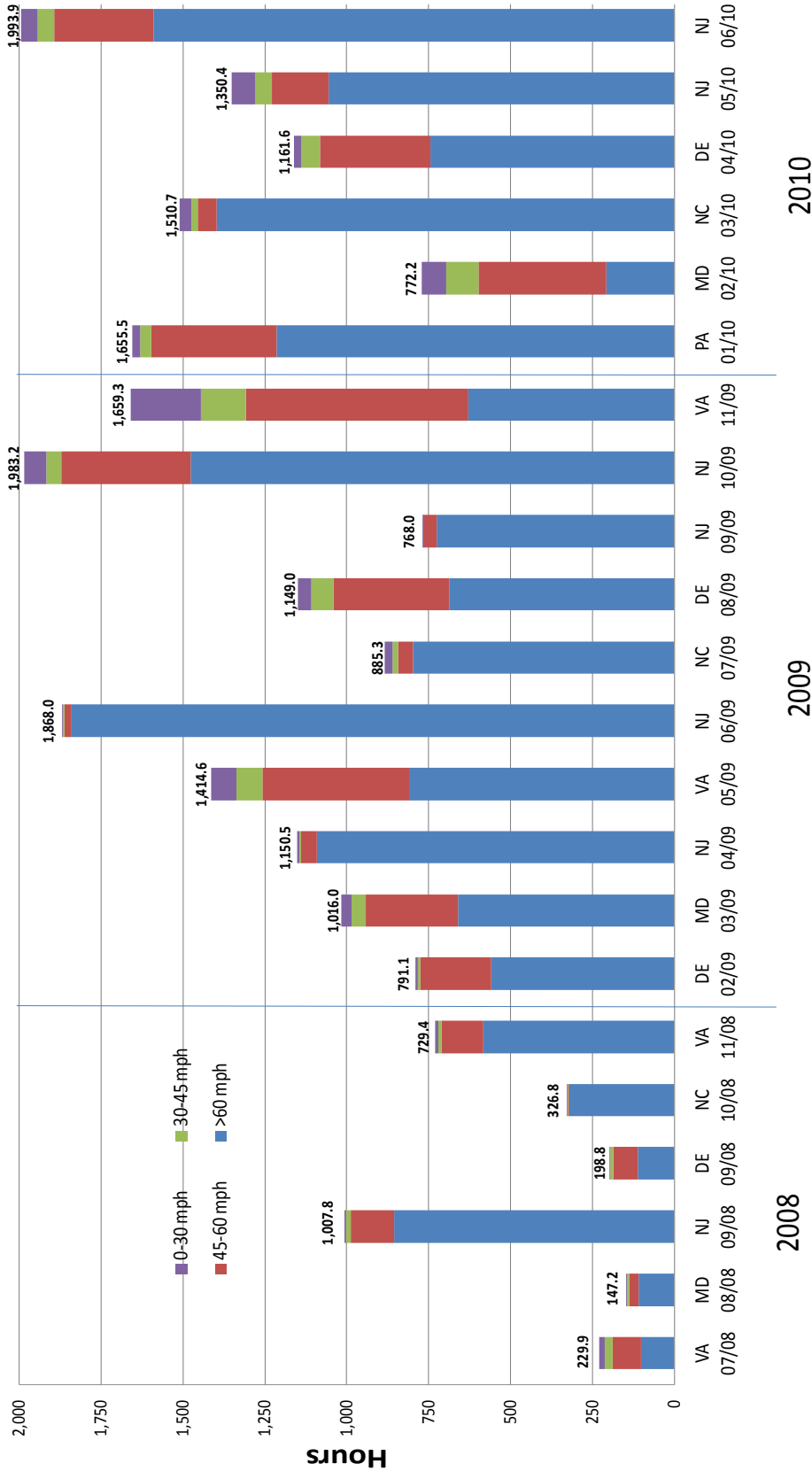


Figure 2B – Hours of Data Collected per Event



## Appendix C – Individual State Data Validation Results

### New Jersey

**Table 1C – New Jersey Data Validation Overall and Cumulative Results**

New Jersey (Overall)					Miles Tested = 162.7	
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	7.4	8.5	5.3	5.8	209.8	2.1%
30-45 MPH	8.0	10.4	4.8	6.0	168.9	1.7%
45-60 MPH	2.7	5.0	0.6	1.6	1111.4	19.4%
> 60 MPH	2.8	5.3	-2.5	-4.4	8631.7	85.3%
All Speeds	3.0	5.4	-1.9	-3.3	10121.8	100.0%

Southern New Jersey (June 2010)					Miles Tested = 14.3	
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	5.9	6.9	4.6	5.1	50.4	0.5%
30-45 MPH	5.4	7.2	2.2	2.9	50.2	0.5%
45-60 MPH	2.3	4.0	0.0	0.4	303.0	3.0%
> 60 MPH	3.3	5.6	-2.6	-4.3	1590.3	15.7%
All Speeds	3.3	5.4	-1.9	-3.2	1993.9	19.7%

Northern New Jersey (May 2010)					Miles Tested = 11.5	
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	3.2	4.1	1.7	2.0	72.7	5.4%
30-45 MPH	4.0	6.2	1.1	1.9	49.0	3.6%
45-60 MPH	1.7	4.1	0.2	1.4	174.6	12.9%
> 60 MPH	2.3	4.9	-2.1	-4.0	1054.1	78.1%
All Speeds	2.3	4.8	-1.5	-2.8	1350.4	100.0%

Southern New Jersey (October 2009)					Miles Tested = 13.7	
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	12.5	13.6	9.2	9.6	67.7	3.4%
30-45 MPH	14.4	17.5	11.1	13.0	45.7	2.3%
45-60 MPH	3.6	6.0	1.0	2.0	393.2	19.8%
> 60 MPH	3.7	6.3	-3.2	-5.2	1476.6	74.5%
All Speeds	4.2	6.7	-1.6	-2.8	1983.2	100.0%



