



I-95 Corridor Coalition

I-95 Corridor Coalition Vehicle Probe Project: Validation of INRIX Data Monthly Report Pennsylvania



January 2012

I-95 CORRIDOR COALITION VEHICLE PROBE PROJECT: VALIDATION OF INRIXDATA JANUARY 2012

Monthly Report

Prepared for:

I-95 Corridor Coalition

Sponsored by:

I-95 Corridor Coalition

Prepared by:

Ali Haghani, Masoud Hamedi, Kaveh Farokhi Sadabadi
University of Maryland, College Park

Acknowledgements:

The research team would like to express its gratitude for the assistance it received from the state highway officials in Delaware, Maryland, New Jersey, North Carolina, South Carolina, Virginia, and Pennsylvania during the course of this study. Their effort was instrumental during the data collection phase of the project. This report would not have been completed without their help.

January 2012

Evaluation Results for the State of Pennsylvania

Executive Summary

Travel time samples were collected in Pennsylvania along approximately 32 freeway miles from Thursday, September 1, 2011 through Thursday, September 15, 2011. Freeway segments studied were located along I-83 and I-81 in Dauphin and Cumberland Counties. Data collected for the freeway validation was compared with travel time and speed data reported by INRIX as part of the I-95 Vehicle Probe project. The freeway validation data below represents approximately 1760 hours of observations along 14 freeway segments, totaling approximately 32 miles.

ES Table 1, below summarizes the results of the comparison between the validation data and the INRIX data for freeway segments during this period. As shown, the average absolute speed error (AASE) and Speed Error Bias were within specification for all speed bins. Even when errors are measured against the mean (rather than the SEM band) the average absolute speed error meets contract specifications.

ES Table 1 - Pennsylvania Evaluation Summary						
Speed Bin	Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Number of 5 Minute Samples	Hours of Data Collection
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	3.50	5.20	2.90	3.80	514	42.8
30-45 MPH	5.20	8.10	3.60	5.20	521	43.4
45-60 MPH	1.30	3.40	0.80	2.20	8410	700.8
> 60 MPH	0.90	2.80	-0.60	-1.90	11659	971.6
All Speeds	1.23	3.23	0.15	0.05	21104	1758.7

Based upon data collected from September 1, 2011 through September 15, 2011 across 32 miles of roadway.

As part of the on-going validation process, vehicle probe data from each state is validated on a rotating basis. Since the inception of the validation process, data on roadways in Pennsylvania was validated on three occasions: January 2010, August 2010, and September 2011. These three validations represent nearly 4380 hours of observations along approximately 50 miles of freeway segments in Pennsylvania. ES Table 2 provides a summary of the cumulative validation effort. As shown, the average absolute speed error and speed error bias are within specification for all speed bins even when errors are measured against the mean.

ES Table 2 - Pennsylvania - Cumulative to Date						
Speed Bin	Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Number of 5 Minute Samples	Hours of Data Collection
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	4.68	5.81	2.71	3.08	3228	269.0
30-45 MPH	5.10	7.07	1.95	2.71	1861	155.1
45-60 MPH	1.88	3.78	-0.08	0.51	19933	1661.1
> 60 MPH	2.24	4.56	-2.05	-3.95	27519	2293.3
All Speeds	2.35	4.43	-0.87	-1.59	52541	4378.4

Data Collection

Bluetooth sensor deployments in Pennsylvania started on Thursday, September 1, 2011. The actual deployments in Pennsylvania were performed with the assistance of Pennsylvania Department of Transportation (PennDOT) personnel. Sensors remained in the same position until they were retrieved two weeks later on Thursday, September 15, 2011. This round of data collection in Pennsylvania was designed to cover segments of the highways along which both recurrent and non-recurrent congestion could be expected during both peak and off-peak periods.

Figure 1 presents snapshot of the roadway segments over which Bluetooth sensors were deployed in Pennsylvania. In this figure, red segments represent freeway segments selected for analysis in this round of validation.

Table 1 presents a list of specific TMC segments that were selected as the validation sample in Pennsylvania. These segments cover a total length of over 32 freeway miles. Since some TMC segments in this corridor are less than one mile long, when appropriate, consecutive TMC segments are combined to form path segments longer than one mile. This document includes the results of validation performed on fourteen freeway segments. Twelve freeway segments considered are path segments combined from multiple standard TMC segments. The coordinates of the locations at which the Bluetooth sensors were deployed throughout the state of Pennsylvania are highlighted in Table 2. It should be noted that the configuration of consecutive TMC segments is such that the endpoint of one TMC segment and the start point of the next TMC segment are overlapping, so one Bluetooth sensor in that location is covering both TMC segments.

Finally, Table 3 summarizes the segment definitions used in the validation process which also presents the distances that have been used in the estimation of Bluetooth speeds based on travel times. Details of the algorithm used to estimate equivalent path travel times based on INRIX data feeds for individual TMC segments are provided in a separate report. This algorithm finds an equivalent INRIX travel time (and therefore travel speed) corresponding to each sample Bluetooth travel time observation on the path segment of interest.

Analysis of Results

Table 4 summarizes the data quality measures obtained as a result of comparison between Bluetooth and all reported INRIX speeds. In all speed bins, INRIX data meets the data quality measures set forth in the contract when errors are measured as a distance from the 1.96 times the standard error band.

Table 5 shows the percentage of the time intervals that fall within 5 mph of the SEM band and the mean for each speed bin for all TMC segments in Pennsylvania.

Tables 6 and 7 present similar data on reported INRIX speeds with a score less than 25, while Tables 8 and 9 present the same data on reported INRIX speeds with a score higher than 25.

Tables 10 and 11 present detailed data for individual TMC segments in Pennsylvania in similar format as Tables 4 and 5, respectively. Note that for some segments and in some speed bins the comparison results may not be reliable due to small number of observations.

