I-95 Corridor Coalition

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

Monthly Report: Virginia

I-95 CORRIDOR COALITION

June 2015

I-95 CORRIDOR COALITION VEHICLE PROBE PROJECT VALIDATION OF HERE DATA JUNE 2015

Monthly Report

Prepared for:

I-95 Corridor Coalition

Sponsored by:

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June 2015

Evaluation Results for the State of Virginia

Executive Summary

The data from the Vehicle Probe Project is validated using Bluetooth™ Traffic Monitoring (BTM) technology on a near monthly basis. The validation of arterial data is similar to that of freeway data, however the following should be noted. The boundaries of the speed bins used for arterials are different than those used for freeways to accommodate the lower speeds on this type of corridor.

BTMs sensor were deployed at the beginning and ending points of eight different segments along the US-1 corridor. There are two lanes per direction with an average signal density of 1.5 signal per mile. Average Annual Daily Traffic (AADT) along the corridor is 21,500 and the speed limit is 45 MPH.

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The Bluetooth sensor deployment covers the range from Joplin Road to Harrison Road along US-1. Travel time data was collected for both directions along the arterial, between January 15 and January 28, 2015. The dataset collected represents approximately 1410 hours of observations along eight arterial segments, totaling approximately 34 miles. The total number of effective five-minute travel time samples observed was 16,930.

ES Table 1, below summarizes the results of the comparison between the BTM reference data and the HERE data for arterial segments during the above noted time period. As shown, the average absolute speed error (AASE) was within specification in all speed bins. The Speed Error Bias (SEB) was within specifications for all speed bins when compared with the Standard Error of the Mean (SEM) Band. Although the data are compared to these specifications, caution should be used when using probe data on arterial roadways. Other factors including signal density and traffic volume should be considered.

ES Table 1 - Virginia Evaluation Summary for Arterial

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		
0-15 MPH	4.6	7.3	4.6	7.1	638	53
15-25 MPH	1.6	4.7	1.2	3.2	3001	250
25-35 MPH	1.1	4.4	0.0	-0.2	4033	336
>35 MPH	2.3	6.0	-2.0	-4.5	9258	772
All Speeds	2.0	5.4	-0.7	-1.7	16930	1411

Based upon data collected from Jan 15, 2015 through Jan 28, 2015 across 33.8 miles of roadway.

Data Collection

Travel time samples were collected along eight arterial segments with the assistance of Virginia Department of Transportation (VDOT) personnel. Arterial segments studied were located along the US-1 corridor from Joplin Road to Harrison Road. Travel time data was collected for both directions along the US-1 arterial between January 15 and January 28, 2015. Segment locations were chosen with a high-likelihood of observing recurrent and non-recurrent congestion during peak and off-peak periods.

Figure 1 presents an overview snapshot of the placement of sensors for the collection of data on the US-1 corridor in Virginia. Red segments represent arterial segments selected for analysis. There are two lanes per direction with average signal density of 1.5 signal per mile. Average Annual Daily Traffic (AADT) along the corridor is 21,500 and the speed limit is 45 MPH.

