I-95 Corridor Coalition

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

Monthly Report
Virginia

I-95 CORRIDOR COALITION

November 2010

I-95 CORRIDOR COALITION VEHICLE PROBE PROJECT: VALIDATION OF INRIX DATA NOVEMBER 2010

Monthly Report

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November 2010

Evaluation Results for the State of Virginia

Executive Summary

Travel time samples were collected along approximately 44 freeway miles and five miles of arterials from Wednesday, September 8, 2010 through Thursday, September 16, 2010 in Virginia. Freeway segments studied were located along I-95 in Prince William, Stafford and Fredericksburg Counties and the arterial data segments studied were located along US Route 1 between Massaponax Church Road and US-17 in Spotsylvania County, just south of Fredericksburg, VA. Data collected were 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 2283 hours of observations along fourteen freeway segments, totaling approximately 44 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, both the average absolute speed error and speed error bias were within specification for all speed bins. Even when errors are measured against the mean (rather than the SEM band), INRIX data quality meets contract quality standards for both the average absolute speed error (AASE) and the Speed Error Bias (SEB).

ES Table 1 - Virginia 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	**4.80**	6.30	**3.20**	4.10	489	40.8
30-45 MPH	**4.00**	7.80	**1.40**	4.30	830	69.2
45-60 MPH	**2.90**	5.20	**0.40**	1.60	1436	119.7
> 60 MPH	**1.80**	3.80	**-1.50**	-2.80	24644	2053.7
All Speeds	1.98	4.04	-1.23	-2.23	27399	2283.3

Based upon data collected from September 8, 2010 through September 16, 2010 across 43.8 miles of roadway. For more information please visit i95coalition.org.

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 Virginia was validated on five occasions: July 2008, November 2008, May 2009, November 2009, and September 2010. These five validations represent more than 6300 hours of observations along approximately 125 miles of freeway segments in Virginia. ES Table 2 provides a summary of the cumulative validation effort. As shown, the absolute average speed error and speed error bias are within specification for all speed bins even when errors are measured against the mean.

ES Table 2 - Virginia - Cumulative to Date						
	Absolute Speed Error		Speed Error Bias		Number of 5 Minute Samples	Hours of Data Collection
Speed Bin	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	**4.51**	5.72	**1.40**	1.66	4300	358.3
30-45 MPH	**6.26**	8.87	**1.20**	2.53	3820	318.3
45-60 MPH	**2.77**	4.85	**-0.06**	0.62	17569	1464.1
> 60 MPH	**2.06**	4.12	**-1.65**	-2.97	50105	4175.4
All Speeds	2.57	4.62	-0.96	-1.59	75794	6316.2

Travel time samples collected along US Route 1 were compared with travel time and speed data reported by INRIX as part of this project. The arterial data is included for informational purposes noting that INRIX has volunteered arterial data at no cost to the Coalition for the first three years, and that the method to evaluate quality on arterial roadways has not been fully evaluated. The Coalition is currently in the process of developing appropriate quality metrics and validation methods.

Data Collection

Bluetooth sensor deployments in Virginia started on Wednesday, September 8, 2010. The actual deployments in Virginia were performed with the assistance of Virginia Department of Transportation (VDOT) personnel. Sensors remained in the same position until they were retrieved a week later on Thursday, September 16, 2010. This round of data collections in Virginia was designed to cover segments of the highways along which both recurrent and non-recurrent congestions could be expected during both peak and off-peak periods.

Figure 1 presents snapshots of the roadway segments over which Bluetooth sensors were deployed in Virginia. In this figure, red segments represent freeway segments while the blue color indicates the arterial 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 Virginia. These segments cover a total length of about 44 freeway miles and five arterial 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. In total, this document reports the results of validation performed on fourteen freeway segments; ten of which 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 Virginia 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 while also presenting 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 Virginia. Tables 6 and 7 present detailed data for individual TMC segments in Virginia 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.

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 Virginia, respectively. These figures correspond to Table 4.