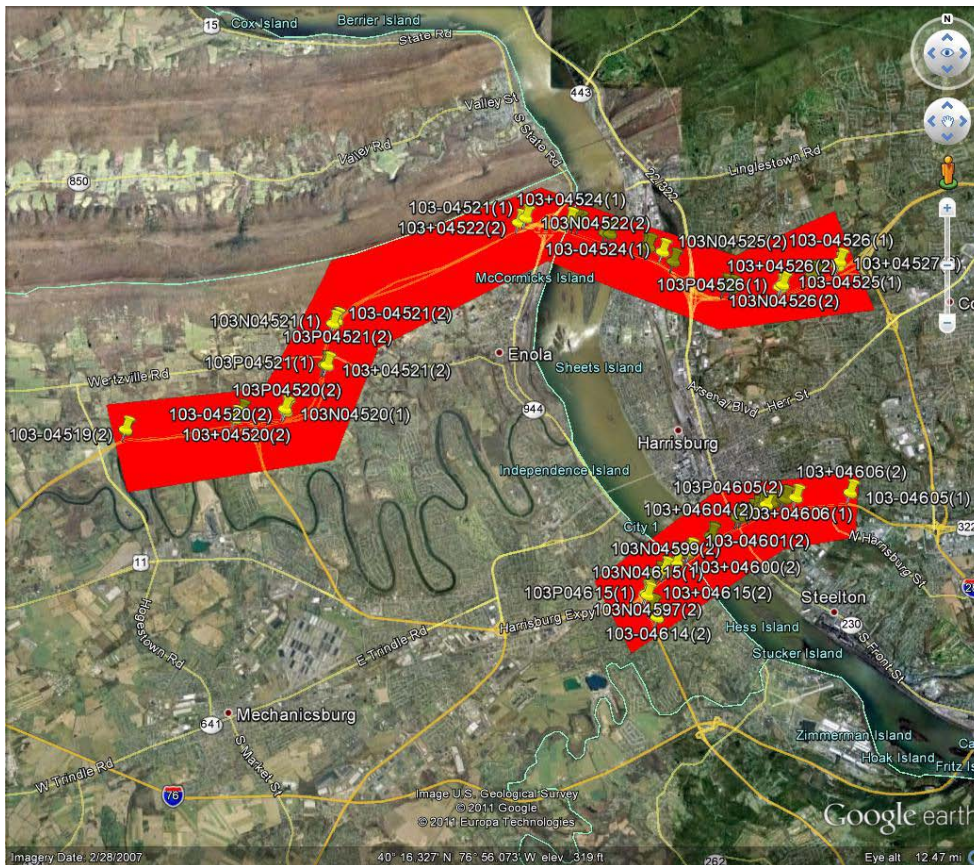


Figure 1
TMC segments selected for validation in Pennsylvania

Figures 2 and 3 show the overall speed error biases for different speed bins, and the average absolute speed errors for all validation segments in Pennsylvania, respectively. These figures correspond to Table 4.

Figures 4 and 5 show the speed error biases for different speed bins, and the average absolute speed errors, respectively, based only on INRIX speed data with a score less than 25 on all considered freeway segments in Pennsylvania. These figures correspond to Table 6.

Likewise, Figures 6 and 7 show the speed error biases for different speed bins, and the average absolute speed errors, respectively, based only on INRIX speed data with a score higher than 25 on all considered freeway segments in Pennsylvania. These figures correspond to Table 8.

Table 1
Traffic Message Channel segments picked for validation in Pennsylvania

No.	TYPE	TMC	HIGHWAY	STARTING AT	ENDING AT	COUNTY	DIRECTION	LENGTH (mile)
1	Freeway	103-04605	I-83	32nd St/Exit 45	19th St/Exit 44	DAUPHIN	Southbound	1.0
2	Freeway	103N04605	I-83	19th St/Exit 44	19th St/Exit 44	DAUPHIN	Southbound	0.0
3	Freeway	103N04604	I-83	17th St/Exit 44	17th St/Exit 44	DAUPHIN	Southbound	0.3
4	Freeway	103-04603	I-83	17th St/Exit 44	13th St/Exit 44	DAUPHIN	Southbound	0.1
5	Freeway	103N04603	I-83	13th St/Exit 44	13th St/Exit 44	DAUPHIN	Southbound	0.2
6	Freeway	103-04602	I-83	13th St/Exit 44	2nd St/Exit 43	DAUPHIN	Southbound	0.1
7	Freeway	103N04602	I-83	2nd St/Exit 43	2nd St/Exit 43	DAUPHIN	Southbound	0.5
8	Freeway	103-04601	I-83	2nd St/Exit 43	John Harris Brg	CUMBERLAND	Southbound	0.4
9	Freeway	103N04600	I-83	John Harris Brg	Lowther St/Exit 42	CUMBERLAND	Southbound	0.2
10	Freeway	103-04599	I-83	Lowther St/Exit 42	3rd St/Exit 42	CUMBERLAND	Southbound	0.2
11	Freeway	103N04599	I-83	3rd St/Exit 42	3rd St/Exit 42	CUMBERLAND	Southbound	0.0
12	Freeway	103-04598	I-83	3rd St/Exit 42	Maple St/Exit 6B	CUMBERLAND	Southbound	0.1
13	Freeway	103N04597	I-83	Maple St/Exit 6B	PA-581 (Lemoyne) (North) (Retired)	CUMBERLAND	Southbound	0.4
14	Freeway	103N04615	I-83	PA-581 (Lemoyne) (North) (Retired)	Lowther St/Exit 41	CUMBERLAND	Southbound	0.2
15	Freeway	103-04614	I-83	Lowther St/Exit 41	Carlisle Rd/Simpson Ferry Rd/Exit 40	CUMBERLAND	Southbound	0.2
16	Freeway	103+04615	I-83	Carlisle Rd/Simpson Ferry Rd/Exit 40	Lowther St/Exit 41	CUMBERLAND	Northbound	0.4
17	Freeway	103P04615	I-83	Lowther St/Exit 41	Lowther St/Exit 41	CUMBERLAND	Northbound	0.0
18	Freeway	103P04598	I-83	Lowther St/Exit 41	Maple St/Exit 6B	CUMBERLAND	Northbound	0.2
19	Freeway	103+04599	I-83	Maple St/Exit 6B	3rd St/Exit 42	CUMBERLAND	Northbound	0.3
20	Freeway	103P04599	I-83	3rd St/Exit 42	3rd St/Exit 42	CUMBERLAND	Northbound	0.0
21	Freeway	103+04600	I-83	3rd St/Exit 42	Lowther St/Exit 42	CUMBERLAND	Northbound	0.2
22	Freeway	103P04600	I-83	Lowther St/Exit 42	Lowther St/Exit 42	CUMBERLAND	Northbound	0.2
23	Freeway	103+04602	I-83	Lowther St/Exit 42	2nd St/Exit 43	DAUPHIN	Northbound	0.4
24	Freeway	103P04602	I-83	2nd St/Exit 43	2nd St/Exit 43	DAUPHIN	Northbound	0.5
25	Freeway	103+04603	I-83	2nd St/Exit 43	13th St/Exit 44	DAUPHIN	Northbound	0.1
26	Freeway	103P04603	I-83	13th St/Exit 44	13th St/Exit 44	DAUPHIN	Northbound	0.2
27	Freeway	103+04604	I-83	13th St/Exit 44	17th St/Exit 44	DAUPHIN	Northbound	0.0
28	Freeway	103P04604	I-83	17th St/Exit 44	17th St/Exit 44	DAUPHIN	Northbound	0.1
29	Freeway	103P04605	I-83	17th St/Exit 44	19th St/Exit 44	DAUPHIN	Northbound	0.4
30	Freeway	103+04606	I-83	19th St/Exit 44	32nd St/Exit 45	DAUPHIN	Northbound	0.8
31	Freeway	103-04526	I-81	US-322/Exit 70	Progress Ave/Exit 69	DAUPHIN	Southbound	0.4
32	Freeway	103N04526	I-81	Progress Ave/Exit 69	Progress Ave/Exit 69	DAUPHIN	Southbound	0.5
33	Freeway	103-04525	I-81	Progress Ave/Exit 69	US-322/US-22/Exit 67	DAUPHIN	Southbound	0.9