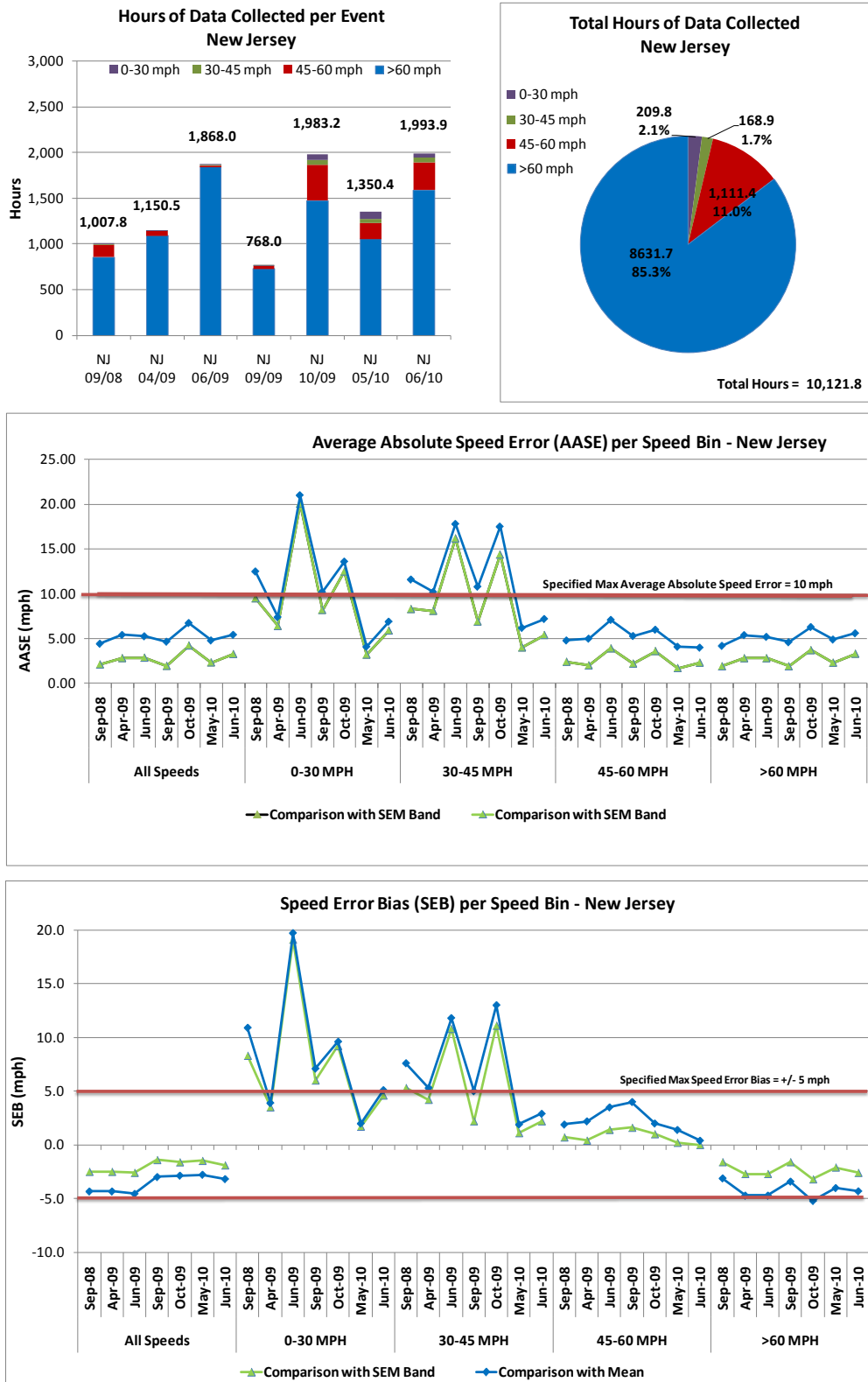
**Table 1C – New Jersey Data Validation Overall and Cumulative Results (cont'd)**

<b>Southern New Jersey (September 2009)</b>					<b>Miles Tested = 16.3</b>	
<b>Speed Bin</b>	<b>Average Absolute Speed Error (&lt;10mph)</b>		<b>Speed Error Bias (&lt;5mph)</b>		<b>Hours of Data Collection</b>	<b>Percent of Total Data</b>
	<b>Comparison with SEM Band</b>	<b>Comparison with Mean</b>	<b>Comparison with SEM Band</b>	<b>Comparison with Mean</b>		
0-30 MPH	8.2	10.2	6.0	7.1	3.2	0.4%
30-45 MPH	6.9	10.8	2.2	5.0	0.8	0.1%
45-60 MPH	2.2	5.3	1.6	4.0	38.3	5.0%
> 60 MPH	1.9	4.6	-1.6	-3.4	725.7	94.5%
All Speeds	1.9	4.7	-1.4	-3.0	768.0	100.0%

<b>Southern New Jersey (June 2009)</b>					<b>Miles Tested = 63.3</b>	
<b>Speed Bin</b>	<b>Average Absolute Speed Error (&lt;10mph)</b>		<b>Speed Error Bias (&lt;5mph)</b>		<b>Hours of Data Collection</b>	<b>Percent of Total Data</b>
	<b>Comparison with SEM Band</b>	<b>Comparison with Mean</b>	<b>Comparison with SEM Band</b>	<b>Comparison with Mean</b>		
0-30 MPH	20.1	21.0	19.1	19.7	2.2	0.1%
30-45 MPH	16.2	17.8	10.8	11.8	4.3	0.2%
45-60 MPH	3.9	7.1	1.4	3.5	21.2	1.1%
> 60 MPH	2.8	5.2	-2.7	-4.7	1840.3	98.5%
All Speeds	2.9	5.3	-2.6	-4.5	1868.0	100.0%