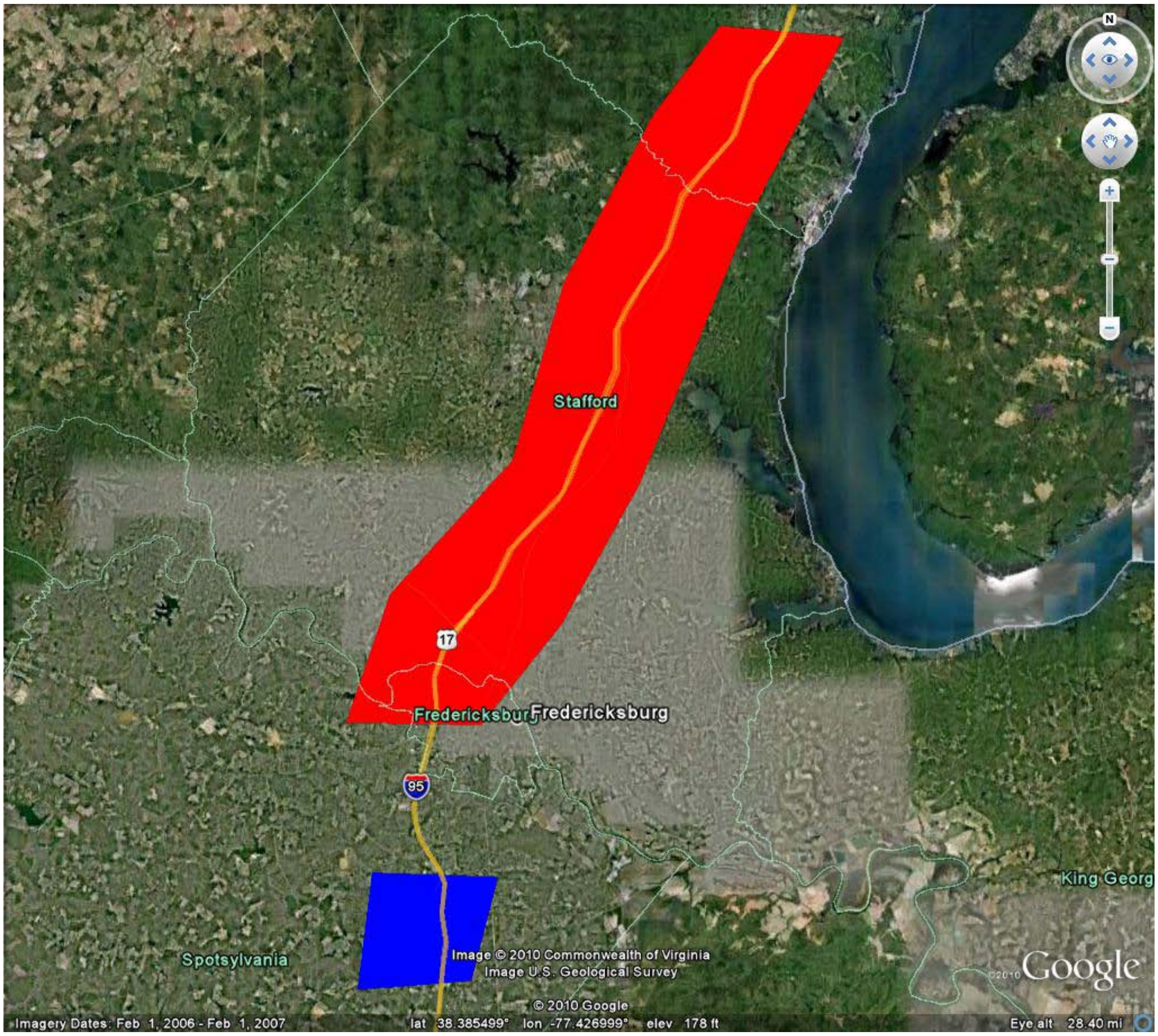

Figure 1
TMC segments selected for validation in Virginia

Table 1
Traffic Message Channel segments picked for validation in Virginia

TYPE	TMC	HIGHWAY	STARTING AT	ENDING AT	COUNTY	DIRECTION	LENGTH (mile)
Freeway	**110-04147**	I-95	VA-234/EXIT 152	EXIT 150	PRINCE WILLIAM	SOUTHBOUND	1.9
Freeway	**110N04147**	I-95	EXIT 150	EXIT 150	PRINCE WILLIAM	SOUTHBOUND	0.5
Freeway	**110-04146**	I-95	EXIT 150	RUSSELL RD/EXIT 148	PRINCE WILLIAM	SOUTHBOUND	1.9
Freeway	**110N04146**	I-95	RUSSELL RD/EXIT 148	RUSSELL RD/EXIT 148	PRINCE WILLIAM	SOUTHBOUND	0.2
Freeway	**110-04145**	I-95	RUSSELL RD/EXIT 148	US-1/VA-610/EXIT 143	STAFFORD	SOUTHBOUND	4.2
Freeway	**110N04145**	I-95	US-1/VA-610/EXIT 143	US-1/VA-610/EXIT 143	STAFFORD	SOUTHBOUND	0.6
Freeway	**110-04144**	I-95	US-1/VA-610/EXIT 143	VA-630/EXIT 140	STAFFORD	SOUTHBOUND	2.7
Freeway	**110N04144**	I-95	VA-630/EXIT 140	VA-630/EXIT 140	STAFFORD	SOUTHBOUND	0.5
Freeway	**110-04143**	I-95	VA-630/EXIT 140	US-17/EXIT 133	STAFFORD	SOUTHBOUND	6.3
Freeway	**110N04143**	I-95	US-17/EXIT 133	US-17/EXIT 133	STAFFORD	SOUTHBOUND	0.7
Freeway	**110-04142**	I-95	US-17/EXIT 133	FREDERICKSBURG/STAFFORD CO LINE (FREDERICKSBURG)	STAFFORD	SOUTHBOUND	0.8
Freeway	**110-04926**	I-95	FREDERICKSBURG/STAFFORD CO LINE (FREDERICKSBURG)	VA-3/EXIT 130	FREDERICKSBURG	SOUTHBOUND	1.8
Freeway	**110+04927**	I-95	VA-3/EXIT 130	FREDERICKSBURG/STAFFORD CO LINE	STAFFORD	NORTHBOUND	1.8
Freeway	**110+04143**	I-95	FREDERICKSBURG/STAFFORD CO LINE	US-17/EXIT 133	STAFFORD	NORTHBOUND	0.6
Freeway	**110P04143**	I-95	US-17/EXIT 133	US-17/EXIT 133	STAFFORD	NORTHBOUND	1.3
Freeway	**110+04144**	I-95	US-17/EXIT 133	VA-630/EXIT 140	STAFFORD	NORTHBOUND	5.9
Freeway	**110P04144**	I-95	VA-630/EXIT 140	VA-630/EXIT 140	STAFFORD	NORTHBOUND	0.5
Freeway	**110+04145**	I-95	VA-630/EXIT 140	US-1/VA-610/EXIT 143	STAFFORD	NORTHBOUND	2.3
Freeway	**110P04145**	I-95	US-1/VA-610/EXIT 143	US-1/VA-610/EXIT 143	STAFFORD	NORTHBOUND	0.9
Freeway	**110+04146**	I-95	US-1/VA-610/EXIT 143	RUSSELL RD/EXIT 148	PRINCE WILLIAM	NORTHBOUND	4.0
Freeway	**110P04146**	I-95	RUSSELL RD/EXIT 148	RUSSELL RD/EXIT 148	PRINCE WILLIAM	NORTHBOUND	0.5
Freeway	**110+04147**	I-95	RUSSELL RD/EXIT 148	EXIT 150	PRINCE WILLIAM	NORTHBOUND	1.7
Freeway	**110P04147**	I-95	EXIT 150	EXIT 150	PRINCE WILLIAM	NORTHBOUND	0.5
Freeway	**110+04148**	I-95	EXIT 150	VA-234/EXIT 152	PRINCE WILLIAM	NORTHBOUND	1.9
Arterial	**110+09514**	US-1	MASSAPONAX CHURCH RD	US-17	SPOTSYLVANIA	NORTHBOUND	2.3
Arterial	**110-09513**	US-1	US-17	MASSAPONAX CHURCH RD	SPOTSYLVANIA	SOUTHBOUND	2.3
							48.5