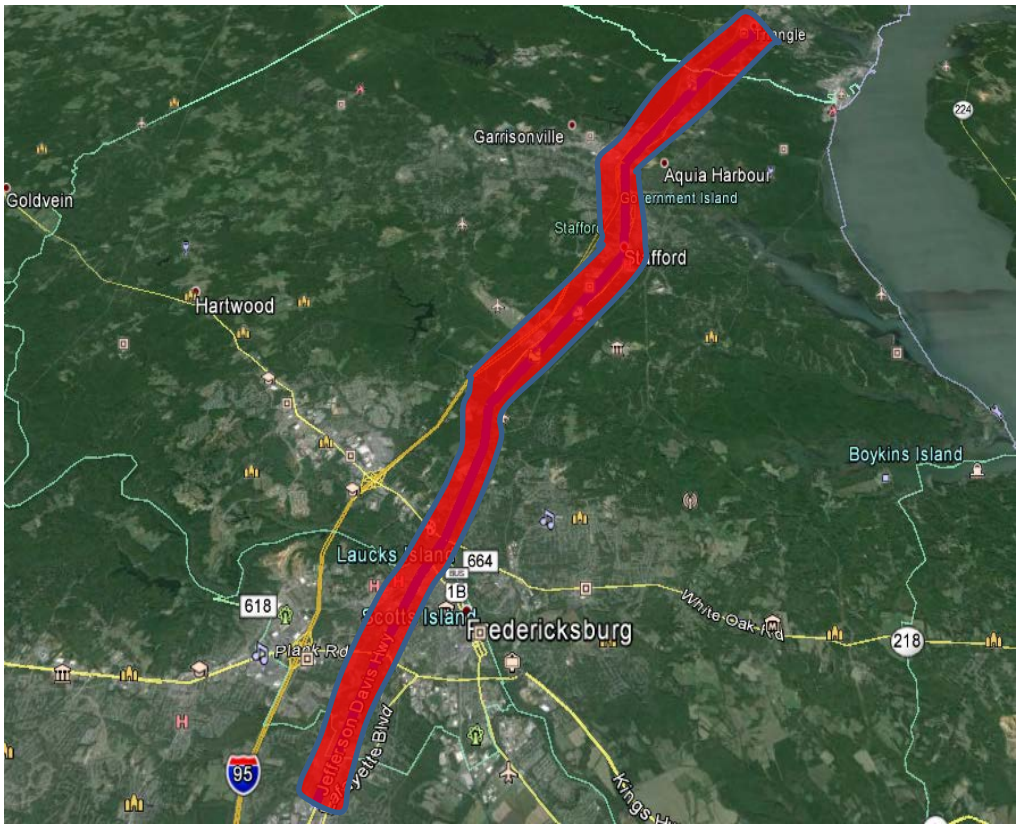

Figure 1 — Locations of all segments selected for analysis in Virginia

TMC segments selected for validation in Virginia

Table 1 presents a list of data collection segments from Virginia. In total, these segments cover a total length of approximately 33.8 arterial miles. Data collection segments are comprised of one or more Traffic Message Channel (TMC) base segments, such that the total length of the data collection segment is one mile long or greater for arterials. When appropriate, consecutive TMC segments are combined to form a data collection segment longer than one mile. The results of the validation performed on eight arterial segments are included in this report. Table 1 contains the summary information on each data collection segment. The latitude/longitude coordinates of the locations at which the Bluetooth sensors were deployed along the US-1 in Northern Virginia are provided in Table 1 as well as an active map link to view the data collection segment in detail. Click on the map link to see a detailed map for the respective data collection segment. It should be noted 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 Bluetooth sensor covers both data collection segments.

Table 1 also provides data on the precise length of the TMCs comprising the test segment as compared to the measured length between Bluetooth™ Traffic Monitoring (BTM) sensors placed on the roadway. An algorithm was developed and documented in a separate report[1] as part of the initial VPP project and is being used for the validation of all vendors in VPPII. Details of the algorithm used to estimate equivalent path travel times based on HERE data feeds for individual data collection segments are provided in this separate report. This algorithm finds an equivalent HERE travel time (and therefore travel speed) corresponding to each sample BTM travel time observation on the test segment of interest.

[1] Ali Haghani, Masoud Hamedi, Kaveh Farokhi Sadabadi, Estimation of Travel Times for Multiple TMC Segments, prepared for I-95 Corridor Coalition, February 2010 (link)