<b>Northern New Jersey (April 2009)</b>					<b>Miles Tested = 15.9</b>	
<b>Speed Bin</b>	<b>Average Absolute Speed Error (&lt;10mph)</b>		<b>Speed Error Bias (&lt;5mph)</b>		<b>Hours of Data Collection</b>	<b>Percent of Total Data</b>
	<b>Comparison with SEM Band</b>	<b>Comparison with Mean</b>	<b>Comparison with SEM Band</b>	<b>Comparison with Mean</b>		
0-30 MPH	6.4	7.4	3.5	3.9	7.0	0.6%
30-45 MPH	8.1	10.2	4.2	5.3	4.9	0.4%
45-60 MPH	2.0	5.0	0.4	2.2	48.2	4.2%
> 60 MPH	2.8	5.4	-2.7	-4.7	1090.4	94.8%
All Speeds	2.8	5.4	-2.5	-4.3	1150.5	100.0%

<b>New Jersey (September/October 2008)</b>					<b>Miles Tested = 27.7</b>	
<b>Speed Bin</b>	<b>Average Absolute Speed Error (&lt;10mph)</b>		<b>Speed Error Bias (&lt;5mph)</b>		<b>Hours of Data Collection</b>	<b>Percent of Total Data</b>
	<b>Comparison with SEM Band</b>	<b>Comparison with Mean</b>	<b>Comparison with SEM Band</b>	<b>Comparison with Mean</b>		
0-30 MPH	9.5	12.5	8.3	10.9	6.6	0.7%
30-45 MPH	8.3	11.6	5.3	7.6	14.0	1.4%
45-60 MPH	2.4	4.8	0.7	1.9	132.9	13.2%
> 60 MPH	1.9	4.2	-1.6	-3.1	854.3	84.8%
All Speeds	2.1	4.4	-1.1	-2.2	1007.8	100.0%



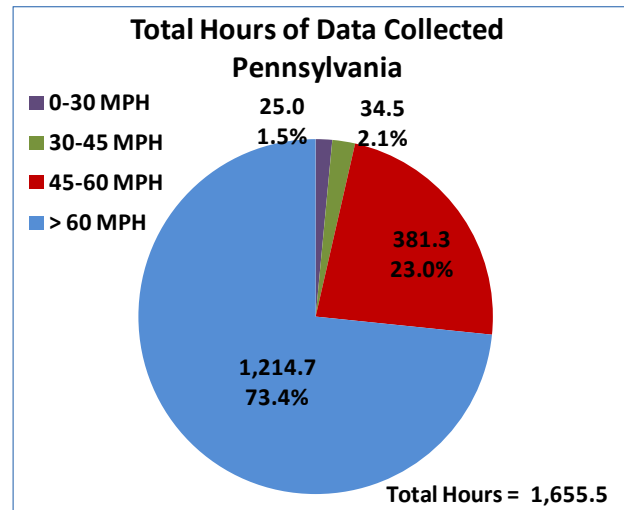
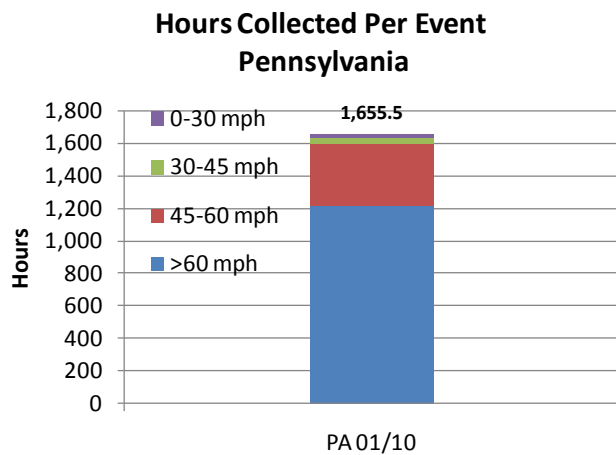
**Figure 1C - Overall New Jersey State Data Validation Results**



## Pennsylvania

**Table 2C – Pennsylvania Data Validation Overall and Cumulative Results**

Pennsylvania (Overall/January 2010)					Miles Tested = 16.3	
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	6.5	7.7	2.5	2.5	25.0	1.5%
30-45 MPH	7.0	8.6	1.1	1.4	34.5	2.1%
45-60 MPH	2.3	4.3	-0.3	0.0	381.3	19.4%
> 60 MPH	3.3	5.9	-3.2	-5.5	1214.7	73.4%
All Speeds	3.2	5.6	-2.4	-4.0	1655.5	100.0%



**Figure 2C - Overall Pennsylvania State Data Validation Results**



## Delaware

**Table 3C - Delaware Data Validation Overall and Cumulative Results**

Delaware (Overall) <span style="float: right;">Miles Tested = 45.5</span>						
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	6.0	7.8	3.7	4.6	75.9	2.3%
30-45 MPH	4.5	7.1	1.5	2.8	140.9	4.3%
45-60 MPH	2.0	4.3	-0.6	-1.0	979.4	19.4%
> 60 MPH	2.6	5.3	-2.4	-4.6	2104.3	63.8%
All Speeds	2.6	5.1	-1.6	-3.0	3300.5	100.0%

Delaware (April 2010) <span style="float: right;">Miles Tested = 13.4</span>						
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	4.7	7.2	4.0	5.7	22.6	1.9%
30-45 MPH	1.9	5.3	0.7	2.4	57.9	5.0%
45-60 MPH	1.8	4.2	-1.2	-2.3	335.7	28.9%
> 60 MPH	2.8	5.2	-2.7	-4.7	745.4	64.2%
All Speeds	2.5	5.0	-2.0	-3.4	1161.6	100.0%

