2. STATE OF CONGESTION

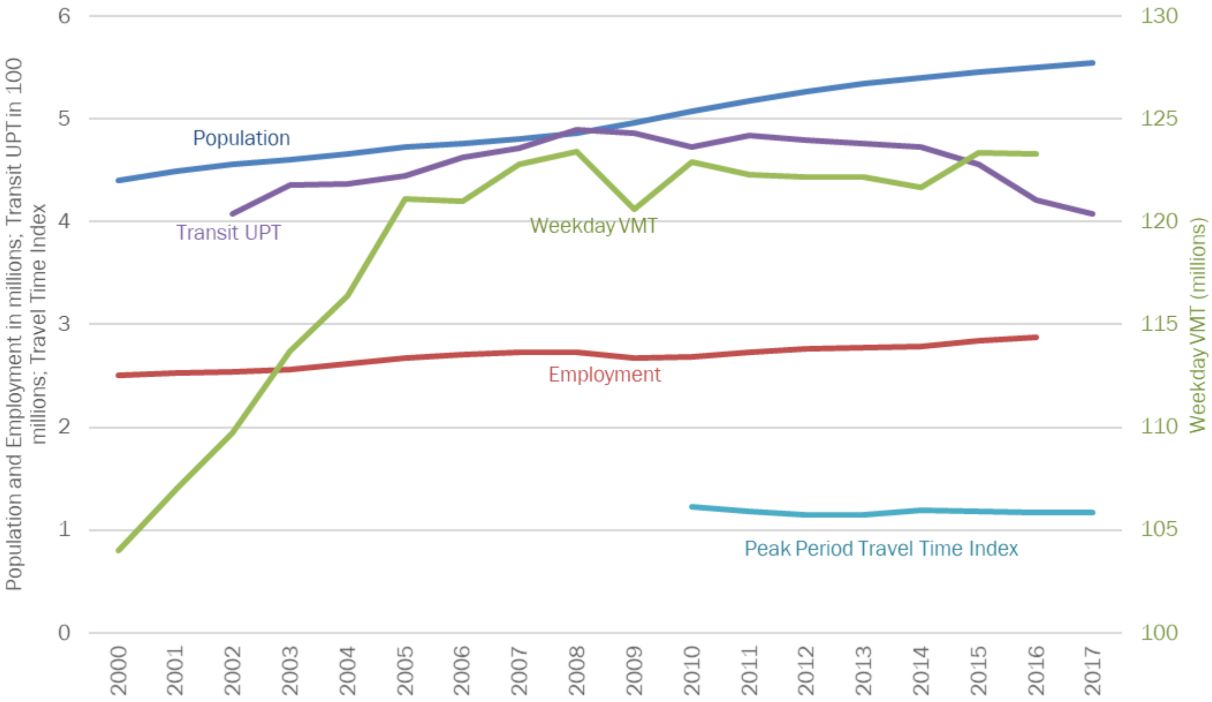
2.1. Regional Travel Trends

The Washington region had robust population growth and overall employment increase between 2000-2017 (Figure 2-1)[1]. The weekday vehicle miles traveled (VMT) increased rapidly, 18.7%, between 2000 and 2008, but slightly reduced 0.1%, between 2008 and 2016. This has resulted in declining VMT per capita in recent years.

Peak period congestion, indicated by Travel Time Index, on the area's 6,525 directional miles of roadways decreased slightly from 2010 to 2012, but increased in 2014 then almost went back to the 2012 level in 2017 (discussed in section 2.2). The peak period travel time index looks unchanged over the period due to the scale factor of the figure, even though the variation is insignificant.

Weekday transit ridership, including Metrorail, Metrobus, local transit and commuter rail, rose slightly from 2010 to 2012, but went down constantly since 2012.