**Table 1
Traffic Message Channel segments picked for validation in Pennsylvania (Cont'd)**

No.	TYPE	TMC	HIGHWAY	STARTING AT	ENDING AT	COUNTY	DIRECTION	LENGTH (mile)
34	Freeway	103N04525	I-81	US-322/US-22/Exit 67	US-322/US-22/Exit 67	DAUPHIN	Southbound	1.1
35	Freeway	103-04524	I-81	US-322/US-22/Exit 67	Front St/Exit 66	DAUPHIN	Southbound	0.2
36	Freeway	103N04524	I-81	Front St/Exit 66	Front St/Exit 66	DAUPHIN	Southbound	0.6
37	Freeway	103-04523	I-81	Front St/Exit 66	George N Wade Brg	CUMBERLAND	Southbound	0.6
38	Freeway	103N04522	I-81	George N Wade Brg	US-15/US-11/Exit 21	CUMBERLAND	Southbound	0.8
39	Freeway	103-04521	I-81	US-15/US-11/Exit 21	PA-944/Wertzville Rd/Exit 61	CUMBERLAND	Southbound	3.3
40	Freeway	103N04521	I-81	PA-944/Wertzville Rd/Exit 61	PA-944/Wertzville Rd/Exit 61	CUMBERLAND	Southbound	0.6
41	Freeway	103-04520	I-81	PA-944/Wertzville Rd/Exit 61	PA-581/Exit 19	CUMBERLAND	Southbound	1.0
42	Freeway	103N04520	I-81	PA-581/Exit 19	PA-581/Exit 19	CUMBERLAND	Southbound	0.6
43	Freeway	103-04519	I-81	PA-581/Exit 19	PA-114/Exit 18	CUMBERLAND	Southbound	1.7
44	Freeway	103+04520	I-81	PA-114/Exit 18	PA-581/Exit 19	CUMBERLAND	Northbound	1.6
45	Freeway	103P04520	I-81	PA-581/Exit 19	PA-581/Exit 19	CUMBERLAND	Northbound	0.7
46	Freeway	103+04521	I-81	PA-581/Exit 19	PA-944/Wertzville Rd/Exit 61	CUMBERLAND	Northbound	1.0
47	Freeway	103P04521	I-81	PA-944/Wertzville Rd/Exit 61	PA-944/Wertzville Rd/Exit 61	CUMBERLAND	Northbound	0.7
48	Freeway	103+04522	I-81	PA-944/Wertzville Rd/Exit 61	US-15/US-11/Exit 21	CUMBERLAND	Northbound	3.1
49	Freeway	103P04522	I-81	US-15/US-11/Exit 21	US-15/US-11/Exit 21	CUMBERLAND	Northbound	0.8
50	Freeway	103+04524	I-81	US-15/US-11/Exit 21	Front St/Exit 66	DAUPHIN	Northbound	0.6
51	Freeway	103P04524	I-81	Front St/Exit 66	Front St/Exit 66	DAUPHIN	Northbound	0.6
52	Freeway	103+04525	I-81	Front St/Exit 66	US-322/US-22/Exit 67	DAUPHIN	Northbound	0.5
53	Freeway	103P04525	I-81	US-322/US-22/Exit 67	US-322/US-22/Exit 67	DAUPHIN	Northbound	1.0
54	Freeway	103+04526	I-81	US-322/US-22/Exit 67	Progress Ave/Exit 69	DAUPHIN	Northbound	0.7
55	Freeway	103P04526	I-81	Progress Ave/Exit 69	Progress Ave/Exit 69	DAUPHIN	Northbound	0.6
56	Freeway	103+04527	I-81	Progress Ave/Exit 69	US-322/Exit 70	DAUPHIN	Northbound	0.3
Total								32.3

Table 2
TMC segment lengths and distances between sensor deployment locations in the state of Pennsylvania

SEGMENT TYPE	TMC	STANDARD TMC					SENSOR DEPLOYMENT			
		Endpoint (1)		Endpoint (2)		Length (mile)	Endpoint (1)		Endpoint (2)	
		Lat	Long	Lat	Long		Lat	Long	Lat	Long
Freeway	103-04605	40.258220	-76.837887	40.256922	-76.855807	0.95	40.258160	-76.840640		
Freeway	103N04605	40.256922	-76.855807	40.256828	-76.856413	0.03				
Freeway	103N04604	40.256828	-76.856413	40.255315	-76.862562	0.34				
Freeway	103-04603	40.255315	-76.862562	40.254692	-76.863986	0.09	40.255480	-76.862160		
Freeway	103N04603	40.254692	-76.863986	40.253332	-76.867653	0.22				
Freeway	103-04602	40.253332	-76.867653	40.252916	-76.868891	0.07				
Freeway	103N04602	40.252916	-76.868891	40.249289	-76.876233	0.46				
Freeway	103-04601	40.249289	-76.876233	40.245897	-76.882173	0.39				
Freeway	103N04600	40.245897	-76.882173	40.243786	-76.885945	0.25	40.245930	-76.882030		
Freeway	103-04599	40.243786	-76.885945	40.242012	-76.889171	0.21				
Freeway	103N04599	40.242012	-76.889171	40.241977	-76.889230	0.00				
Freeway	103-04598	40.241977	-76.889230	40.240927	-76.891016	0.12				
Freeway	103N04597	40.240927	-76.891016	40.237005	-76.894267	0.42				
Freeway	103N04615	40.23701	-76.89427	40.23412	-76.89255	0.22				
Freeway	103-04614	40.23412	-76.89255	40.23194	-76.89127	0.16			40.232590	-76.891710
Freeway	103+04615	40.231880	-76.891121	40.236627	-76.893941	0.36	40.231490	-76.890210		
Freeway	103P04615	40.236627	-76.893941	40.236938	-76.894124	0.02				
Freeway	103P04598	40.236938	-76.894124	40.239445	-76.893226	0.20				
Freeway	103+04599	40.239445	-76.893226	40.241893	-76.889118	0.28				
Freeway	103P04599	40.241893	-76.889118	40.241924	-76.889065	0.00				
Freeway	103+04600	40.241924	-76.889065	40.243642	-76.885902	0.21				
Freeway	103P04600	40.243642	-76.885902	40.245303	-76.882861	0.20				
Freeway	103+04602	40.245303	-76.882861	40.249086	-76.876250	0.44	40.245070	-76.883000		
Freeway	103P04602	40.249086	-76.876250	40.253158	-76.867740	0.53				
Freeway	103+04603	40.253158	-76.867740	40.253985	-76.865349	0.14				
Freeway	103P04603	40.253985	-76.865349	40.255498	-76.861701	0.22				
Freeway	103+04604	40.255498	-76.861701	40.255736	-76.861005	0.04	40.254510	-76.863240		
Freeway	103P04604	40.255736	-76.861005	40.256210	-76.859231	0.10				
Freeway	103P04605	40.256104	-76.859691	40.257183	-76.852896	0.37				
Freeway	103+04606	40.257183	-76.852896	40.258126	-76.837919	0.79			40.257840	-76.840390

