

# I-95 Corridor Coalition Vehicle Probe Project: HERE and INRIX Data Validation

## Report for Pennsylvania Turnpike (#1) Freeway Validation

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# Executive Summary

Wireless re-identification traffic monitoring (WRTM) technology (Bluetooth and/or Wi-Fi) is used to evaluate the quality of speeds reported by probe data vendors on selected validation road segments. WRTM equipment is deployed at strategic locations along these segments and identifies – and later re-identifies – unique signals emitted by in-vehicle electronic equipment via Bluetooth, Wi-Fi and other technologies, thus allowing direct measurement of travel times from a sample of vehicles. Prior research indicates that this sampling approach is capable of accurately characterizing actual travel times (speeds)<sup>1</sup>; therefore, WRTM data serves as the ground-truth data source against which reported probe speeds are compared. The following bullets summarize key information about the data collection effort, while ES Table 1 provides a summary description of the study area:

## Study area

- Pennsylvania Turnpike, PA (see Figure 1)
- Freeway segments along Pennsylvania Turnpike, a limited access toll facility
- Number of validation segments: 18
- Directional miles: 66

## WRTM sensors

- Re-identification technology: Bluetooth & Wi-Fi
- Number deployed: 20

## Data collection:

- Dates: October 9-20, 2019
- Effective five-minute travel time samples observed: 51,062

ES Table 1 -- Freeway Corridor Description			
Corridor Name	Number of Directional Lanes	AADT	Speed Limit
Pennsylvania Turnpike	2 lanes	32,853	70 mph

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<sup>1</sup> Ali Haghani, Masoud Hamedi, Kaveh Farokhi Sadabadi, I-95 Corridor Coalition Vehicle Probe Project: Validation of INRIX Data July-September 2008, January 2010 ([link](#))

ES Tables 2-3 summarize the evaluation results using the “traditional analysis”, which involves comparing reported probe speeds to (a) the mean WRTM speed, and (b) the 95% confidence band of WRTM mean speed for each 5-minute time interval. These comparisons are quantified in terms of two error metrics: Average Absolute Speed Error (AASE) and Speed Error Bias (SEB), which are calculated separately for four different speed bins.

Columns relevant to contract specifications are outlined in red, and error metric values are colored green or red to indicate whether the value is within contract specifications (AASE <= 10 mph, SEB <= 5 mph).

Note that there were only 13 five-minute samples in the lowest speed bin (0-30 mph). Given the lack of opportunity to meaningfully evaluate the data in this bin, the error metrics are reported below, but not colored red or green.

ES Table 2 – HERE Traditional Analysis Summary					
Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Number of 5 Minute Samples
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean	
0-30	7.24	8.9	0.79	0.8	13
30-45	6.21	8.25	2.22	3.51	143
45-60	3	5.08	1.05	2.08	8584
60+	1.81	3.84	0.06	0.31	40251
All Speeds	2.04	4.07	0.24	0.63	48991

- **AASE:** Within specification (< 10 mph) in all speed bins
- **SEB:** Within specification (< 5 mph) in all speed bins

**ES Table 3 – INRIX Traditional Analysis Summary**

Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Number of 5 Minute Samples
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean	
0-30	16.17	18	14.78	16.44	13
30-45	5.71	7.67	2.37	3.44	143
45-60	3.18	5.35	2.55	4.19	8572
60+	1.84	3.89	1.34	2.37	40215
All Speeds	2.09	4.16	1.56	2.7	48943

- **AASE:** Within specification (< 10 mph) in the upper three speed bins, but not in the lowest bin (0-30 mph).
- **SEB:** Within specification (< 5 mph) in all but the 15-25 mph speed bin, but not in the lowest bin (0-30 mph).

*“For this validation report, there were only two vendor submittals – from HERE and INRIX. Due to a technical issue, data from the vendor TomTom was not accessible for this report.”*

## Introduction

The University of Maryland (UMD), acting on behalf of the I-95 Corridor Coalition, was given the responsibility of evaluating the quality of Vehicle Probe Project (VPP) data at the inception of the project in 2009. To assess the quality of travel time and speed data, UMD developed a methodology using wireless re-identification traffic monitoring (WRTM) technology, which is documented in detail in the previously referenced full report: I-95 Corridor Coalition Vehicle Probe Project: Validation of INRIX Data.