Figure 2-1 Population, Employment, Weekday VMT and Transit Ridership, and Peak Period Travel Time Index in the TPB Planning Area



With these regional trends in mind, the rest of this chapter will discuss congestion on highways, transit systems and other travel monitoring activities. A national comparison of the Washington

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[1] Data Sources: Population – U.S. Census Bureau, Annual Estimates of the Resident Population; Employment – U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages; Weekday VMT – National Capital Region Transportation Planning Board, Regional Transportation Data Clearinghouse; Weekday Transit Trips – National Capital Region Transportation Planning Board, Regional Transportation Data Clearinghouse; Peak Period Travel Time Index – This Report.

region's congestion and an outlook of the future's congestion in the Constrained Long-Range Plan (CLRP) will be provided towards the end of this chapter.

2.2. Congestion on Highways

Federal Highway Administration of the U.S. Department of Transportation has established a set of performance measures [82 FR 5970][2] for State departments of transportation (State DOT) and Metropolitan Planning Organizations (MPO) to use as required by the Moving Ahead for Progress in the 21st Century Act (MAP-21) and the Fixing America's Surface Transportation (FAST) Act for assessing performance of the National Highway System, Freight Movement on the Interstate System, and the Congestion Mitigation and Air Quality Improvement (CMAQ) Program. All the measures, except the GHG measure, became effective on May 20, 2017 [82 FR 22879].
The final rule, as effective on May 20, 2017, has established the following four performance measures relevant to the CMP, including

- percent of reliable person-miles traveled on the Interstate.
- percent of reliable person-miles traveled on the non-Interstate NHS.
- percentage of Interstate system mileage providing for reliable truck travel time (Truck Travel Time Reliability Index)
- annual hours of peak hour excessive delay per capita

The TPB has a multiplicity of traffic monitoring programs on the freeways and arterials in the Washington region. It is advantageous to have monitoring data from a variety of sources and methodologies for the purposes of cross-checking and ensuring resiliency in data sources.

2.2.1. I-95 CORRIDOR COALITION VEHICLE PROBE PROJECT TRAFFIC MONITORING

Since 2010[3], major roadways in the Metropolitan Washington area have been monitored under the I-95 Corridor Coalition Vehicle Probe Project (VPP)[4]. This project was a groundbreaking initiative and collaborative effort among the Coalition, the University of Maryland and private sector data vendors INRIX, HERE, and TomTom, providing comprehensive and continuous real-time and historical traffic information to members.[5] The objective of this project is to acquire travel times and speeds on freeways and arterials using probe technology. While the dominant source of data is obtained from fleet systems that use GPS to monitor vehicle location, speed, and trajectory, other data sources such as sensors may also be used. The INRIX system fuses data from various sources to present a comprehensive picture of traffic, including vehicle speed and travel time at 5-minute granularity for each road segment

As an affiliate member of the coalition, the TPB was granted gratis access to the historical archive data in 2009. The initial effort to utilize this third-party data for freeway congestion monitoring was summarized in the 2010 Congestion Management Process (CMP) Technical Report[6]. An enhanced effort that included expanded full coverage of the freeways in the Washington region and a speed-

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[2] Federal Register, Vol. 82. No. 11, January 18, 2017.
[3] Data for some roadways are available back to July 1, 2008.
[4] I-95 Corridor Coalition, http://i95coalition.org/projects/vehicle-probe-project/
[5] In 2014, the VPP data contract was re-competed by the I-95 Corridor Coalition; HERE and TomTom joined INRIX as data providers. As of this report only data from INRIX among those vendors has been made available gratis to TPB.
[6] COG/TPB, http://www1.mwcog.org/clrp/elements/cmp/files/CMP_Tech_Report_2010%20FINAL_09032010.pdf

volume data fusion was reported in the 2012 Congestion Management Process (CMP) Technical Report[7].

As of March 31, 2018, the VPP/INRIX data covers approximately 6,500 directional miles of roads in the TPB Planning Area (Figure 2-2), including 550 miles of the Interstate System, 2,450 miles of Non-Interstate NHS, and 3,500 miles of Non-NHS; if categorized by freeway/arterial, this coverage includes around 800 miles of freeways and around 5700 miles of arterials.