Table 2

TMC segment lengths and distances between sensor deployment locations in the state of Pennsylvania (Cont'd)

SEGMENT TYPE	TMC	STANDARD TMC					SENSOR DEPLOYMENT			
		Endpoint (1)		Endpoint (2)		Length (mile)	Endpoint (1)		Endpoint (2)	
		Lat	Long	Lat	Long		Lat	Long	Lat	Long
Freeway	103-04526	40.306848	-76.840772	40.304163	-76.848434	0.45	40.306300	-76.842900		
Freeway	103N04526	40.304163	-76.848434	40.301942	-76.856617	0.46				
Freeway	103-04525	40.301942	-76.856617	40.301498	-76.872669	0.85				
Freeway	103N04525	40.301498	-76.872669	40.308944	-76.889708	1.07				
Freeway	103-04524	40.308944	-76.889708	40.310040	-76.893519	0.22	40.308290	-76.887920		
Freeway	103N04524	40.310040	-76.893519	40.312773	-76.904109	0.59				
Freeway	103-04523	40.312773	-76.904109	40.315648	-76.915271	0.62				
Freeway	103N04522	40.314969	-76.912672	40.316010	-76.927545	0.82				
Freeway	103-04521	40.316010	-76.927545	40.293803	-76.980682	3.26	40.314960	-76.930520		
Freeway	103N04521	40.293803	-76.980682	40.285082	-76.983087	0.62	40.294550	-76.980420		
Freeway	103-04520	40.285082	-76.983087	40.275811	-76.993882	0.96				
Freeway	103N04520	40.275811	-76.993882	40.275057	-77.005990	0.64				
Freeway	103-04519	40.275057	-77.005990	40.271528	-77.037912	1.71			40.271730	-77.034420
Freeway	103+04520	40.271225	-77.037881	40.273798	-77.007646	1.61	40.270990	-77.038360		
Freeway	103P04520	40.273798	-77.007646	40.275350	-76.993701	0.74				
Freeway	103+04521	40.275350	-76.993701	40.285068	-76.982365	1.04				
Freeway	103P04521	40.285068	-76.982365	40.294440	-76.979788	0.67				
Freeway	103+04522	40.294440	-76.979788	40.315016	-76.929431	3.06	40.293870	-76.980250		
Freeway	103P04522	40.315016	-76.929431	40.315200	-76.914106	0.85	40.314640	-76.930160		
Freeway	103+04524	40.315528	-76.915340	40.312975	-76.905433	0.55				
Freeway	103P04524	40.312975	-76.905433	40.310132	-76.894452	0.61				
Freeway	103+04525	40.310132	-76.894452	40.306896	-76.886713	0.47				
Freeway	103P04525	40.306896	-76.886713	40.301204	-76.870590	0.98	40.307250	-76.887510		
Freeway	103+04526	40.301204	-76.870590	40.301423	-76.857343	0.70				
Freeway	103P04526	40.301423	-76.857343	40.304224	-76.847179	0.57				
Freeway	103+04527	40.304224	-76.847179	40.305895	-76.841339	0.33			40.304510	-76.845750
Total						32.29				

Table 3
Path segments identified for validation in Pennsylvania

Type	Validation Segment	STANDARD SEGMENTS INCLUDED						
		TMC(1)	TMC(2)	TMC(3)	TMC(4)	TMC(5)	TMC(6)	TMC(7)
Freeway	PA03-0001	103-04605	103N04605	103-04604	103N04604			
Freeway	PA03-0002	103-04603	103N04603	103-04602	103N04602	103-04601		
Freeway	PA03-0003	103N04600	103-04599	103N04599	103-04598	103N04597	103N04615	103-04614
Freeway	PA03-0004	103+04615	103P04615	103P04598	103+04599	103P04599	103+04600	103P04600
Freeway	PA03-0005	103+04602	103P04602	103+04603	103P04603			
Freeway	PA03-0006	103+04604	103P04604	103P04605	103+04606			
Freeway	PA03-0007	103-04526	103N04526	103-04525	103N04525			
Freeway	PA03-0008	103-04524	103N04524	103-04523	103N04522			
Freeway	103-04521	103-04521						
Freeway	PA03-0009	103N04521	103-04520	103N04520	103-04519			
Freeway	PA03-0010	103+04520	103P04520	103+04521	103P04521			
Freeway	103+04522	103+04522						
Freeway	PA03-0011	103P04522	103+04524	103P04524	103+04525			
Freeway	PA03-0012	103P04525	103+04526	103P04526	103+04527			

Table 3
Path segments identified for validation in Pennsylvania (Cont'd)

Type	Validation Segment	STARTING AT	ENDING AT	LENGTH (MILE)		
				Standard	Deployment	Error (%)
Freeway	PA03-0001	32nd St/Exit 45	17th St/Exit 44	1.3	1.16	-12.67%
Freeway	PA03-0002	17th St/Exit 44	John Harris Brg	1.2	1.24	0.95%
Freeway	PA03-0003	John Harris Brg	Carlisle Rd/Simpson Ferry Rd/Exit 40	1.4	1.34	-3.10%
Freeway	PA03-0004	Carlisle Rd/Simpson Ferry Rd/Exit 40	Lowther St/Exit 42	1.3	1.28	1.47%
Freeway	PA03-0005	Lowther St/Exit 42	13th St/Exit 44	1.3	1.23	-7.29%
Freeway	PA03-0006	13th St/Exit 44	32nd St/Exit 45	1.3	1.25	-4.00%
Freeway	PA03-0007	US-322/Exit 70	US-322/US-22/Exit 67	2.8	2.62	-7.22%
Freeway	PA03-0008	US-322/US-22/Exit 67	US-15/US-11/Exit 21	2.2	2.38	6.06%
Freeway	103-04521	US-15/US-11/Exit 21	PA-944/Wertzville Rd/Exit 61	3.3	3.04	-6.78%
Freeway	PA03-0009	PA-944/Wertzville Rd/Exit 61	PA-114/Exit 18	3.9	3.79	-3.57%
Freeway	PA03-0010	PA-114/Exit 18	PA-944/Wertzville Rd/Exit 61	4.1	4.06	-0.21%
Freeway	103+04522	PA-944/Wertzville Rd/Exit 61	US-15/US-11/Exit 21	3.1	3.07	0.24%
Freeway	PA03-0011	US-15/US-11/Exit 21	US-322/US-22/Exit 67	2.5	2.41	-3.02%
Freeway	PA03-0012	US-322/US-22/Exit 67	US-322/Exit 70	2.6	2.38	-7.77%
TOTAL				32.29	31.25	-3.21%

Table 4
Data quality measures for freeway segments greater than one mile in Pennsylvania

SPEED BIN	Data Quality Measures for				No. of Obs.
	1.96 SE Band		Mean		
	Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
0-30	2.9	3.5	3.8	5.2	514
30-45	3.6	5.2	5.2	8.1	521
45-60	0.8	1.3	2.2	3.4	8410
60+	-0.6	0.9	-1.9	2.8	11659