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

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	**110-04147**	38.576785	-77.326826	38.552791	-77.342678	1.90	38.576762	-77.327173		
Freeway	**110N04147**	38.552791	-77.342678	38.545576	-77.345414	0.52			38.545377	-77.345612
Freeway	**110-04146**	38.545576	-77.345414	38.524931	-77.367431	1.87	38.545377	-77.345612		
Freeway	**110N04146**	38.524931	-77.367431	38.522580	-77.370390	0.23			38.521880	-77.371395
Freeway	**110-04145**	38.522580	-77.370390	38.469497	-77.405313	4.17	38.521880	-77.371395		
Freeway	**110N04145**	38.469497	-77.405313	38.461401	-77.409376	0.61			38.460808	-77.408513
Freeway	**110-04144**	38.461401	-77.409376	38.424993	-77.421225	2.65	38.460808	-77.408513		
Freeway	**110N04144**	38.424993	-77.421225	38.418947	-77.424594	0.46			38.418297	-77.425435
Freeway	**110-04143**	38.418947	-77.424594	38.344333	-77.487940	6.29	38.418297	-77.425435	38.344058	-77.488373
Freeway	**110N04143**	38.344333	-77.487940	38.337252	-77.495913	0.65	38.344058	-77.488373		
Freeway	**110-04142**	38.337252	-77.495913	38.326794	-77.501860	0.79			38.325165	-77.502775
Freeway	**110-04926**	38.326794	-77.501860	38.300910	-77.504227	1.83	38.325165	-77.502775	38.301643	-77.504270
Freeway	**110+04927**	38.301117	-77.503383	38.326077	-77.501336	1.76	38.301610	-77.502992		
Freeway	**110+04143**	38.326077	-77.501336	38.333764	-77.497846	0.56			38.333785	-77.497887
Freeway	**110P04143**	38.333764	-77.497846	38.348110	-77.482784	1.29	38.333785	-77.497887	38.347703	-77.483065
Freeway	**110+04144**	38.348110	-77.482784	38.418819	-77.423809	5.92	38.347703	-77.483065		
Freeway	**110P04144**	38.418819	-77.423809	38.424654	-77.419594	0.46			38.424872	-77.419282
Freeway	**110+04145**	38.424654	-77.419594	38.456143	-77.408056	2.31	38.424872	-77.419282		
Freeway	**110P04145**	38.456143	-77.408056	38.468992	-77.404812	0.93			38.469785	-77.404075
Freeway	**110+04146**	38.468992	-77.404812	38.520401	-77.370950	4.03	38.469785	-77.404075		
Freeway	**110P04146**	38.520401	-77.370950	38.526363	-77.364486	0.54			38.527158	-77.363580
Freeway	**110+04147**	38.526363	-77.364486	38.545888	-77.344559	1.74	38.527158	-77.363580		
Freeway	**110P04147**	38.545888	-77.344559	38.552708	-77.342010	0.49			38.552800	-77.341872
Freeway	**110+04148**	38.552708	-77.342010	38.576802	-77.325965	1.91	38.552800	-77.341872	38.577112	-77.325677
Arterial	**110+09514**	38.193279	-77.509171	38.226074	-77.505485	2.30	38.193283	-77.509300	38.223657	-77.506085
Arterial	**110-09513**	38.226112	-77.505790	38.193279	-77.509171	2.30	38.223658	-77.506563	38.193283	-77.509300
						48.51				