Delaware (August 2009) <span style="float: right;">Miles Tested = 11.2</span>						
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	5.5	6.8	2.7	3.1	41.7	3.6%
30-45 MPH	5.9	7.6	2.2	2.9	66.3	5.8%
45-60 MPH	2.4	4.5	-0.3	-0.3	353.5	30.8%
> 60 MPH	2.3	4.9	-2.1	-4.1	687.3	59.8%
All Speeds	2.7	5.0	-1.1	-2.3	1149.0	100.0%

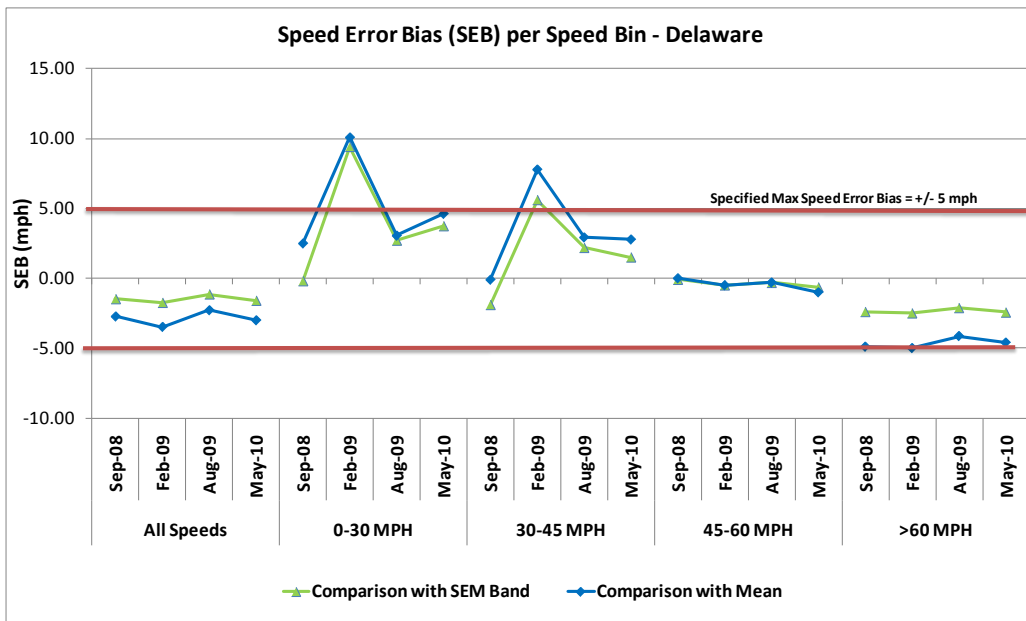
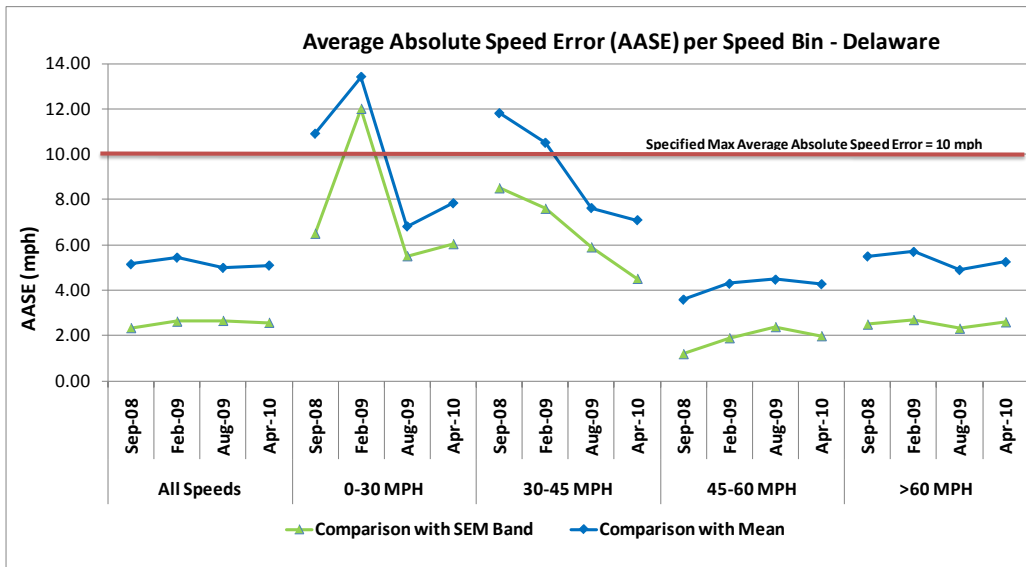
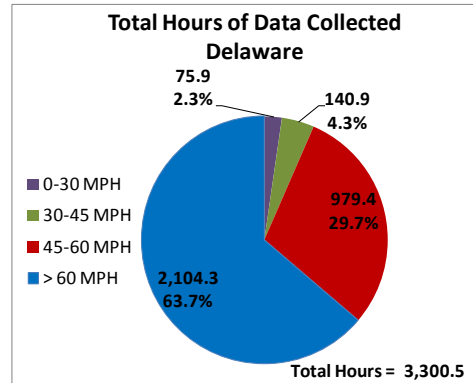
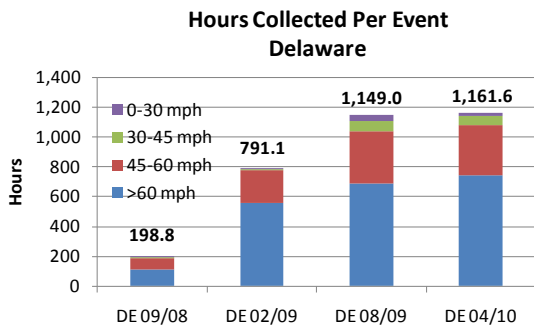
  