This VPP/INRIX data source has become the major source of traffic monitoring for both freeways and arterials in the Washington region, transforming the way by which highway congestion and travel time reliability are analyzed and presented.

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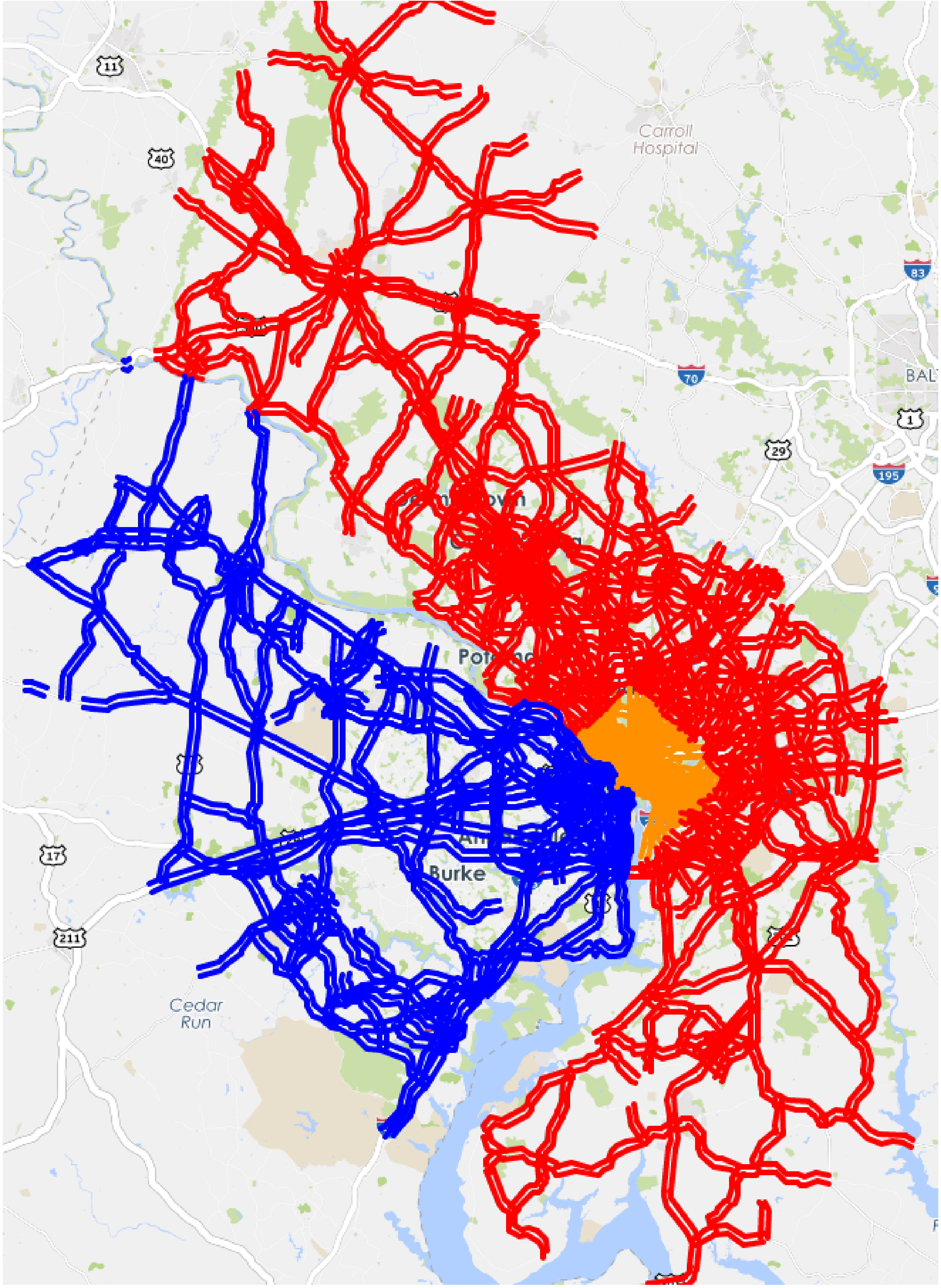
[7] COG/TPB, http://www1.mwcog.org/uploads/committee-documents/IF1dXF5c20120612104611.pdf

Figure 2-2 The I-95 Vehicle Probe Project/INRIX Data Coverage in the Washington Region



(Screenshot captured on the VPP Suite developed by the CATT Lab of University of Maryland.)