Table 3
Path segments identified for validation in Virginia

Type	Validation Segment	STANDARD SEGMENTS INCLUDED TMC(1)	TMC(2)	STARTING AT	ENDING AT	LENGTH (MILE) Standard	Deployment	Error (%)
Freeway	**VA05-0001**	110-04147	110N04147	VA-234/EXIT 152	EXIT 150	2.4	2.42	0.21%
Freeway	**VA05-0002**	110-04146	110N04146	EXIT 150	RUSSELL RD/EXIT 148	2.1	2.15	2.53%
Freeway	**VA05-0003**	110-04145	110N04145	RUSSELL RD/EXIT 148	US-1/VA-610/EXIT 143	4.8	4.74	-0.76%
Freeway	**VA05-0004**	110-04144	110N04144	US-1/VA-610/EXIT 143	VA-630/EXIT 140	3.1	3.14	0.95%
Freeway	**110-04143**	110-04143		VA-630/EXIT 140	US-17/EXIT 133	6.3	6.25	-0.65%
Freeway	**VA05-0005**	110N04143	110-04142	US-17/EXIT 133	FREDERICKSBURG/STAFFORD CO LINE (FREDERICKSBURG)	1.4	1.53	5.70%
Freeway	**110-04926**	110-04926		FREDERICKSBURG/STAFFORD CO LINE (FREDERICKSBURG)	VA-3/EXIT 130	1.8	1.62	-11.26%
Freeway	**VA05-0006**	110+04927	110+04143	VA-3/EXIT 130	US-17/EXIT 133	2.3	2.28	-1.80%
Freeway	**110P04143**	110P04143		US-17/EXIT 133	US-17/EXIT 133	1.3	1.25	-2.93%
Freeway	**VA05-0007**	110+04144	110P04144	US-17/EXIT 133	VA-630/EXIT 140	6.4	6.44	0.83%
Freeway	**VA05-0008**	110+04145	110P04145	VA-630/EXIT 140	US-1/VA-610/EXIT 143	3.2	3.28	1.15%
Freeway	**VA05-0009**	110+04146	110P04146	US-1/VA-610/EXIT 143	RUSSELL RD/EXIT 148	4.6	4.57	-0.02%
Freeway	**VA05-0010**	110+04147	110P04147	RUSSELL RD/EXIT 148	EXIT 150	2.2	2.16	-3.08%
Freeway	**110+04148**	110+04148		EXIT 150	VA-234/EXIT 152	1.9	1.92	0.67%
Arterial	**110+09514**	110+09514		MASSAPONAX CHURCH RD	US-17	2.3	2.16	-6.07%
Arterial	**110-09513**	110-09513		US-17	MASSAPONAX CHURCH RD	2.3	2.16	-6.19%
TOTAL						**48.4**	**48.07**	**-0.68%**

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

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	3.2	4.8	4.1	6.3	489
30-45	1.4	4.0	4.3	7.8	830
45-60	0.4	2.9	1.6	5.2	1436
60+	-1.5	1.8	-2.8	3.8	24644

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

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	15%	74%	0%	66%	489
30-45	18%	70%	0%	54%	830
45-60	29%	80%	0%	60%	1436
60+	42%	89%	0%	72%	24644

Table 6
Data quality measures for individual freeway validation segments greater than one mile in the state of Virginia

TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for 1.96 SE Band: Speed Error Bias	1.96 SE Band: Average Absolute Speed Error	Mean: Speed Error Bias	Mean: Average Absolute Speed Error	No. of Obs.
110+04148	**1.91**	**1.92**	0-30	0.7	2.6	0.7	3.4	25*
			30-45	2.9	4.4	2.9	5.7	23*
			45-60	1.3	2.5	2.4	4.1	237
			60+	-0.7	1.4	-1.1	2.9	1910
110-04143	**6.21**	**6.25**	0-30	-1.1	1.7	-1.4	2.5	14*
			30-45	0.4	2.9	0.4	3.6	40
			45-60	0.8	2.3	1.7	3.8	101
			60+	-1.8	1.8	-3.3	3.9	1800
110-04926	**1.77**	**1.62**	0-30	16.9	16.9	21.7	21.7	22*
			30-45	3.5	5.0	7.2	9.3	73
			45-60	-0.3	3.0	0.8	5.6	230
			60+	-1.3	1.5	-2.5	3.5	1691
110P04143	**1.21**	**1.25**	0-30	10.8	12.4	13.0	15.4	11*
			30-45	9.3	9.3	21.8	21.8	5*
			45-60	-3.2	6.9	-1.3	10.6	10*
			60+	-1.8	1.9	-3.6	4.4	1863
VA05-0001	**2.41**	**2.42**	0-30	0.8	2.8	0.9	3.6	148
			30-45	-0.3	3.7	0.1	5.2	98
			45-60	-1.6	4.4	-0.7	6.7	70
			60+	-1.7	1.9	-3.0	3.8	1786
VA05-0002	**2.11**	**2.15**	0-30	2.5	3.8	2.8	4.4	72
			30-45	0.1	4.3	0.0	5.2	94
			45-60	0.5	4.7	1.4	6.3	45
			60+	-2.5	2.6	-4.1	4.4	1779
VA05-0003	**4.78**	**4.74**	0-30	7.6	7.6	26.7	26.7	3*
			30-45	2.0	3.5	9.5	11.7	110
			45-60	0.3	1.6	2.1	4.8	168
			60+	-0.8	1.1	-1.7	3.0	1460
VA05-0004	**3.17**	**3.14**	0-30	4.7	4.7	5.0	5.0	1*
			30-45	1.0	3.9	2.3	6.4	63
			45-60	0.8	4.3	3.2	7.5	33
			60+	-1.0	1.3	-2.0	3.1	1910
VA05-0005	**1.51**	**1.53**	0-30	11.8	12.0	14.6	14.9	46
			30-45	2.1	5.1	3.8	8.0	119
			45-60	-1.2	4.5	-1.1	7.6	76
			60+	-0.7	1.5	-1.1	3.8	1437

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

Table 6
Data quality measures for individual freeway validation segments greater than one mile in the state of Virginia (Cont'd)

TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for 1.96 SE Band: Speed Error Bias	Data Quality Measures for 1.96 SE Band: Average Absolute Speed Error	Data Quality Measures for Mean: Speed Error Bias	Data Quality Measures for Mean: Average Absolute Speed Error	No. of Obs.
VA05-0006	**2.34**	**2.28**	0-30	1.7	3.4	1.8	4.2	26*
			30-45	0.4	3.3	0.9	4.6	32
			45-60	-0.7	2.9	-0.3	4.5	104
			60+	-1.3	1.5	-2.8	3.7	1778
VA05-0007	**6.43**	**6.44**	0-30	1.9	4.1	6.1	9.1	13*
			30-45	2.7	4.5	14.7	17.1	47
			45-60	0.5	2.5	6.5	9.1	62
			60+	-1.0	1.3	-2.1	3.3	1629
VA05-0008	**3.16**	**3.28**	0-30	2.2	4.3	2.6	5.6	50
			30-45	0.7	3.0	6.1	9.4	55
			45-60	0.7	2.2	2.4	5.1	73
			60+	-2.2	2.3	-4.3	4.7	1589
VA05-0009	**4.57**	**4.57**	0-30	0.1	1.7	0.1	2.2	41
			30-45	0.5	1.8	1.4	3.2	36
			45-60	0.9	2.4	1.1	3.2	146
			60+	-2.2	2.3	-3.6	4.1	1943
VA05-0010	**2.28**	**2.16**	0-30	1.7	4.1	1.9	5.7	17*
			30-45	2.2	5.2	2.4	6.8	35
			45-60	2.5	4.1	3.5	5.9	81
			60+	-2.1	2.3	-3.5	4.3	2069

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

Table 7
Observations meeting data quality criteria for individual freeway validation segments greater than one mile in the state of Virginia

TMC	SPEED BIN	Data Quality Measures for: 1.96 SE Band – Speed Error Bias: No. falling inside the band	1.96 SE Band – Speed Error Bias: % falling inside the band	1.96 SE Band – Average Absolute Speed Error: No. falling within 5 mph of the band	1.96 SE Band – Average Absolute Speed Error: % falling within 5 mph of the band	Mean – Speed Error Bias: No. equal to the mean	Mean – Speed Error Bias: % equal to the mean	Mean – Average Absolute Speed Error: No. within 5 mph of the mean	Mean – Average Absolute Speed Error: % within 5 mph of the mean	No. of Obs.
110+04148	0-30	7	28%	21	84%	0	0%	21	84%	25*
	30-45	6	26%	14	61%	0	0%	13	57%	23*
	45-60	61	26%	197	83%	0	0%	155	65%	237
	60+	828	43%	1790	94%	8	0%	1598	84%	1910
110-04143	0-30	2	14%	13	93%	0	0%	12	86%	14*
	30-45	3	8%	32	80%	0	0%	29	73%	40
	45-60	22	22%	86	85%	0	0%	75	74%	101
	60+	682	38%	1611	90%	0	0%	1254	70%	1800
110-04926	0-30	2	9%	4	18%	0	0%	3	14%	22*
	30-45	15	21%	43	59%	0	0%	22	30%	73
	45-60	73	32%	175	76%	0	0%	123	53%	230
	60+	819	48%	1550	92%	2	0%	1284	76%	1691
110P04143	0-30	2	18%	2	18%	0	0%	2	18%	11*
	30-45	0	0%	3	60%	0	0%	1	20%	5*
	45-60	5	50%	7	70%	0	0%	4	40%	10*
	60+	792	43%	1633	88%	0	0%	1156	62%	1863
VA05-0001	0-30	18	12%	123	83%	0	0%	112	76%	148
	30-45	15	15%	74	76%	0	0%	63	64%	98
	45-60	22	31%	51	73%	0	0%	39	56%	70
	60+	720	40%	1589	89%	0	0%	1295	73%	1786
VA05-0002	0-30	7	10%	52	72%	0	0%	46	64%	72
	30-45	7	7%	65	69%	0	0%	59	63%	94
	45-60	7	16%	32	71%	0	0%	26	58%	45
	60+	442	25%	1479	83%	0	0%	1090	61%	1779
VA05-0003	0-30	0	0%	2	67%	0	0%	0	0%	3*
	30-45	31	28%	76	69%	0	0%	50	45%	110
	45-60	67	40%	155	92%	0	0%	116	69%	168
	60+	783	54%	1400	96%	0	0%	1214	83%	1460
VA05-0004	0-30	0	0%	1	100%	0	0%	1	100%	1*
	30-45	7	11%	46	73%	0	0%	38	60%	63
	45-60	9	27%	21	64%	0	0%	15	45%	33
	60+	897	47%	1790	94%	0	0%	1512	79%	1910
VA05-0005	0-30	2	4%	17	37%	0	0%	14	30%	46
	30-45	16	13%	72	61%	0	0%	55	46%	119
	45-60	18	24%	45	59%	0	0%	27	36%	76
	60+	811	56%	1308	91%	4	0%	1075	75%	1437

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

Table 7
Observations meeting data quality criteria for individual freeway validation segments greater than one mile in the state of Virginia (Cont'd)