Delaware (February 2009) <span style="float: right;">Miles Tested = 15.3</span>						
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	12.0	13.4	9.4	10.1	8.6	1.1%
30-45 MPH	7.6	10.5	5.6	7.8	7.7	1.0%
45-60 MPH	1.9	4.3	-0.5	-0.5	215.8	27.3%
> 60 MPH	2.7	5.7	-2.5	-5.0	559.0	70.7%
All Speeds	2.6	5.4	-1.7	-3.5	791.1	100.0%

Delaware (September 2008) <span style="float: right;">Miles Tested = 5.6</span>						
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	6.5	10.9	-0.2	2.5	3.0	1.5%
30-45 MPH	8.5	11.8	-1.9	-0.1	9.0	4.5%
45-60 MPH	1.2	3.6	-0.1	0.0	74.4	37.4%
> 60 MPH	2.5	5.5	-2.4	-4.9	112.4	56.5%
All Speeds	2.3	5.2	-1.5	-2.7	198.8	100.0%





**Figure 4C –Overall Delaware State Data Validation Results**



## Maryland

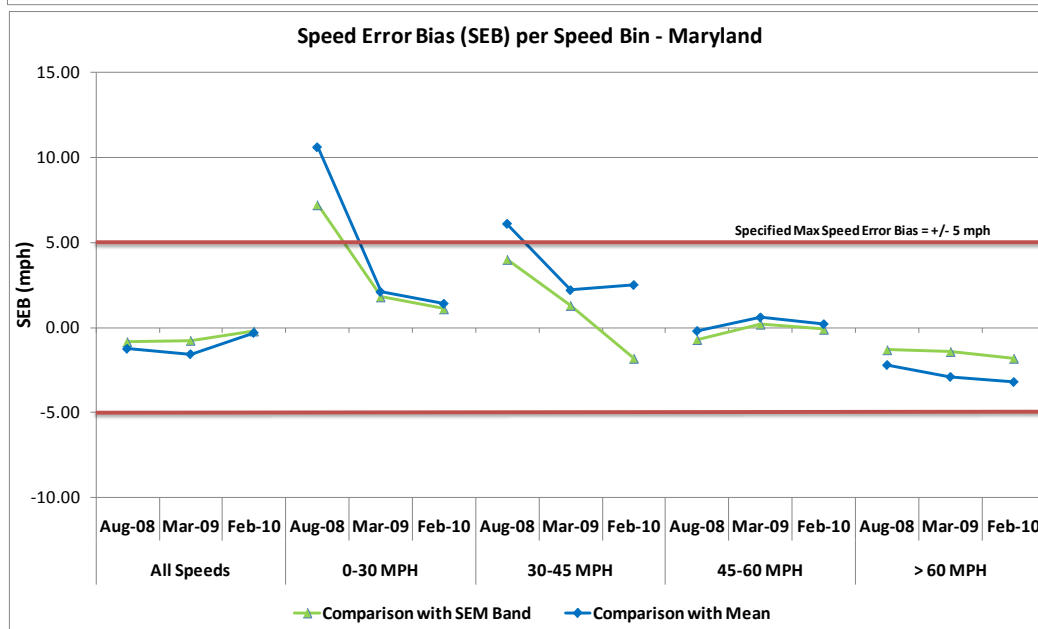
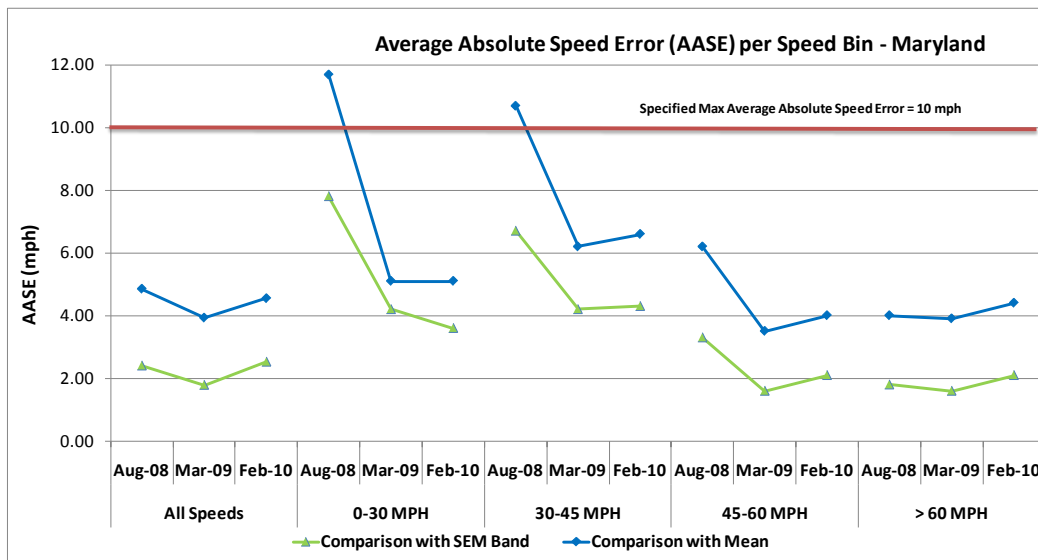
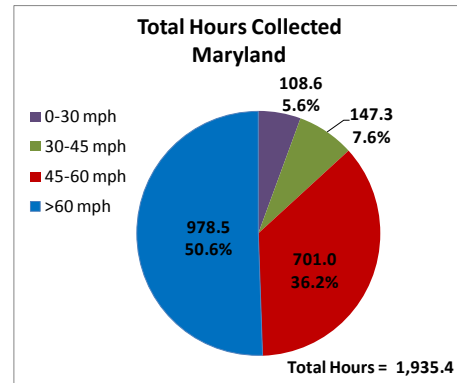
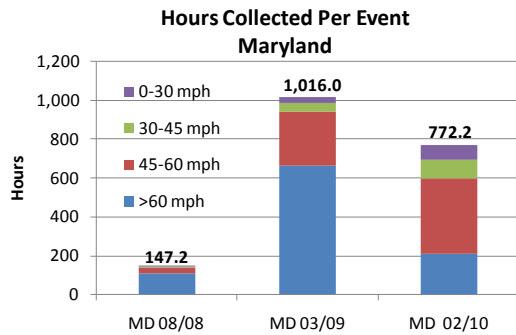
**Table 4C – Maryland Data Validation Overall and Cumulative Results**