At a high level, WRTM equipment is deployed at strategic locations along selected road segments and identifies – and later re-identifies – unique signals emitted by in-vehicle electronic equipment via Bluetooth, Wi-Fi and other technologies, thus allowing direct measurement of travel times from a sample of vehicles. Initial research conducted by UMD shows that this sampling approach is capable of accurately characterizing travel times (speeds); therefore, WRTM data serves as the ground-truth data source against which reported probe speeds are compared.

In 2014, the project moved to a second phase (VPPII), during which a probe data marketplace was created. Currently there are three data vendors that provide travel time and speed data through this marketplace: HERE, INRIX, and TomTom. The purpose of this report, which is produced on a regular basis, is to continue to rigorously assess the accuracy of speeds reported by each vendor on various road segments from I-95 Corridor Coalition member states.

## Probe Data Vendors

Each vendor provides travel time and speed data along the road segments and time periods of interest, which are subsequently compared to ground truth WRTM observations in order to assess data accuracy.

Specifically, each vendor reports travel time and speed data in one-minute intervals either along road segments defined by the WRTM sensor locations (i.e., validation segmentation) or Traffic Message Channel (TMC) segments. In the latter case the TMC-based speeds must first be transformed to equivalent speeds on validation segments before a direct comparison can be made.

## Methodology

The primary means of evaluating the vendor data is through the traditional validation analysis, which is documented in the original report (I-95 Corridor Coalition Vehicle Probe Project: Validation of INRIX Data July-September 2008) and summarized below. Additionally, supplemental analyses may be conducted depending on the road type being evaluated and

observed data characteristics. The most common supplemental analysis is the slowdown analysis, which evaluates probe data quality during major congestion events on arterials.

## Traditional validation analysis

### *Overview*

The traditional validation analysis consists of comparing ground truth (i.e., WRTM) speeds against vendor speeds over five-minute intervals and quantifying the discrepancy in terms of two error metrics defined in the contract specifications.

### *Obtain vendor speed data along validation road segments*

Road segments used for validation are defined based on WRTM sensor locations – often resulting in different segment definitions than those typically reported by the probe vendors. Accordingly, vendors may either report speeds directly on the validation road segmentation used for evaluation, or report speeds based on standard Traffic Message Channel (TMC) segments. In the latter case, equivalent vendor speeds must be obtained for the geometry specified by the WRTM sensors, which is accomplished via a trajectory reconstruction algorithm. This algorithm is described in another report<sup>2</sup> and works by (a) identifying the portions of vendor road segments that correspond to the validation segment, and (b) using the speeds reported on the vendor's segments during multiple time intervals to calculate the equivalent speed.

### *Filter and aggregate ground truth data*

Raw travel time (speed) observations are first filtered to remove outliers. The filtering step is necessary because WRTM sensors sometimes re-identify vehicles that stop between sensors or record travel times from pedestrians or non-motorized vehicles that are not representative of actual traffic conditions. After the outlier observations are removed, the remaining representative observations are aggregated for each segment over five-minute intervals, and intervals with too few observations or excessive variation are discarded.

The remaining intervals are deemed suitable for evaluation of vendor probe data and are summarized in terms of (a) space-mean speed and (b) confidence band around the mean. The space-mean speed captures average ground truth traffic behavior, while the confidence band accounts for sample size and variation in the observed speeds.