Table 5
Percent observations meeting data quality criteria for freeway segments greater than one mile in Pennsylvania

SPEED BIN	Data Quality Measures for				No. of Obs.
	1.96 SE Band		Mean		
	Percentage falling inside the band	Percentage falling within 5 mph of the band	Percentage equal to the mean	Percentage within 5 mph of the mean	
0-30	25%	78%	0%	68%	514
30-45	21%	54%	0%	35%	521
45-60	53%	93%	0%	77%	8410
60+	59%	97%	0%	85%	11659

Table 6
Data quality measures for INRIX speed data with a score less than 25 on freeway segments greater than one mile in Pennsylvania

SPEED BIN	Data Quality Measures for				No. of Obs.
	1.96 SE Band		Mean		
	Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
0-30					
30-45					
45-60	5.2	5.2	8.0	8.0	4*
60+	0.0	0.0	1.5	1.5	1*

*Results in the specified row may not be reliable due to small number of observations

Table 7
Percent observations meeting data quality criteria for INRIX speed data with a score less than 25 on freeway segments greater than one mile in Pennsylvania

SPEED BIN	Data Quality Measures for				No. of Obs.
	1.96 SE Band		Mean		
	Percentage falling inside the band	Percentage falling within 5 mph of the band	Percentage equal to the mean	Percentage within 5 mph of the mean	
0-30					
30-45					
45-60	0%	50%	0%	25%	4*
60+	100%	100%	0%	100%	1*

*Results in the specified row may not be reliable due to small number of observations

Table 8
Data quality measures for INRIX speed data with a score higher than 25 on freeway segments greater than one mile in Pennsylvania

SPEED BIN	Data Quality Measures for				No. of Obs.
	1.96 SE Band		Mean		
	Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
0-30	2.9	3.5	3.8	5.2	514
30-45	3.6	5.2	5.2	8.1	521
45-60	0.8	1.3	2.2	3.4	8406
60+	-0.6	0.9	-1.9	2.8	11658

*Results in the specified row may not be reliable due to small number of observations

Table 9
Percent observations meeting data quality criteria for INRIX speed data with a score higher than 25 on freeway segments greater than one mile in Pennsylvania

SPEED BIN	Data Quality Measures for				No. of Obs.
	1.96 SE Band		Mean		
	Percentage falling inside the band	Percentage falling within 5 mph of the band	Percentage equal to the mean	Percentage within 5 mph of the mean	
0-30	25%	78%	0%	68%	514
30-45	21%	54%	0%	35%	521
45-60	53%	93%	0%	77%	8406
60+	59%	97%	0%	85%	11658

*Results in the specified row may not be reliable due to small number of observations

Table 10
Data quality measures for individual freeway validation segments greater than one mile in the state of Pennsylvania

TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for				No. of Obs.	
				1.96 SE Band		Mean			
				Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error		
103+04522	3.1	3.1	0-30					136	
			30-45				2051		
			45-60	1.5	1.5	3.7			3.7
			60+	-0.8	1.0	-2.1			2.8
103-04521	3.3	3.0	0-30						252
			30-45				835		
			45-60	1.6	1.6	4.2		4.2	
			60+	0.1	0.5	-0.2		2.2	
PA03-0001	1.3	1.2	0-30	2.0	3.7	2.0		4.8	24*
			30-45	3.7	6.1	4.1	7.8	48	
			45-60	0.6	1.2	1.6	3.0	892	
			60+	-1.1	1.3	-3.2	3.7	603	
PA03-0002	1.2	1.2	0-30	1.3	3.1	2.2	5.1	52	
			30-45	7.0	8.1	9.8	11.2	50	
			45-60	1.1	1.5	2.7	3.6	1401	
			60+	-0.9	1.1	-2.6	3.3	519	
PA03-0003	1.4	1.3	0-30	3.9	4.0	4.7	5.3	10*	
			30-45	-0.1	3.1	0.6	4.9	15*	
			45-60	-0.9	1.4	-2.1	3.6	336	
			60+	-2.6	2.6	-6.6	6.6	3*	
PA03-0004	1.3	1.3	0-30	3.5	3.8	5.1	5.6	53	
			30-45	4.9	6.0	7.3	9.0	93	
			45-60	0.9	1.5	2.1	3.7	854	
			60+	-1.2	1.2	-3.9	4.1	16*	
PA03-0005	1.3	1.2	0-30	2.2	3.1	2.7	5.6	56	
			30-45	0.3	3.9	0.6	6.7	91	
			45-60	0.5	1.8	2.1	4.1	854	
			60+	-0.9	1.0	-2.6	3.2	345	
PA03-0006	1.3	1.3	0-30	3.8	4.2	4.9	5.8	136	
			30-45	4.1	5.1	5.2	7.4	106	
			45-60	0.8	1.2	2.2	3.4	898	
			60+	-0.9	1.0	-2.8	3.4	316	
PA03-0007	2.8	2.6	0-30	1.3	1.5	2.1	2.6	87	
			30-45	3.6	4.9	7.0	9.8	35	
			45-60	0.6	1.1	2.0	2.9	412	
			60+	-0.5	0.7	-1.6	2.4	1021	

*Results in the specified row may not be reliable due to small number of observations

Table 10
Data quality measures for individual freeway validation segments greater than one
mile in the state of Pennsylvania (Cont'd)

TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for				No. of Obs.
				1.96 SE Band		Mean		
				Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
PA03-0008	2.2	2.4	0-30	6.0	6.1	7.4	7.9	43
			30-45	5.9	6.0	8.1	9.3	32
			45-60	1.2	1.3	2.9	3.3	779
			60+	-0.4	0.5	-1.8	2.3	249
PA03-0009	3.9	3.8	0-30	3.5	4.0	4.0	5.2	41
			30-45	2.9	3.2	3.6	4.9	30
			45-60	1.6	2.0	4.4	5.0	85
			60+	-0.8	0.9	-2.2	3.0	1381
PA03-0010	4.1	4.1	0-30					
			30-45	5.9	5.9	8.4	8.4	2*
			45-60	1.3	1.4	3.5	3.8	89
			60+	-0.5	0.8	-1.5	2.6	1755
PA03-0011	2.5	2.4	0-30					
			30-45	5.7	5.7	7.7	7.7	7*
			45-60	0.9	0.9	2.3	2.6	883
			60+	-0.5	0.8	-1.9	2.7	1169
PA03-0012	2.6	2.4	0-30	-1.0	2.0	0.5	4.6	12*
			30-45	0.1	1.7	5.3	8.3	12*
			45-60	0.7	0.8	2.1	2.5	539
			60+	-0.6	0.8	-1.8	2.6	1396

*Results in the specified row may not be reliable due to small number of observations

Table 11
Observations meeting data quality criteria for individual freeway validation segments
greater than one mile in the state of Pennsylvania