Maryland (Overall)					Miles Tested = 69.8	
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	3.9	5.2	1.4	1.8	108.6	5.6%
30-45 MPH	4.4	6.6	1.7	2.6	147.3	7.6%
45-60 MPH	2.0	3.9	0.0	0.3	701.0	19.4%
> 60 MPH	1.7	4.0	-1.5	-2.9	978.5	50.6%
All Speeds	2.1	4.2	-0.5	-1.0	1935.4	100.0%

Maryland (February 2010)					Miles Tested = 16.3	
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	3.6	5.1	1.1	1.4	76.5	9.9%
30-45 MPH	4.3	6.6	1.8	2.5	97.4	12.6%
45-60 MPH	2.1	4.0	-0.1	0.2	389.3	50.4%
> 60 MPH	2.1	4.4	-1.8	-3.2	209.0	27.1%
All Speeds	2.5	4.5	-0.2	-0.3	772.2	100.0%

Maryland (March 2009)					Miles Tested = 19.4	
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	4.2	5.1	1.8	2.1	29.7	2.9%
30-45 MPH	4.2	6.2	1.3	2.2	44.1	4.3%
45-60 MPH	1.6	3.5	0.2	0.6	280.9	27.6%
> 60 MPH	1.6	3.9	-1.4	-2.9	661.3	65.1%
All Speeds	1.8	3.9	-0.7	-1.6	1016.0	100.0%

Maryland (August 2008)					Miles Tested = 34.1	
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	7.8	11.7	7.2	10.6	2.4	1.6%
30-45 MPH	6.7	10.7	4.0	6.1	5.8	3.9%
45-60 MPH	3.3	6.2	-0.7	-0.2	30.8	21.0%
> 60 MPH	1.8	4.0	-1.3	-2.2	108.2	73.5%
All Speeds	2.4	4.8	-0.8	-1.2	147.2	100.0%



**Figure 5C - Overall Maryland State Data Validation Results**



**Virginia**

**Table 5C – Virginia Data Validation Overall and Cumulative Results**

<b>Virginia (Overall)</b> Miles Tested = 77.9						
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	4.5	5.6	1.2	1.4	317.6	7.9%
30-45 MPH	6.9	9.2	1.1	2.0	249.3	6.2%
45-60 MPH	2.8	4.8	-0.1	0.5	1344.4	33.3%
> 60 MPH	2.3	4.4	-1.8	-3.1	2121.9	52.6%
All Speeds	2.9	4.9	-0.8	-1.2	4033.2	100.0%

<b>Northern Virginia (November 2009)</b> Miles Tested = 13.6						
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	4.5	5.6	0.7	0.8	213.9	12.9%
30-45 MPH	7.1	9.8	0.6	1.8	137.7	8.3%
45-60 MPH	3.2	5.4	-0.1	0.6	678.4	40.9%
> 60 MPH	3.1	5.3	-1.9	-2.9	629.3	37.9%
All Speeds	3.7	5.8	-0.6	-0.6	1659.3	100.0%