Several statistical measures were initially evaluated to define the width of this uncertainty band, all of which are described and reported in the original report. Ultimately, the standard error of the mean (SEM) measure was selected due to its simplicity and sensitivity to both variability and number of observations used for calculations. The SEM is calculated as the standard deviation

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<sup>2</sup> Ali Haghani, Masoud Hamed, Kaveh Farokhi Sadabadi, Estimation of Travel Times for Multiple TMC Segments, prepared for I-95 Corridor Coalition, February 2010 ([link](#))

(SD) of the WRTM speeds divided by the square root of the number WRTM data points ( $n$ ) taken for a given time. In other words,  $SEM = \frac{SD_{WRTM}}{\sqrt{n}}$ . The confidence band based on this statistic (i.e., the SEM band) narrows when there is a higher degree of confidence in the ground truth data (i.e., more observations or less variation) and widens when there is less confidence, serving as a proxy for a 95% confidence interval of ground truth speeds.

### *Compute Error Metrics*

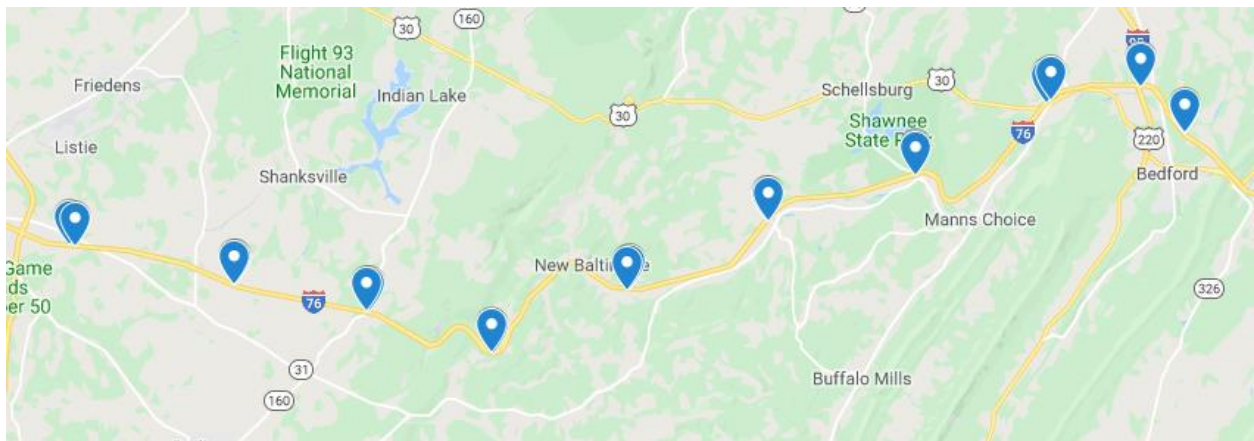
A statistical analysis of the data is conducted for four defined speed bins, where each five-minute interval is associated with a speed bin based on its corresponding ground truth space-mean speed (0-15 mph, 15-30 mph, 30-45 mph, 45+ mph for arterials; 0-30 mph, 30-45 mph, 45-60 mph, 60+ mph for freeways). Reported probe speeds are compared to both the space-mean and SEM band ground truth speed for each five-minute time interval, and the discrepancies are quantified in terms of two error metrics: Average Absolute Speed Error (AASE) and Speed Error Bias (SEB), which are reported separately for each speed bin. According to contract specifications, AASE and SEB values must be within 10 mph and 5 mph, respectively, when compared with the SEM band.

AASE is calculated by summing up the absolute difference between probe vendor speeds ( $S_P$ ) and ground truth speeds ( $S_{GT}$ ) for each time interval and taking the average over  $n$  observations. That is,  $AASE = \frac{1}{n} \sum_{i=1}^n |S_P - S_{GT}|$ . Because the absolute value is used, positive and negative errors cannot cancel, and the result is always positive. Speed Error Bias is calculated similarly, with the difference that the absolute value of the errors is not taken. In other words,  $SEB = \frac{1}{n} \sum_{i=1}^n S_P - S_{GT}$ . Thus, positive and negative errors can cancel each other out, and the resulting value can provide insight into whether there is a consistent positive or negative error.