Table 1
Segments selected for validation in Virginia

SEGMENT	DESCRIPTION			TMC CODES		Deployment		
(Map Link)	Highway	State	Starting at	Begin	Number	Begin Lat/Lon		Length
	Pennsylvania	County	Ending at	End	Length	End Lat/Lon		% Diff
Arterials								All Lengths in Miles
A1	US-1	Virginia	Joplin Rd	110-09526	2.13	38.545472	-77.336879	2.19
VA10-0001	Southbound	Prince William	Russell Rd	110N09526	2	38.521074	-77.360451	2.82%
A2	US-1	Virginia	Russell Rd	110-09525	4.65	38.521074	-77.360451	4.75
VA10-0002	Southbound	Stafford	VA-610/Garrisonville Rd	110-09525	1	38.4637	-77.405727	2.03%
A5	US-1	Virginia	American Legion Rd	110-09522	2.70	38.395746	-77.429713	2.74
VA10-0005	Southbound	Stafford	Mountain View Rd	110-09522	1	38.363967	-77.45708	1.48%
A6	US-1	Virginia	Mountain View Rd	110-09521	0.90	38.363967	-77.45708	0.86
VA10-0006	Southbound	Stafford	Forbes St	110-09521	1	38.351058	-77.457959	-4.45%
A7	US-1	Virginia	Forbes St	110-09520	1.97	38.351058	-77.457959	2.00
VA10-0007	Southbound	Stafford	US-17/VA-212/Warrenton Rd	110-09520	1	38.324019	-77.468435	1.52%
A8	US-1	Virginia	US-17/VA-212/Warrenton Rd	110-09519	0.76	38.324019	-77.468435	0.76
VA10-0008	Southbound	Stafford	Fall Hill Ave	110-09519	1	38.314289	-77.474837	0.00%
A9	US-1	Virginia	Fall Hill Ave	110N09519	1.56	38.314289	-77.474837	1.50
VA10-0009	Southbound	Fredericksburg	VA-3/William St	110N09518	3	38.293127	-77.484856	-3.83%
A10	US-1	Virginia	VA-3/William St	110-09517	2.08	38.293127	-77.484856	2.12
VA10-0010	Southbound	Spotsylvania	Harrison Rd	110N09517	2	38.264219	-77.495507	1.93%

Table 1 (Cont'd)
Segments selected for validation in Virginia

SEGMENT	DESCRIPTION			TMC CODES		Deployment		
(Map Link)	Highway	State	Starting at	Begin	Number	Begin Lat/Lon		Length
	Pennsylvania	County	Ending at	End	Length	End Lat/Lon		% Diff
Arterials								All Lengths in Miles
A11	US-1	Virginia	Harrison Rd	110-09522	2.15	38.264113	-77.495391	2.12
VA10-0011	Northbound	Stafford	VA-3/William St	110-09522	2	38.294	-77.484411	-1.40%
A12	US-1	Virginia	VA-3/William St	110-09521	1.50	38.294	-77.484411	1.51
VA10-0012	Northbound	Stafford	Fall Hill Ave	110-09521	3	38.314236	-77.474704	0.67%
A13	US-1	Virginia	Fall Hill Ave	110-09520	0.76	38.314236	-77.474704	0.76
VA10-0013	Northbound	Stafford	US-17/VA-212/Warrenton Rd	110-09520	1	38.324019	-77.468435	0.00%
A14	US-1	Virginia	US-17/VA-212/Warrenton Rd	110-09519	1.98	38.324019	-77.468435	2.01
VA10-0014	Northbound	Stafford	Forbes St	110-09519	1	38.351058	-77.457959	1.52%
A15	US-1	Virginia	Forbes St	110N09519	0.90	38.351058	-77.457959	0.86
VA10-0015	Northbound	Fredericksburg	Mountain View Rd	110N09518	1	38.363946	-77.456898	-4.46%
A16	US-1	Virginia	Mountain View Rd	110-09517	2.69	38.363946	-77.456898	2.73
VA10-0016	Northbound	Spotsylvania	American Legion Rd	110N09517	1	38.395712	-77.429605	1.48%
A19	US-1	Virginia	VA-610/Garrisonville Rd	110+09526	4.84	38.661743	-77.247195	4.75
VA10-0019	Northbound	Prince William	Russell Rd	110+09526	1	38.677623	-77.230068	-1.86%
A20	US-1	Virginia	Russell Rd	110P09526	2.04	38.677623	-77.230068	2.17
VA10-0020	Northbound	Prince William	Joplin Rd	110+09527	2	38.705713	-77.205011	6.36%

Analysis of Arterial Results

Table 2 summarizes the data quality measures obtained as a result of a comparison between Bluetooth and all reported HERE speeds. Specifications used for comparison include the Average Absolute Speed Error (AASE) and the Speed Error Bias (SEB).