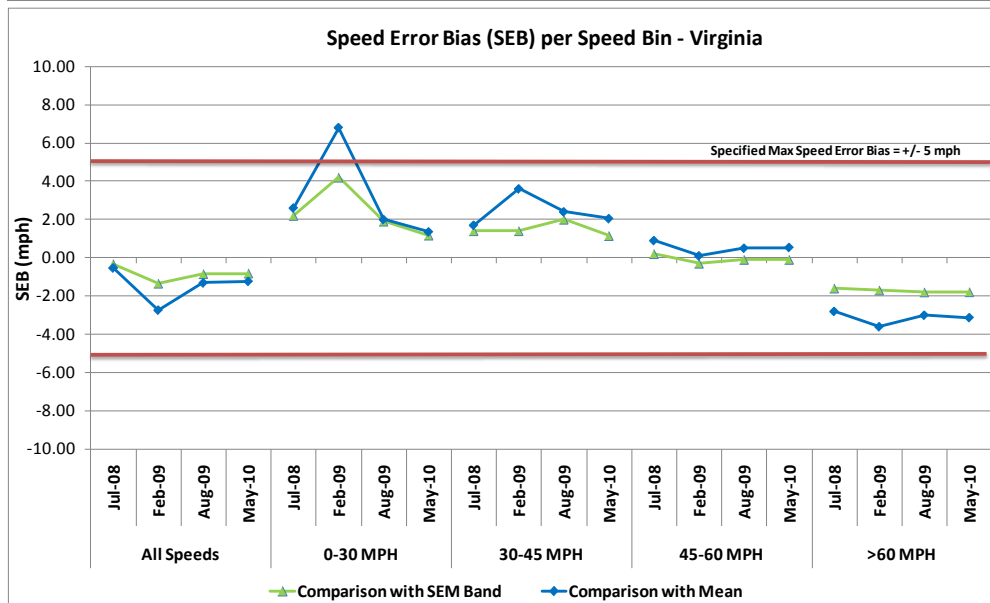
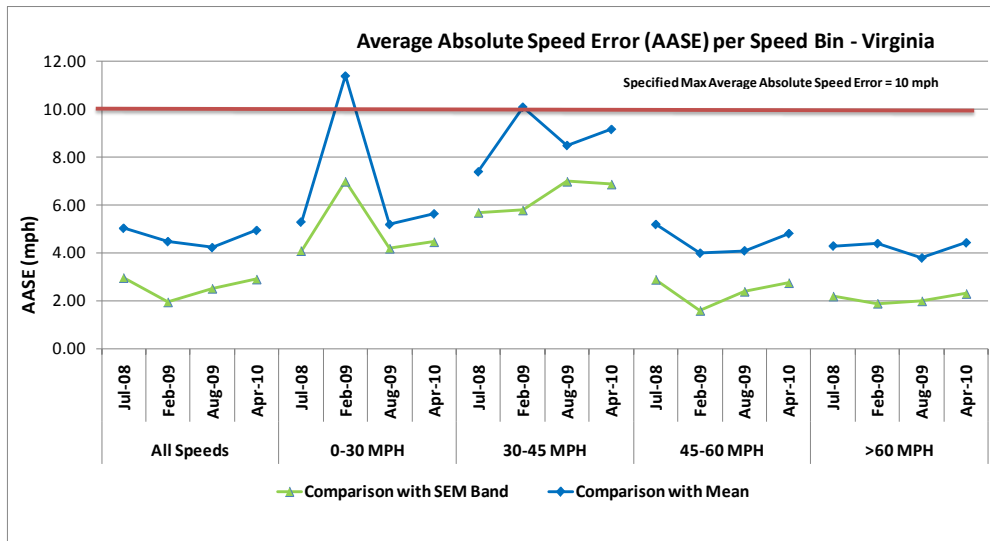
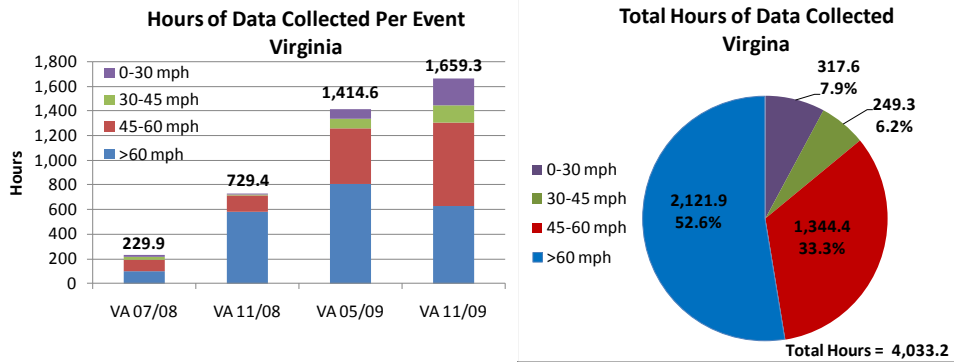
<b>Northern Virginia (May 2009)</b> Miles Tested = 13.9						
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	4.2	5.2	1.9	2.0	78.5	5.5%
30-45 MPH	7.0	8.5	2.0	2.4	78.0	5.5%
45-60 MPH	2.4	4.1	-0.1	0.5	449.9	31.8%
> 60 MPH	2.0	3.8	-1.8	-3.0	808.2	57.1%
All Speeds	2.5	4.2	-0.8	-1.3	1414.6	100.0%

<b>Central Virginia (November 2008)</b> Miles Tested = 17.0						
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	7.0	11.4	4.2	6.8	8.5	1.2%
30-45 MPH	5.8	10.1	1.4	3.6	9.3	1.3%
45-60 MPH	1.6	4.0	-0.3	0.1	128.9	17.7%
> 60 MPH	1.9	4.4	-1.7	-3.6	582.7	79.9%
All Speeds	2.0	4.5	-1.3	-2.7	729.3	100.0%

<b>Northern Virginia (July 2008)</b> Miles Tested = 33.4						
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	4.1	5.3	2.2	2.6	16.7	7.3%
30-45 MPH	5.7	7.4	1.4	1.7	24.3	10.6%
45-60 MPH	2.9	5.2	0.2	0.9	87.2	37.9%
> 60 MPH	2.2	4.3	-1.6	-2.8	101.7	44.3%
All Speeds	3.0	5.0	-0.3	-0.5	229.8	100.0%