TMC	SPEED BIN	Data Quality Measures for 1.96 SE Band: Speed Error Bias: No. falling inside the band	1.96 SE Band: Speed Error Bias: % falling inside the band	1.96 SE Band: Average Absolute Speed Error: No. falling within 5 mph of the band	1.96 SE Band: Average Absolute Speed Error: % falling within 5 mph of the band	Mean: Speed Error Bias: No. equal to the mean	Mean: Speed Error Bias: % equal to the mean	Mean: Average Absolute Speed Error: No. within 5 mph of the mean	Mean: Average Absolute Speed Error: % within 5 mph of the mean	No. of Obs.
VA05-0006	0-30	4	15%	24	92%	0	0%	20	77%	26*
	30-45	7	22%	23	72%	0	0%	20	63%	32
	45-60	28	27%	82	79%	0	0%	69	66%	104
	60+	834	47%	1617	91%	0	0%	1273	72%	1778
VA05-0007	0-30	2	15%	10	77%	0	0%	8	62%	13*
	30-45	10	21%	31	66%	0	0%	16	34%	47
	45-60	29	47%	51	82%	0	0%	15	24%	62
	60+	859	53%	1520	93%	1	0%	1293	79%	1629
VA05-0008	0-30	12	24%	43	86%	0	0%	38	76%	50
	30-45	17	31%	43	78%	0	0%	30	55%	55
	45-60	32	44%	62	85%	0	0%	41	56%	73
	60+	586	37%	1349	85%	1	0%	951	60%	1589
VA05-0009	0-30	8	20%	38	93%	0	0%	37	90%	41
	30-45	7	19%	34	94%	0	0%	33	92%	36
	45-60	24	16%	127	87%	0	0%	115	79%	146
	60+	538	28%	1662	86%	0	0%	1302	67%	1943
VA05-0010	0-30	5	29%	12	71%	0	0%	9	53%	17*
	30-45	10	29%	22	63%	0	0%	19	54%	35
	45-60	15	19%	53	65%	0	0%	41	51%	81
	60+	672	32%	1744	84%	1	0%	1330	64%	2069