## Data Collection

Travel time samples were collected along 18 directional validation road segments between Somerset and Bedford, PA along the PA Turnpike from October 9-20, 2019. These validation segments are defined based on WRTM sensor locations, which are shown in Figure 1. Table 1 contains the summary information for each data collection segment, including WRTM sensor latitude/longitudes and an active map link, which can be followed to view each data collection segment in detail. Please note that the configuration of the test segments is often such that the endpoint of one segment coincides with the start point of the next segment, so that one WRTM sensor covers both data collection segments.



**Figure 1 – WRTM Sensor locations**

Table 1 - Validation Segment Attributes

Segment (Map Link)	DESCRIPTION						Deployment		
	Highway	Starting at	Lane (Min)	Signals	AADT	Access Points	Begin Lat/Lon		Length (mile)
Direction	Ending at	Lane (Max)	Signal/mile	Speed Limit		End Lat/Lon			
	<b>Freeway</b>								
A1 <a href="#">PATPK-0001</a>	PA TURNPIKE Eastbound	BicyclePA Rte S Brotherton Rd	2 2	0 0	32853	1 70	39.9930 -79.0142 39.9789 -78.9398	4.10	
A2 <a href="#">PATPK-0002</a>	PA TURNPIKE Eastbound	Brotherton Rd Huckleberry Hwy	2 2	0 0	32853	2 70	39.9789 -78.9398 39.9695 -78.8783	3.33	
A3 <a href="#">PATPK-0003</a>	PA TURNPIKE Eastbound	Huckleberry Hwy Wambaugh Hollow Rd	2 2	0 0	32853	2 70	39.9695 -78.8783 39.9547 -78.8192	3.82	
A4 <a href="#">PATPK-0004</a>	PA TURNPIKE Eastbound	Huckleberry Hwy Wambaugh Hollow Rd	2 2	0 0	32853	0 70	39.9547 -78.8192 39.9774 -78.7567	4.65	
A5 <a href="#">PATPK-0005</a>	PA TURNPIKE Eastbound	New Baltimore Rd Buffalo Rd	2 2	0 0	32853	2 70	39.9774 -78.7567 40.0021 -78.6909	4.11	
A6 <a href="#">PATPK-0006</a>	PA TURNPIKE Eastbound	New Baltimore Rd Buffalo Rd	2 2	0 0	32853	2 70	40.0021 -78.6909 40.0185 -78.6223	3.91	
A7 <a href="#">PATPK-0007</a>	PA TURNPIKE Eastbound	Shawnee Rd US-30	2 2	0 0	32853	0 70	40.0185 -78.6223 40.0451 -78.5594	4.89	
A8 <a href="#">PATPK-0008</a>	PA TURNPIKE Eastbound	US-30 US-220	2 2	0 0	32853	1 70	40.0451 -78.5594 40.0500 -78.5175	2.31	
A9 <a href="#">PATPK-0009</a>	PA TURNPIKE Eastbound	US-220 North Midway Travel Plaza	2 2	0 0	32853	2 70	40.0500 -78.5175 40.0333 -78.4967	1.72	
A10 <a href="#">PATPK-0010</a>	PA TURNPIKE Westbound	North Midway Travel Plaza US-220	2 2	0 0	32853	2 70	40.0331 -78.4964 40.0501 -78.5170	1.72	
A11 <a href="#">PATPK-0011</a>	PA TURNPIKE Westbound	US-220 US-30	2 2	0 0	32853	1 70	40.0501 -78.5170 40.0438 -78.5609	2.46	