**Figure 6C - Overall Virginia State Data Validation Results**



## North Carolina

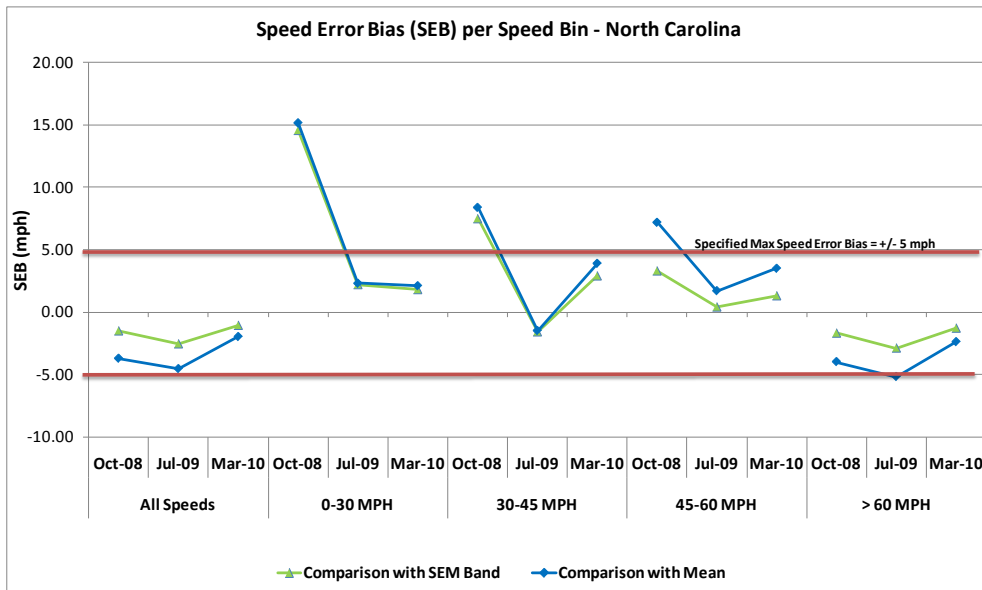
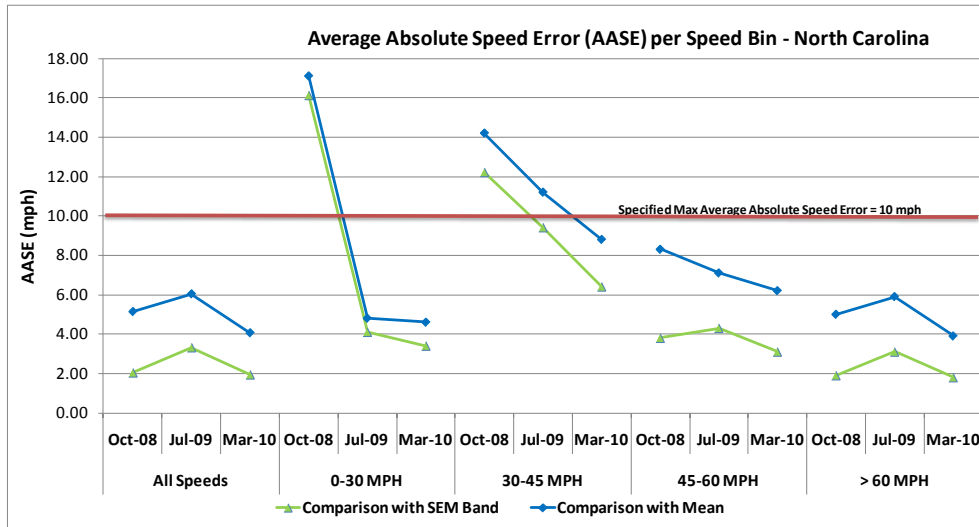
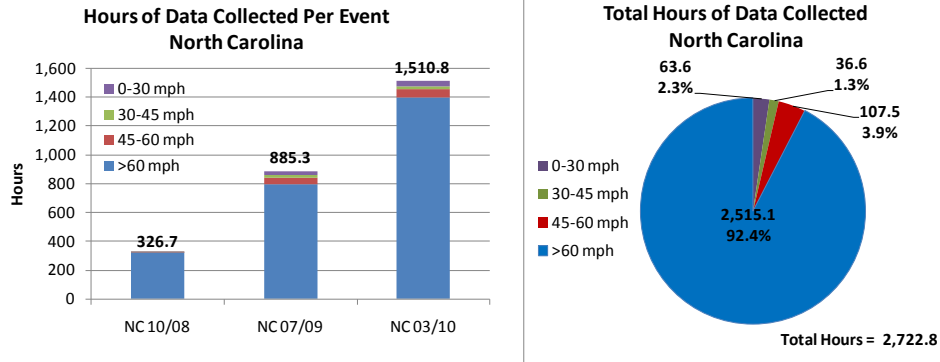
**Table 6C – North Carolina Data Validation Overall and Cumulative Results**

North Carolina (Overall)					Miles Tested = 103.2	
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	4.0	5.0	2.3	2.5	63.6	2.3%
30-45 MPH	8.1	10.2	0.9	1.5	36.6	1.3%
45-60 MPH	3.6	6.6	1.0	2.8	107.5	3.9%
> 60 MPH	2.2	4.7	-1.9	-3.5	2515.1	92.4%
All Speeds	2.4	4.8	-1.6	-3.0	2722.8	100.0%

North Carolina (March 2010)					Miles Tested = 18.5	
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	3.4	4.6	1.8	2.1	38.0	2.5%
30-45 MPH	6.4	8.8	2.9	3.9	17.0	1.1%
45-60 MPH	3.1	6.2	1.3	3.5	58.4	3.9%
> 60 MPH	1.8	3.9	-1.3	-2.4	1397.3	92.5%
All Speeds	1.9	4.1	-1.1	-2.0	1510.7	100.0%

North Carolina (July 2009)					Miles Tested = 42.4	
Speed Bin	Average Absolute Speed Error		Speed Error Bias		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	4.1	4.8	2.2	2.3	24.0	2.7%
30-45 MPH	9.4	11.2	-1.6	-1.5	17.8	2.0%
45-60 MPH	4.3	7.1	0.4	1.7	45.9	5.2%
> 60 MPH	3.1	5.9	-2.9	-5.2	797.6	90.1%
All Speeds	3.3	6.0	-2.6	-4.6	885.3	100.0%

North Carolina (October 2008)					Miles Tested = 42.3	
Speed Bin	Average Absolute Speed Error		Speed Error Bias		Hours of Data Collection	Percent of Total Data
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	16.10	17.10	14.60	15.20	1.6	0.5%
30-45 MPH	12.20	14.20	7.50	8.40	1.8	0.5%
45-60 MPH	3.80	8.30	3.30	7.20	3.2	1.0%
> 60 MPH	1.90	5.00	-1.70	-4.00	320.2	98.0%
All Speeds	2.04	5.14	-1.52	-3.73	326.8	100.0%



**Figure 7C - Overall North Carolina State Data Validation Results**