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

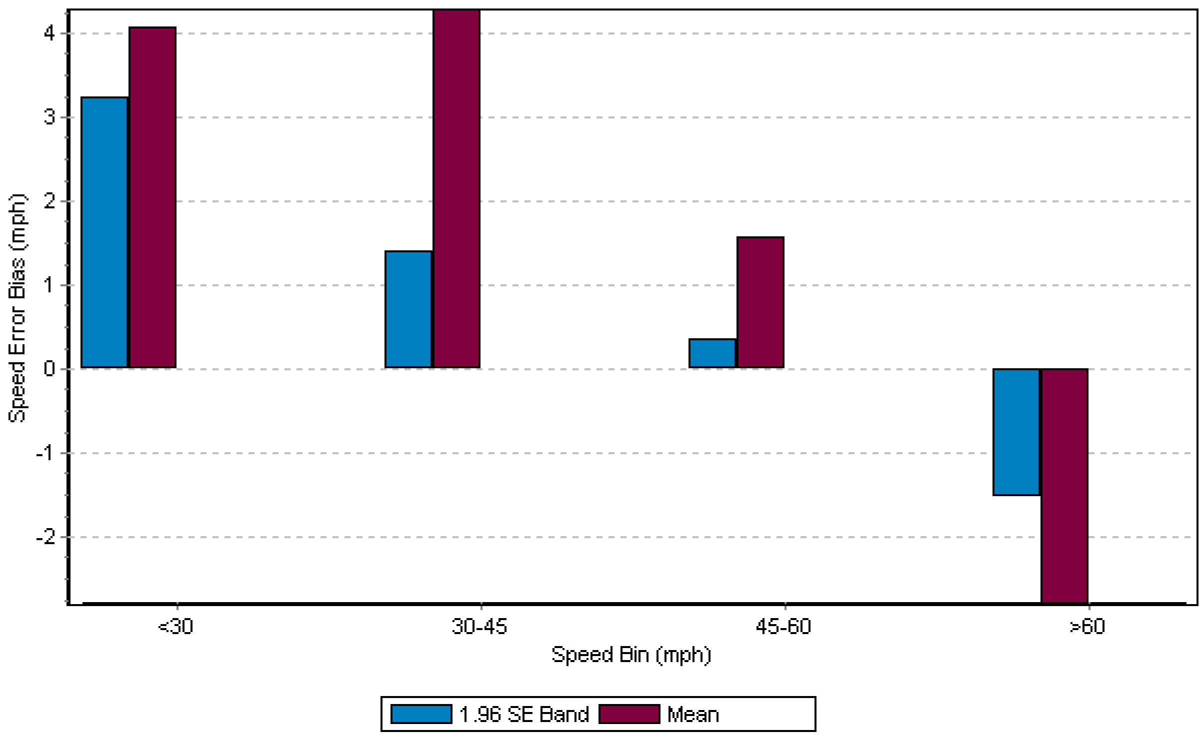

Figure 2
Speed error bias for freeway segments greater than one mile in Virginia

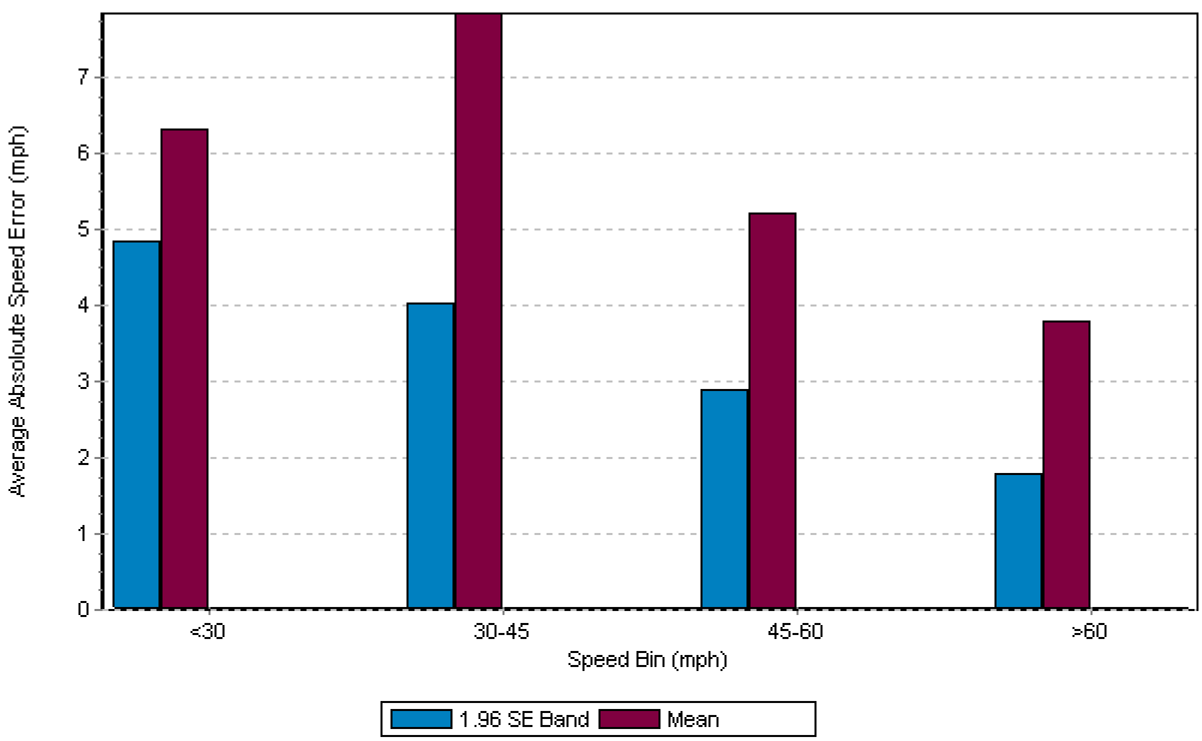

Figure 3
Average absolute speed error for freeway segments greater than one mile in Virginia

Analysis of Results for Arterials

Travel time samples collected along US Route 1 were compared with travel time and speed data reported by INRIX as part of this project. The arterial data is included for informational purposes noting that INRIX has volunteered arterial data at no cost to the Coalition for the first three years, and that the method to evaluate quality on arterial roadways has not been fully evaluated. The Coalition is currently in the process of developing appropriate quality metrics and validation methods.

Table 8 summarizes the data quality measures obtained as a result of comparison between Bluetooth and all reported INRIX speeds on two arterial segments considered in this round of validations. In all speed bins below 60mph, INRIX data meets the freeway data quality measures set forth in the contract when errors are measured as a distance from the 1.96 times the standard error band. In addition, no observations are made in the speed bin above 60 mph, which is compatible with the posted speed limits on the arterial segments in question.

Table 9 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 arterial segments in Virginia. Tables 10 and 11 present detailed data for individual arterial segments in Virginia in similar format as Tables 8 and 9, respectively. Note that for some segments and in some speed bins the comparison results may not be reliable due to small number of observations.

Figures 4 and 5 show the overall speed error biases for different speed bins, and the average absolute speed errors for all considered arterial segments in Virginia, respectively. These figures correspond to Table 8.

Table 8
Data quality measures for arterial segments greater than one mile in Virginia

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	3.0	3.0	15.3	15.3	39
30-45	-0.7	1.1	-2.4	4.1	272
45-60	-4.7	4.7	-8.9	8.9	78
60+					

Table 9
Percent observations meeting data quality criteria for arterial segments greater than one mile in Virginia

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	46%	72%	0%	0%	39
30-45	67%	93%	0%	68%	272
45-60	27%	60%	0%	10%	78
60+					

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

TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for 1.96 SE Band: Speed Error Bias	1.96 SE Band: Average Absolute Speed Error	Mean: Speed Error Bias	Mean: Average Absolute Speed Error	No. of Obs.
110+09514	**2.30**	**2.16**	0-30	2.3	2.3	14.4	14.4	22*
			30-45	-1.3	1.4	-3.9	4.8	158
			45-60	-6.1	6.1	-9.9	9.9	41
			60+					
110-09513	**2.30**	**2.16**	0-30	3.9	3.9	16.3	16.3	17*
			30-45	0.2	0.6	-0.2	3.1	114
			45-60	-3.2	3.2	-7.8	7.8	37
			60+					

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

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

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+05623	0-30	12	55%	18	82%	0	0%	0	0%	22*
	30-45	99	63%	142	90%	0	0%	90	57%	158
	45-60	6	15%	19	46%	0	0%	3	7%	41
	60+									
103-04821	0-30	6	35%	10	59%	0	0%	0	0%	17*
	30-45	82	72%	111	97%	0	0%	96	84%	114
	45-60	15	41%	28	76%	0	0%	5	14%	37
	60+									