TMC	SPEED BIN	Data Quality Measures for								No. of Obs.
		1.96 SE Band				Mean				
		Speed Error Bias		Average Absolute Speed Error		Speed Error Bias		Average Absolute Speed Error		
		No. falling inside the band	% falling inside the band	No. falling within 5 mph of the band	% falling within 5 mph of the band	No. equal to the mean	% equal to the mean	No. within 5 mph of the mean	% within 5 mph of the mean	
103+04522	0-30									
	30-45									
	45-60	50	37%	124	91%	0	0%	103	76%	
	60+	1057	52%	1967	96%	0	0%	1726	84%	
103-04521	0-30									
	30-45									
	45-60	66	26%	237	94%	0	0%	175	69%	
	60+	589	71%	821	98%	1	0%	770	92%	
PA03-0001	0-30	2	8%	18	75%	0	0%	16	67%	
	30-45	6	13%	20	42%	0	0%	15	31%	
	45-60	530	59%	824	92%	0	0%	723	81%	
	60+	292	48%	568	94%	0	0%	447	74%	
PA03-0002	0-30	13	25%	45	87%	0	0%	39	75%	
	30-45	3	6%	15	30%	0	0%	6	12%	
	45-60	708	51%	1278	91%	0	0%	1033	74%	
	60+	279	54%	498	96%	4	1%	419	81%	
PA03-0003	0-30	3	30%	5	50%	0	0%	4	40%	
	30-45	4	27%	9	60%	0	0%	8	53%	
	45-60	163	49%	316	94%	0	0%	257	76%	
	60+	0	0%	2	67%	0	0%	1	33%	
PA03-0004	0-30	8	15%	39	74%	1	2%	33	62%	
	30-45	17	18%	41	44%	0	0%	24	26%	
	45-60	438	51%	771	90%	0	0%	620	73%	
	60+	9	56%	15	94%	0	0%	10	63%	
PA03-0005	0-30	18	32%	47	84%	0	0%	39	70%	
	30-45	26	29%	62	68%	0	0%	36	40%	
	45-60	438	51%	757	89%	1	0%	593	69%	
	60+	209	61%	327	95%	0	0%	284	82%	
PA03-0006	0-30	29	21%	102	75%	0	0%	87	64%	
	30-45	27	25%	62	58%	0	0%	45	42%	
	45-60	521	58%	843	94%	0	0%	679	76%	
	60+	195	62%	296	94%	0	0%	250	79%	
PA03-0007	0-30	28	32%	83	95%	0	0%	75	86%	
	30-45	4	11%	16	46%	0	0%	12	34%	
	45-60	229	56%	392	95%	0	0%	344	84%	
	60+	640	63%	1004	98%	0	0%	935	92%	

*Results in the specified row may not be reliable due to small number of observations

Table 11
Observations meeting data quality criteria for individual freeway validation segments
greater than one mile in the state of Pennsylvania (Cont'd)

TMC	SPEED BIN	Data Quality Measures for								No. of Obs.
		1.96 SE Band				Mean				
		Speed Error Bias		Average Absolute Speed Error		Speed Error Bias		Average Absolute Speed Error		
		No. falling inside the band	% falling inside the band	No. falling within 5 mph of the band	% falling within 5 mph of the band	No. equal to the mean	% equal to the mean	No. within 5 mph of the mean	% within 5 mph of the mean	
PA03-0008	0-30	13	30%	24	56%	0	0%	22	51%	43
	30-45	7	22%	14	44%	0	0%	5	16%	32
	45-60	393	50%	736	94%	1	0%	608	78%	779
	60+	179	72%	244	98%	0	0%	232	93%	249
PA03-0009	0-30	9	22%	29	71%	0	0%	27	66%	41
	30-45	12	40%	24	80%	0	0%	23	77%	30
	45-60	35	41%	75	88%	0	0%	50	59%	85
	60+	785	57%	1329	96%	0	0%	1133	82%	1381
PA03-0010	0-30									
	30-45	0	0%	1	50%	0	0%	0	0%	2*
	45-60	32	36%	84	94%	0	0%	70	79%	89
	60+	1065	61%	1702	97%	0	0%	1537	88%	1755
PA03-0011	0-30									
	30-45	0	0%	4	57%	0	0%	3	43%	7*
	45-60	485	55%	853	97%	0	0%	777	88%	883
	60+	726	62%	1131	97%	0	0%	1002	86%	1169
PA03-0012	0-30	6	50%	11	92%	0	0%	9	75%	12*
	30-45	5	42%	11	92%	0	0%	6	50%	12*
	45-60	328	61%	524	97%	0	0%	471	87%	539
	60+	863	62%	1356	97%	0	0%	1216	87%	1396

*Results in the specified row may not be reliable due to small number of observations

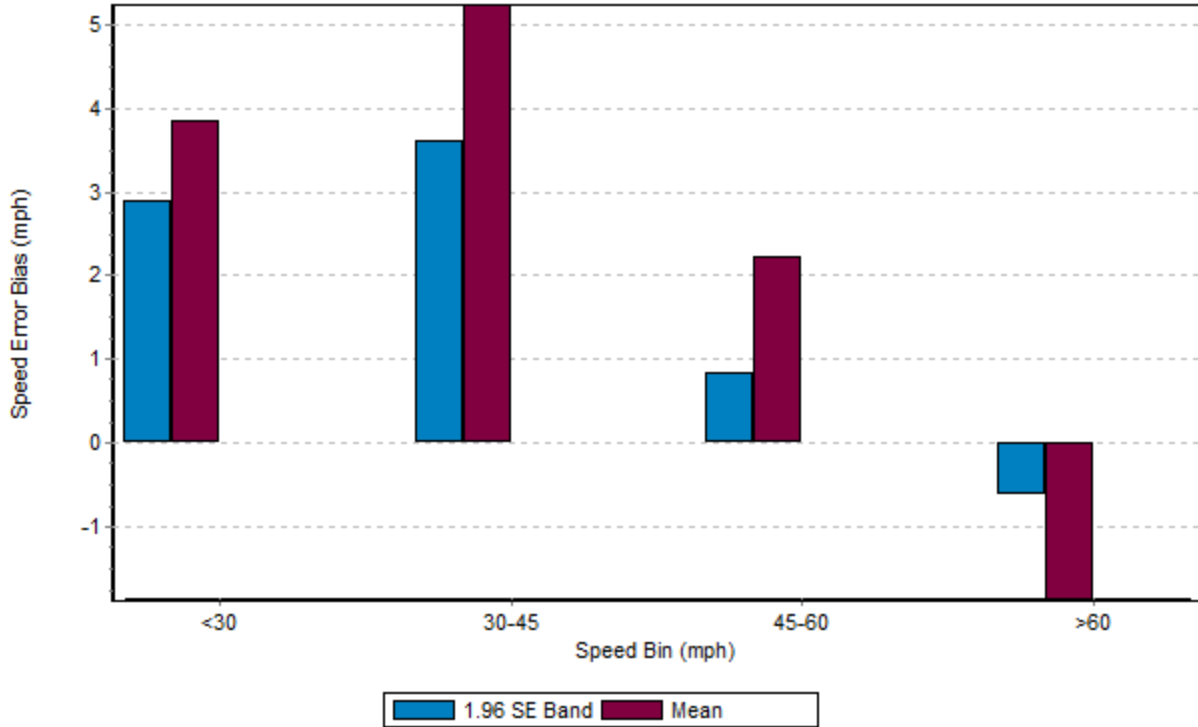


Figure 2
Speed error bias for freeway segments greater than one mile in Pennsylvania