Average Absolute Speed Error (AASE)
The AASE is defined as the mean absolute value of the difference between the mean speed reported from the VPP and the ground truth mean speed for a specified time period. The AASE is the primary accuracy metric. Based on the contract specifications, the speed data from the VPP shall have a maximum average absolute error of 10 miles per hour (MPH) in each of four speed ranges: 0-15 MPH, 15-25 MPH, 25-35 MPH, and > 35 MPH.

Speed Error Bias (SEB)
The SEB is defined as the average speed error (not the absolute value) in each speed range. SEB is a measure of whether the speed reported in the VPP consistently under or over estimates speed as compared to ground truth speed. Based on the contract specifications, the VPP data shall have a maximum SEB of +/- 5 MPH in each of speed ranges as defined above.

The results are presented as compared against the mean of the ground truth data as well as the 95th percent confidence interval for the mean, referred to as the Standard Error of the Mean (SEM) band. The SEM band takes into account any uncertainty in the ground truth speed as measured by BTM equipment due to limited samples and/or data variance. Contract specifications are assessed against the SEM band. (See the *Vehicle Probe Project: Data Use and Application Guide* for additional details on the validation process.) The AASE in the lower two speed bands have proven to be the critical specification (and most difficult) to attain. As shown, the average absolute speed error (AASE) was within specification for all the speed bins. The Speed Error Bias (SEB) was within specifications for all speed bins when compared with the Standard Error of the Mean (SEM) Band.

TABLE 2 Data quality measures for arterial segments in Virginia

SPEED BIN	Data Quality Measures for				No. of 5 Minute Samples	Hours of Data Collection
	1.96 SEM Band		Mean			
	SEB 5 mph (contract specifications)	AASE 10 mph	SEB	AASE		
0-15	4.6	4.6	7.1	7.3	638	53
15-25	1.2	1.6	3.2	4.7	3001	250
25-35	0.0	1.1	-0.2	4.4	4033	336
35+	-2.0	2.3	-4.5	6.0	9258	772

Table 3 shows the percentage of the time HERE data falls within 5 mph of the SEM band and the mean for each speed bin for all arterial data segments in this validation report.

Table 3 Percent observations meeting data quality criteria for arterial segments in Virginia

SPEED BIN	Data Quality Measures for				No. of Obs.
	1.96 SEM 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	
0-15	24%	63%	0%	37%	638
15-25	58%	88%	0%	62%	3001
25-35	66%	92%	0%	63%	4033
35+	51%	81%	0%	50%	9258

Tables 4 and 5 present detailed data for individual TMC segments in this validation in a similar format as Tables 2 and 3, respectively. Note that for some segments and in some speed bins the comparison results may not be reliable due to the small number of observations.

Table 4
Data quality measures for individual arterial validation segments in the state of Virginia

TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for				No. of Obs.
				1.96 SEM Band		Mean		
				Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
VA10-0001	2.13	2.13	0-15	-	-	-	-	-
			15-25	-	-	-	-	-
			25-35	-	-	-	-	-
			35+	-2.9	3.0	-6.9	7.2	863
VA10-0002	4.77	4.77	0-15	12.3	12.3	15.5	15.5	8*
			15-25	3.1	3.1	6.4	6.4	87
			25-35	0.5	0.9	3.4	4.6	98
			35+	-0.9	1.1	-2.1	3.4	292
VA10-0005	2.70	2.70	0-15	-	-	-	-	-
			15-25	-	-	-	-	-
			25-35	5.5	5.5	12.8	12.8	14*
			35+	-0.1	1.5	0.4	4.2	744
VA10-0006	0.90	0.90	0-15	-	-	-	-	-
			15-25	9.9	9.9	14.2	14.2	3*
			25-35	0.9	1.1	4.9	5.4	72
			35+	-2.5	2.5	-6.3	6.6	1295
VA10-0007	1.97	1.97	0-15	10.8	10.8	12.7	12.7	72
			15-25	6.3	6.3	10.6	10.6	154
			25-35	0.9	1.0	3.3	4.2	347
			35+	-2.1	2.4	-4.7	5.7	146
VA10-0008	0.76	0.76	0-15	3.6	3.6	6.2	6.2	72
			15-25	0.7	0.8	2.4	3.2	885
			25-35	-0.6	0.7	-2.7	3.5	355
			35+	-3.9	3.9	-12.6	12.6	53
VA10-0009	1.57	1.57	0-15	7.4	7.4	13.7	13.7	6*
			15-25	0.6	0.6	2.3	2.8	48
			25-35	-1.3	1.3	-5.0	5.2	339
			35+	-7.6	7.6	-12.1	12.1	225
VA10-0010	2.08	2.08	0-15	-	-	-	-	-
			15-25	3.7	3.7	7.3	7.3	74
			25-35	1.0	1.1	3.1	3.9	714
			35+	-0.6	0.9	-1.9	3.4	528