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

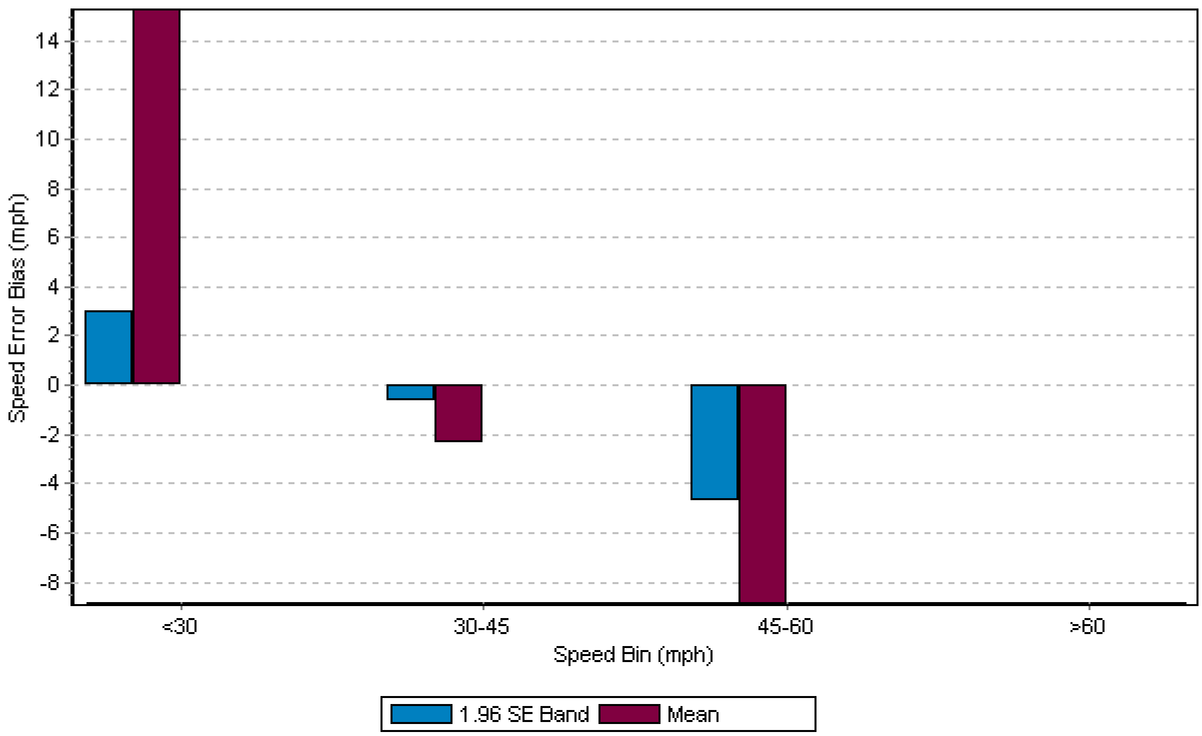

Figure 4
Speed error bias for arterial segments greater than one mile in Virginia

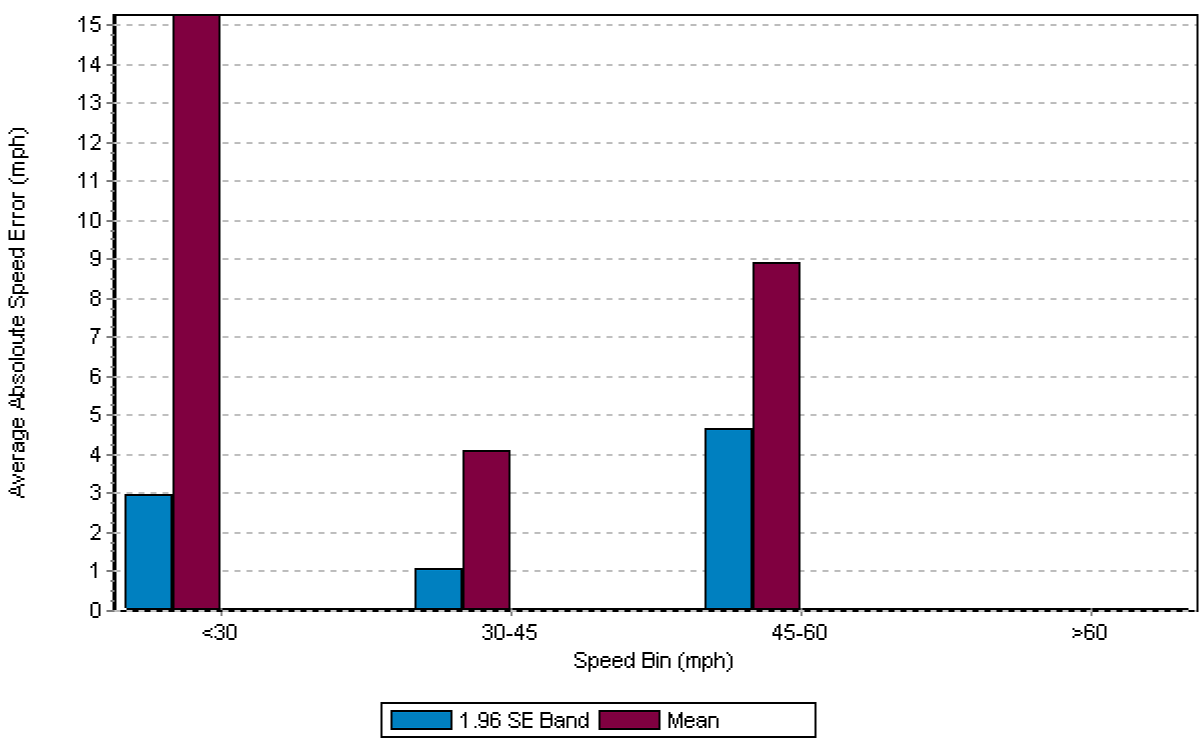

Figure 5
Average absolute speed error for arterial segments greater than one mile in Virginia