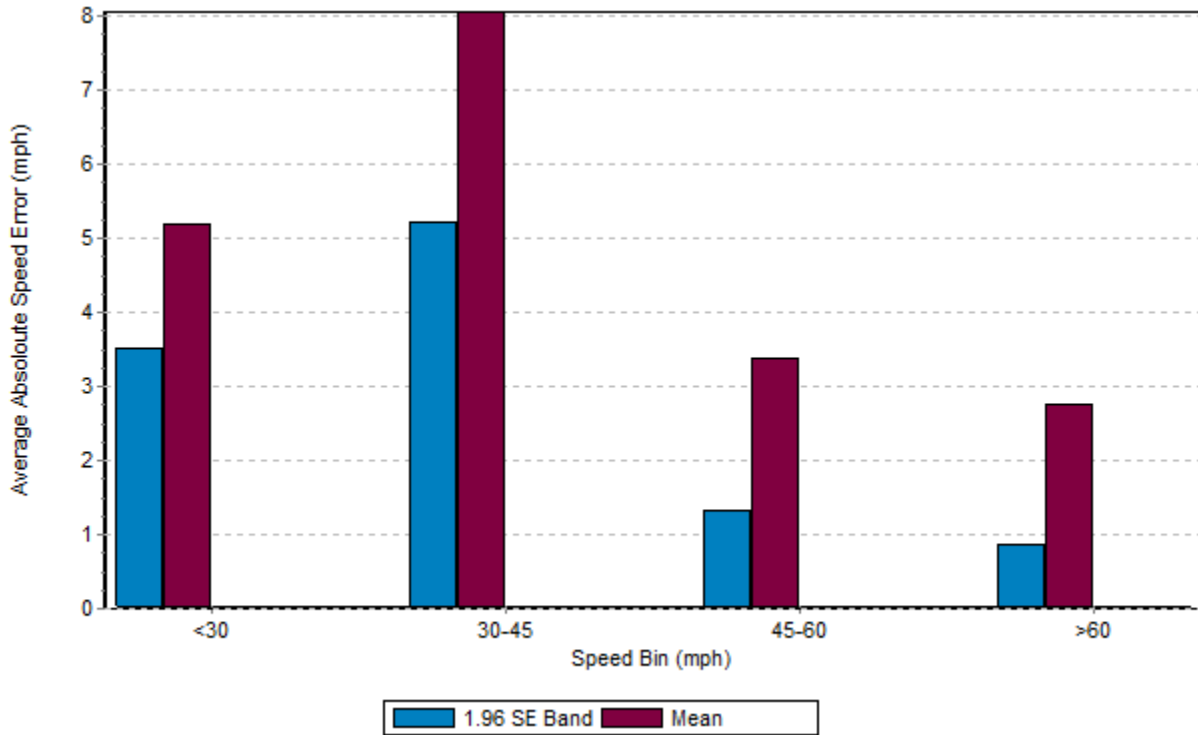


Figure 3
Average absolute speed error for freeway segments greater than one mile in Pennsylvania

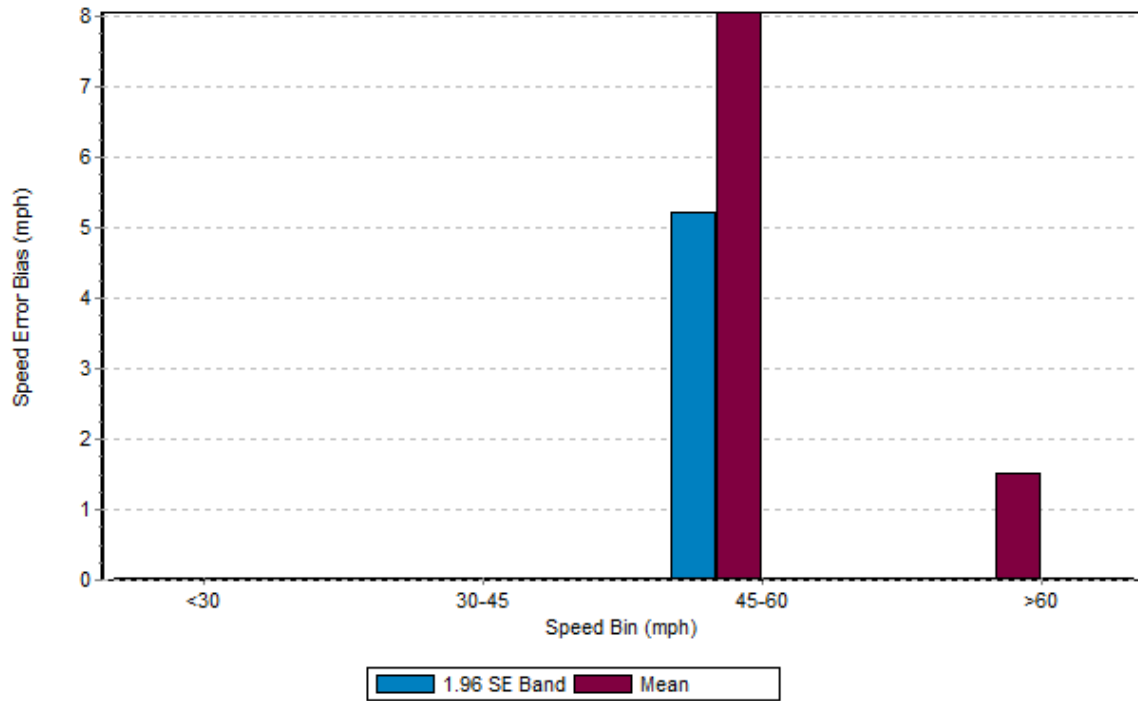


Figure 4
Speed error bias for INRIX speed data with a score less than 25 on freeway segments greater than one mile in Pennsylvania