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

Table 4 (Cont'd)
Data quality measures for individual arterial validation segments in the state of Virginia

TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for				No. of Obs.
				1.96 SEM Band		Mean		
				Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
VA10-0011	2.15	2.15	0-15	-	-	-	-	-
			15-25	4.7	4.7	16.5	16.5	12*
			25-35	0.5	0.6	2.2	3.0	165
			35+	-1.8	1.8	-4.6	4.9	1062
VA10-0012	1.49	1.49	0-15	2.9	2.9	5.1	5.3	425
			15-25	-0.6	1.2	-1.2	4.1	681
			25-35	-2.4	2.4	-6.3	6.8	165
			35+	-4.4	4.4	-14.1	14.1	13*
VA10-0013	0.76	0.76	0-15	2.9	2.9	5.1	5.3	425
			15-25	-0.6	1.2	-1.2	4.1	681
			25-35	-2.4	2.4	-6.3	6.8	165
			35+	-4.4	4.4	-14.1	14.1	13*
VA10-0014	1.98	1.98	0-15	29.4	29.4	32.6	32.6	2*
			15-25	0.0	0.0	15.7	15.7	2*
			25-35	1.7	1.7	5.8	5.8	25*
			35+	-2.5	2.6	-5.1	5.4	522
VA010-0015	0.90	0.90	0-15	10.2	10.2	22.2	22.2	2*
			15-25	5.6	5.6	13.6	14.0	17*
			25-35	1.6	1.7	6.8	7.2	147
			35+	-1.8	1.9	-4.7	5.9	1205
VA010-0016	2.69	2.69	0-15	-	-	-	-	-
			15-25	-	-	-	-	-
			25-35	8.9	8.9	12.4	12.4	1*
			35+	-0.7	1.5	-1.6	4.3	584
VA010-0019	4.84	4.84	0-15	29.4	29.4	30.6	30.6	5*
			15-25	11.7	11.7	21.2	21.2	9*
			25-35	2.0	2.0	10.7	10.7	27*
			35+	-2.3	2.3	-4.9	5.3	339
VA010-0020	2.04	2.04	0-15	-	-	-	-	-
			15-25	-	-	-	-	-
			25-35	5.0	5.0	10.3	10.4	94
			35+	0.5	1.3	1.8	4.5	670

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

Table 5
Observations meeting data quality criteria for individual arterial validation segments in the state of Virginia