Segment (Map Link)	DESCRIPTION						Deployment		
	Highway	Starting at	Lane (Min)	Signals	AADT	Access Points	Begin Lat/Lon		Length (mile)
	Direction	Ending at	Lane (Max)	Signal/mile		Speed Limit	End Lat/Lon		
	<b>Freeway</b>								
A12 <a href="#">PATPK -0012</a>	PA TURNPIKE Westbound	US-30 Shawnee Rd	2 2	0 0	32853	1 70	40.0438 -78.5609 40.0186 -78.6223	4.77	
A13 <a href="#">PATPK -0013</a>	PA TURNPIKE Westbound	Shawnee Rd Buffalo Rd	2 2	0 0	32853	1 70	40.0186 -78.6223 40.0019 -78.6912	3.94	
A14 <a href="#">PATPK -0014</a>	PA TURNPIKE Westbound	Buffalo Rd New Baltimore Rd	2 2	0 0	32853	2 70	40.0019 -78.6912 39.9773 -78.7552	4.01	
A15 <a href="#">PATPK -0015</a>	PA TURNPIKE Westbound	New Baltimore Rd Wambaugh Hollow Rd	2 2	0 0	32853	2 70	39.9773 -78.7552 39.9550 -78.8204	4.80	
A16 <a href="#">PATPK -0016</a>	PA TURNPIKE Westbound	New Baltimore Rd Wambaugh Hollow Rd	2 2	0 0	32853	2 70	39.9550 -78.8204 39.9695 -78.8770	3.67	
A17 <a href="#">PATPK -0017</a>	PA TURNPIKE Westbound	Huckleberry Hwy Brotherton Rd	2 2	0 0	32853	3 70	39.9695 -78.8770 39.9791 -78.9397	3.40	
A18 <a href="#">PATPK -0018</a>	PA TURNPIKE Westbound	Huckleberry Hwy Brotherton Rd	2 2	0 0	32853	2 70	39.9791 -78.9397 39.9933 -79.0168	4.24	

# Validation Results

## Traditional Validation Results

HERE

Table 2 summarizes the standard error metrics computed between ground truth (i.e., WRTM) and HERE speeds. Both Average Absolute Speed Error (AASE) and SEB are within specifications for all speed bins. Note that the lowest speed bin only has 13 observations, and thus it is hard to draw strong conclusions about the performance in this speed range.

**Table 2 – HERE data quality measures**

Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Number of 5 Minute Samples
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean	
0-30	7.24	8.9	0.79	0.8	13
30-45	6.21	8.25	2.22	3.51	143
45-60	3	5.08	1.05	2.08	8584
60+	1.81	3.84	0.06	0.31	40251
All Speeds	2.04	4.07	0.24	0.63	48991

Table 3 shows the percentage of time the HERE data falls within 5mph of the mean and SEM band for each speed bin.

**Table 3 – Percent of HERE observations meeting data quality criteria**

Speed Bin	Data Quality Measures for				Number of 5 Minute Samples
	SEM Band		Mean		
	Percent inside band	Percent within 5mph of band	Percent equal to mean	Percent within 5mph of mean	
0-30	7.69	38.46	-	23.08	13
30-45	6.29	49.65	-	32.17	143
45-60	32.01	79.28	-	60.55	8584
60+	44.94	90.29	-	73.8	40251

Table 4 reports the standard error metrics on individual validation segments. Note that some segments and time bins only have a few observations, and thus may not be representative of the overall performance in each speed bin.

**Table 4 – HERE data quality measures by validation segment**

Path	Sensor distance	SPEED BIN	Data Quality Measures for				No. of Obs.
			Avg. Absolute Speed Error		Speed Error Bias		
			SEM Band	Mean	SEM band	Mean	
PA TURNPIKE-0001	4.10	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	5.2	7.97	2.36	4.35	21
		60+	1.63	3.4	0.62	1.44	3235
PA TURNPIKE-0002	3.33	0-30	7.47	8.6	-3.5	-4.51	5
		30-45	4.75	7.41	0.15	0.54	15
		45-60	8.91	10.82	-8.07	-8.53	58
		60+	1.7	3.77	-0.89	-1.39	3051
PA TURNPIKE-0003	3.82	0-30	5.79	8.37	3.26	4.39	5
		30-45	7.38	9.06	0.51	1.14	55
		45-60	2.58	4.16	0.75	1.33	1865
		60+	1.43	3.34	-0.55	-1.07	1209
PA TURNPIKE-0004	4.65	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	3.15	5.19	2.68	4.4	1021
		60+	2.32	4.33	1.84	3.28	2054
PA TURNPIKE-0005	4.11	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	3.49	6	3.18	4.1	15
		60+	1.55	3.62	-0.9	-1.57	3052
PA TURNPIKE-0006	3.91	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	2.96	4.19	-1.18	-0.73	42
		60+	1.4	3.29	-0.42	-0.72	3038
PA TURNPIKE-0007	4.89	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	1.69	3.32	0.52	1.51	68
		60+	1.36	3.11	0.48	1.03	3156
PA TURNPIKE-0008	2.31	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	4.84	9.06	4.84	9.02	119
		60+	1.98	4.49	1.67	3.42	1580
PA TURNPIKE-0009	1.72	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	3.69	7.25	3.63	6.99	252
		60+	0.9	3.99	0.1	0.17	1445
PA TURNPIKE-0010	1.72	0-30	-	-	-	-	-
		30-45	0.78	14.18	0.78	14.18	1
		45-60	5.28	8.66	5.25	8.48	715
		60+	1.9	4.46	1.22	2.56	811