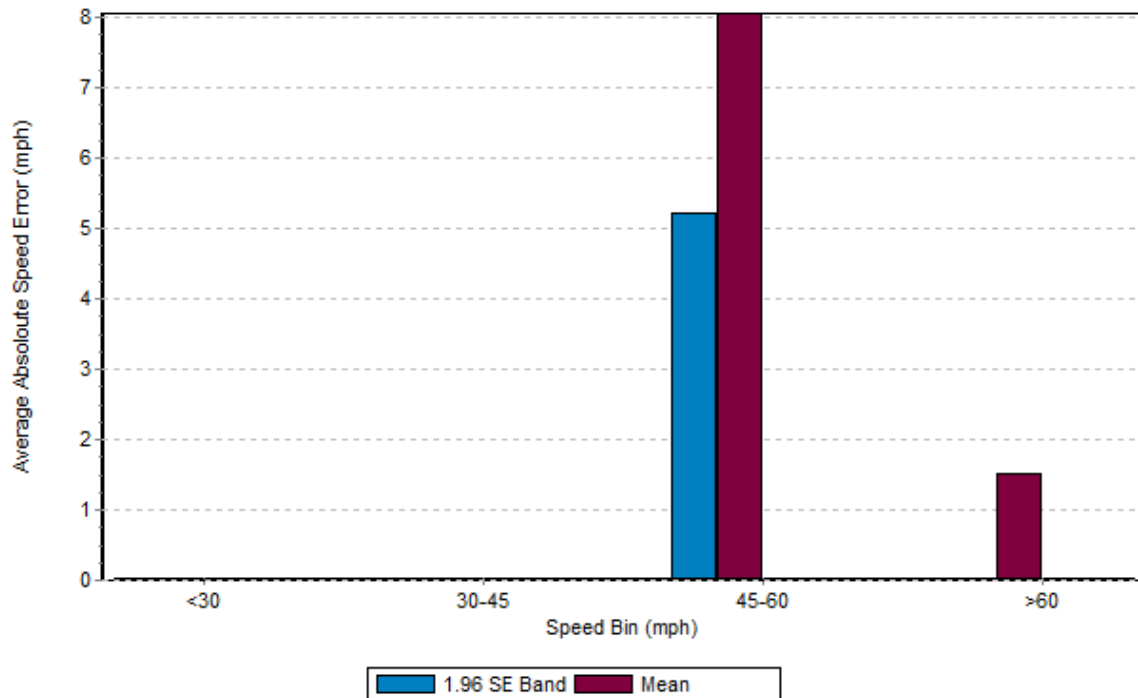


Figure 5
Average absolute speed error for INRIX speed data with a score less than 25 on freeway segments greater than one mile in Pennsylvania

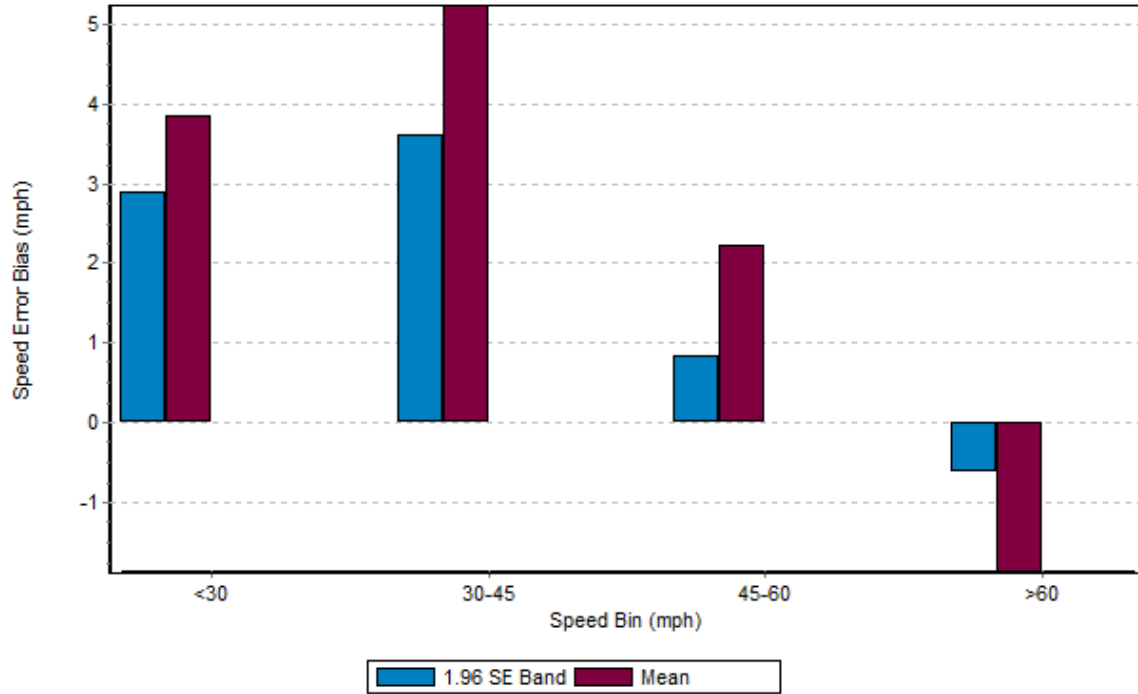


Figure 6
Speed error bias for INRIX speed data with a score higher than 25 on freeway segments greater than one mile in Pennsylvania

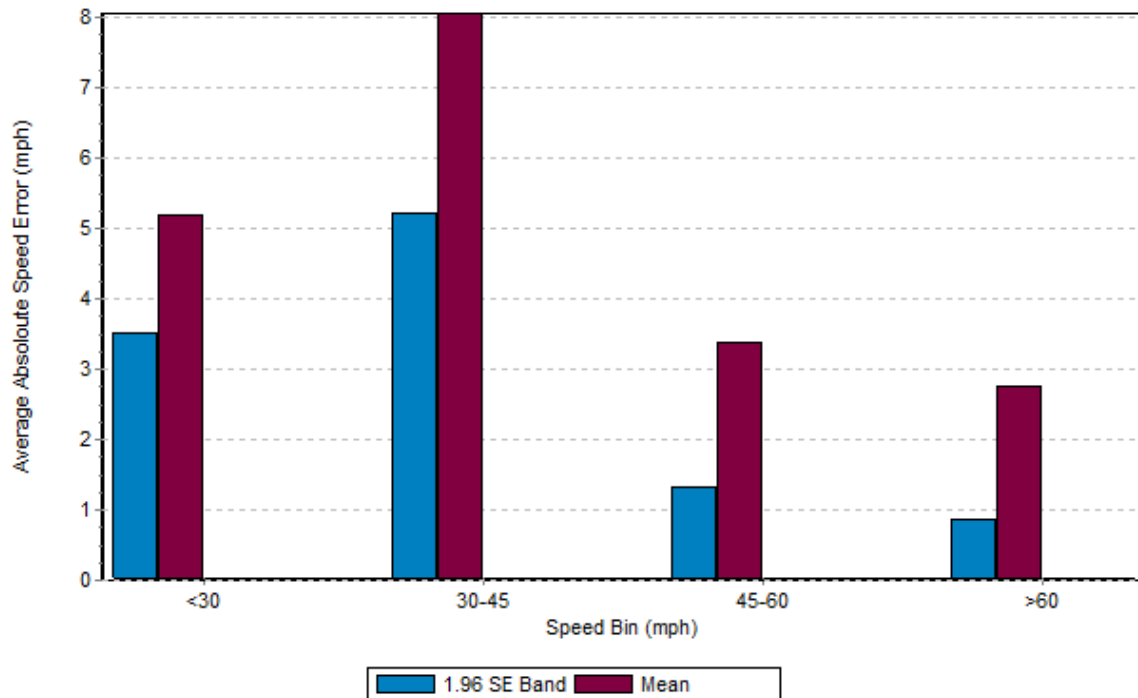


Figure 7
Average absolute speed error for INRIX speed data with a score higher than 25 on freeway segments greater than one mile in Pennsylvania