TMC	SPEED BIN	Data Quality Measures for								No. of Obs.
		1.96 SEM 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	
VA10-0001	0-15	-	-	-	-	-	-	-	-	-
	15-25	-	-	-	-	-	-	-	-	-
	25-35	-	-	-	-	-	-	-	-	-
	35+	48	6%	387	45%	114	13%	476	55%	863
VA10-0002	0-15	0	0%	2	25%	0	0%	3	38%	8*
	15-25	5	6%	56	64%	6	7%	59	68%	87
	25-35	12	12%	72	73%	28	29%	85	87%	98
	35+	53	18%	244	84%	96	33%	246	84%	292
VA10-0005	0-15	-	-	-	-	-	-	-	-	-
	15-25	-	-	-	-	-	-	-	-	-
	25-35	0	0%	1	7%	0	0%	4	29%	14*
	35+	135	18%	574	77%	242	33%	625	84%	744
VA10-0006	0-15	-	-	-	-	-	-	-	-	-
	15-25	0	0%	0	0%	0	0%	0	0%	3*
	25-35	15	21%	49	68%	28	39%	56	78%	72
	35+	178	14%	693	54%	353	27%	838	65%	1295
VA10-0007	0-15	0	0%	7	10%	0	0%	10	14%	72
	15-25	2	1%	21	14%	7	5%	41	27%	154
	25-35	79	23%	268	77%	162	47%	298	86%	347
	35+	18	12%	95	65%	47	32%	104	71%	146
VA10-0008	0-15	0	0%	29	40%	1	1%	44	61%	72
	15-25	211	24%	770	87%	377	43%	807	91%	885
	25-35	94	26%	306	86%	174	49%	329	93%	355
	35+	1	2%	6	11%	7	13%	15	28%	53
VA10-0009	0-15	0	0%	0	0%	0	0%	1	17%	6*
	15-25	9	19%	46	96%	20	42%	47	98%	48
	25-35	42	12%	221	65%	75	22%	258	76%	339
	35+	0	0%	7	3%	0	0%	14	6%	225
VA10-0010	0-15	-	-	-	-	-	-	-	-	-
	15-25	3	4%	26	35%	6	8%	33	45%	74
	25-35	155	22%	556	78%	255	36%	601	84%	714
	35+	116	22%	446	84%	215	41%	471	89%	528

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

Table 5 (Cont'd)
Observations meeting data quality criteria for individual arterial validation segments in the state of Virginia

TMC	SPEED BIN	Data Quality Measures for								No. of Obs.
		1.96 SEM 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	
VA10-0011	0-15	-	-	-	-	-	-	-	-	-
	15-25	0	0%	0	0%	0	0%	2	17%	12*
	25-35	32	19%	144	87%	66	40%	154	93%	165
	35+	123	12%	704	66%	250	24%	800	75%	1062
VA10-0012	0-15	17	4%	254	60%	56	13%	282	66%	425
	15-25	152	22%	519	76%	291	43%	564	83%	681
	25-35	23	14%	96	58%	48	29%	108	65%	165
	35+	0	0%	0	0%	0	0%	3	23%	13*
VA10-0013	0-15	17	4%	254	60%	56	13%	282	66%	425
	15-25	152	22%	519	76%	291	43%	564	83%	681
	25-35	23	14%	96	58%	48	29%	108	65%	165
	35+	0	0%	0	0%	0	0%	3	23%	13*
VA10-0014	0-15	0	0%	0	0%	0	0%	0	0%	2*
	15-25	0	0%	0	0%	0	0%	0	0%	2*
	25-35	0	0%	16	64%	3	12%	20	80%	25*
	35+	52	10%	309	59%	106	20%	341	65%	522
VA10-0015	0-15	0	0%	0	0%	0	0%	0	0%	2*
	15-25	0	0%	2	12%	2	12%	4	24%	17*
	25-35	18	12%	83	56%	42	29%	104	71%	147
	35+	292	24%	768	64%	473	39%	865	72%	1205
VA10-0016	0-15	-	-	-	-	-	-	-	-	-
	15-25	-	-	-	-	-	-	-	-	-
	25-35	0	0%	0	0%	0	0%	0	0%	1*
	35+	108	18%	449	77%	191	33%	480	82%	584
VA10-0019	0-15	0	0%	0	0%	0	0%	0	0%	5*
	15-25	0	0%	0	0%	0	0%	0	0%	9*
	25-35	0	0%	8	30%	5	19%	16	59%	27*
	35+	30	9%	206	61%	59	17%	231	68%	339
VA10-0020	0-15	-	-	-	-	-	-	-	-	-
	15-25	-	-	-	-	-	-	-	-	-
	25-35	4	4%	16	17%	9	10%	26	28%	94
	35+	139	21%	483	72%	248	37%	542	81%	670

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