Path	Sensor distance	SPEED BIN	Data Quality Measures for				No. of Obs.
			Avg. Absolute Speed Error		Speed Error Bias		
			SEM Band	Mean	SEM Band	Mean	
PA TURNPIKE-0011	2.46	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	4.56	8.37	4.56	8.37	22
		60+	2.6	4.81	-0.93	-1.02	3077
PA TURNPIKE-0012	4.77	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	4.43	7.35	4.43	7.35	5
		60+	1.6	3.31	0.66	1.37	3001
PA TURNPIKE-0013	3.94	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	3.47	7.75	3.47	7.75	2
		60+	2	4.08	-1.56	-2.68	3006
PA TURNPIKE-0014	4.01	0-30	-	-	-	-	-
		30-45	21.25	29.76	21.25	29.76	1
		45-60	4.12	5.99	-2.28	-1.83	400
		60+	2.29	4.08	0.58	1.38	2652
PA TURNPIKE-0015	4.80	0-30	-	-	-	-	-
		30-45	1.54	6.99	1.54	6.99	1
		45-60	2.13	4.3	0.12	0.59	1448
		60+	1.97	4.38	-0.79	-1.24	1174
PA TURNPIKE-0016	3.67	0-30	9.28	10.3	3.82	3.68	3
		30-45	5.52	7.42	3.76	5.44	70
		45-60	2.53	4.33	0.03	0.46	2419
		60+	2.31	4.98	-1.81	-3.31	148
PA TURNPIKE-0017	3.40	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	5.64	8.35	5.12	7.55	92
		60+	2.3	4.38	1.31	2.59	2427
PA TURNPIKE-0018	4.24	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	2.87	5.13	2.87	4.6	20
		60+	1.73	3.51	0.39	0.79	2135

## INRIX

Table 5 summarizes the standard error metrics computed between ground truth (i.e., WRTM) and INRIX speeds. Both Average Absolute Speed Error (AASE) and Speed Error Bias (SEB) are within specifications in the upper three speed bins, but not in the lowest one (0-30 mph). Note that the lowest speed bin only has 13 observations, and thus it is hard to draw strong conclusions about the performance in this speed range.

**Table 5 – INRIX data quality measures**

Speed Bin	Average Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Number of 5 Minute Samples
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean	
0-30	16.17	18	14.78	16.44	13
30-45	5.71	7.67	2.37	3.44	143
45-60	3.18	5.35	2.55	4.19	8572
60+	1.84	3.89	1.34	2.37	40215
All Speeds	2.09	4.16	1.56	2.7	48943

Table 6 shows the percentage of time the INRIX data falls within 5 mph of the mean and SEM band for each speed bin.

**Table 6 – Percent of INRIX observations meeting data quality criteria**

Speed Bin	Data Quality Measures for				Number of 5 Minute Samples.
	SEM Band		Mean		
	Percent inside band	Percent within 5mph of band	Percent equal to mean	Percent within 5mph of mean	
0-30	0	15.38	-	15.38	13
30-45	16.08	55.24	-	41.96	143
45-60	26.49	74.6	-	54.07	8572
60+	41.92	88.04	-	70.27	40215

Table 7 reports the standard error metrics on individual validation segments. Note that some segments and time bins only have a few observations, and thus may not be representative of the overall performance in each speed bin.

**Table 7 – INRIX data quality measures by validation segment**

Path	Sensor distance	SPEED BIN	Data Quality Measures for				No. of Obs.
			Avg. Absolute Speed Error		Speed Error Bias		
			SEM Band	Mean	SEM Band	Mean	
PA TURNPIKE-0001	4.10	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	4.47	7.54	4.2	7.12	21
		60+	1.89	3.81	1.81	3.45	3235
PA TURNPIKE-0002	3.33	0-30	23.61	24.73	23.61	24.73	5
		30-45	15.76	18.42	14.93	16.55	15
		45-60	3.42	5.84	1.52	2.79	58
		60+	0.96	2.95	0.46	0.85	3047
PA TURNPIKE-0003	3.82	0-30	11.17	14.21	11.17	14.21	5
		30-45	3.67	5.09	-1.01	-0.91	55
		45-60	2.31	3.9	1	1.85	1859
		60+	1.19	3.02	0.2	0.36	1208
PA TURNPIKE-0004	4.65	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	4.47	6.74	4.42	6.69	1021
		60+	3.64	5.78	3.62	5.62	2054
PA TURNPIKE-0005	4.11	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	3	5.58	3	5.58	15
		60+	1.03	2.98	0.47	0.82	3052
PA TURNPIKE-0006	3.91	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	3.31	4.76	3.26	4.63	42
		60+	1.12	2.94	0.69	1.35	3038
PA TURNPIKE-0007	4.89	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	2.91	4.82	2.91	4.82	68
		60+	1.66	3.45	1.46	2.7	3149
PA TURNPIKE-0008	2.31	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	6.06	10.5	6.06	10.5	119
		60+	3.31	6.16	3.27	6	1582
PA TURNPIKE-0009	1.72	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	3.82	7.35	3.82	7.3	252
		60+	0.79	3.93	0.31	0.49	1445
PA TURNPIKE-0010	1.72	0-30	-	-	-	-	-
		30-45	12.29	25.69	12.29	25.69	1
		45-60	6.54	9.97	6.54	9.95	715
		60+	2.31	4.88	2.06	3.69	812



Path	Sensor distance	SPEED BIN	Data Quality Measures for				No. of Obs.
			Avg. Absolute Speed Error		Speed Error Bias		
			SEM Band	Mean	SEM Band	Mean	
PA TURNPIKE-0011	2.46	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	4.29	10.25	4.29	10.25	5
		60+	1.96	3.75	1.78	3.12	2992
PA TURNPIKE-0012	4.77	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	3.67	7.95	3.67	7.95	2
		60+	0.92	2.79	-0.04	-0.37	3005
PA TURNPIKE-0013	3.94	0-30	-	-	-	-	-
		30-45	10.2	18.71	10.2	18.71	1
		45-60	3.72	5.98	3.67	5.83	400
		60+	3.02	5.02	2.82	4.6	2642
PA TURNPIKE-0014	4.01	0-30	-	-	-	-	-
		30-45	0.33	5.78	0.33	5.78	1
		45-60	2.39	4.62	2.2	3.94	1443
		60+	1.65	4.11	1.25	2.61	1169
PA TURNPIKE-0015	4.80	0-30	12.09	13.1	6.09	6.35	3
		30-45	5.08	7	2.1	3.48	70
		45-60	2.32	4.17	1.25	2.17	2418
		60+	1.59	3.97	-0.78	-1.36	148
PA TURNPIKE-0016	3.67	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	7.04	9.84	7.04	9.84	92
		60+	2.48	4.66	2.37	4.21	2426
PA TURNPIKE-0017	3.40	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	2.79	5.23	2.79	5.23	20
		60+	2.05	3.87	1.69	2.73	2134
PA TURNPIKE-0018	4.24	0-30	-	-	-	-	-
		30-45	-	-	-	-	-
		45-60	4.29	10.25	4.29	10.25	5
		60+	1.96	3.75	1.78	3.12	2992