2.2.1.1. Travel Time Index

Travel Time Index (TTI) is an indicator of the intensity of congestion, calculated as the ratio of actual experienced travel time to free flow travel time. A travel time index of 1.00 implies free flow travel without any delays, while a travel time index of 1.30 means one has to spend 30% more time to finish a trip compared to free flow travel. More information about TTI and its calculation can be found in Chapter 4.1.

The annual average Travel Time Index on monitored highways in the TPB Planning Area is shown below. Figure 2-3 is the average TTI of total AM Peak (6:00-10:00 am) and PM Peak (3:00-7:00 pm) on all weekdays in a year, Federal holidays excluded, Figure 2-4 is the TTI for the AM Peak, and Figure 2-5 is the TTI for the PM Peak. The TTI is reported by the following five highway categories:

i. Interstate System, about 554 directional miles.
ii. Non-Interstate NHS, about 2,455 directional miles. The NHS designation used in this report was defined on October 1, 2012. The MAP-21 NHS includes all principal arterials[8].
iii. Non-NHS, about 3,516 directional miles. This category mainly includes minor arterials covered by the VPP/INRIX data.
iv. Transit-Significant Roads[9], about 950 directional miles. This category consists of road segments with at least 6 buses in the AM Peak Hour (equivalent to one bus in either direction in every 10 minutes) and the total length is about 1,400 directional miles in the TPB planning area, but only 950 miles of which are covered by the VPP monitoring. This category could include Interstate, Non-Interstate NHS and Non-NHS by definition.
v. All Roads, about 6,525 directional miles. All roads covered by the VPP/INRIX data in the TPB Planning Area.

Observations from examining the regional annual average TTI for 2010-2017 include:

- Overall, the Peak Period congestion in the region decreased between 2010-2012, but has increased slightly in the five years following. The TTI decreased by 6.7% between 2010 and 2012 and increased by 2.0% between 2012 and 2017.

- Among all highway categories, the Interstate was the most congested and the Non-NHS was the least congested roadways. The Transit-Significant Roads was the second most congested category, highlighting the challenges facing transit bus operations.

- The region's PM Peak Period was more congested than the AM Peak Period over the years, especially on Interstates. One exception was on the Non-NHS roads, where the difference between the two peak periods was minimal. The differences in congestion among the five highway categories were more pronounced in the PM peak than the AM peak.

2017 weekday (Monday through Friday) peak hour (8:00-9:00 am; 5:00-6:00 pm) Travel Time Index on the Interstate System and other monitored roads were visualized by the "Trend Map" tool of the I-95 Vehicle Probe Project (VPP) Suite Developed by the CATT Lab of the University of Maryland[10], as provided in Appendix A.

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[8] FHWA, National Highway System, http://www.fhwa.dot.gov/planning/national_highway_system/nhs_maps/
[9] Pu, W. National Capital Region Congestion Report, 1st Quarter 2015, p.11-12. https://www.mwcog.org/file.aspx?D=IhCuCwV1tlyW641B%2bg%2b4SF%2bN6k9XjI4cbRqIHxnFodA%3d&A=Z7cxzRwPfUbEVw2pIDS3kvWdOO5DkTrGjfVIJNmt8XE%3d
[10] Center for Advanced Transportation Technology Laboratory (CATT Lab), University of Maryland, Vehicle Probe Project Suite, https://vpp.ritis.org.

Figure 2-3 Annual Average Travel Time Index by Highway Category: Total AM and PM Peaks

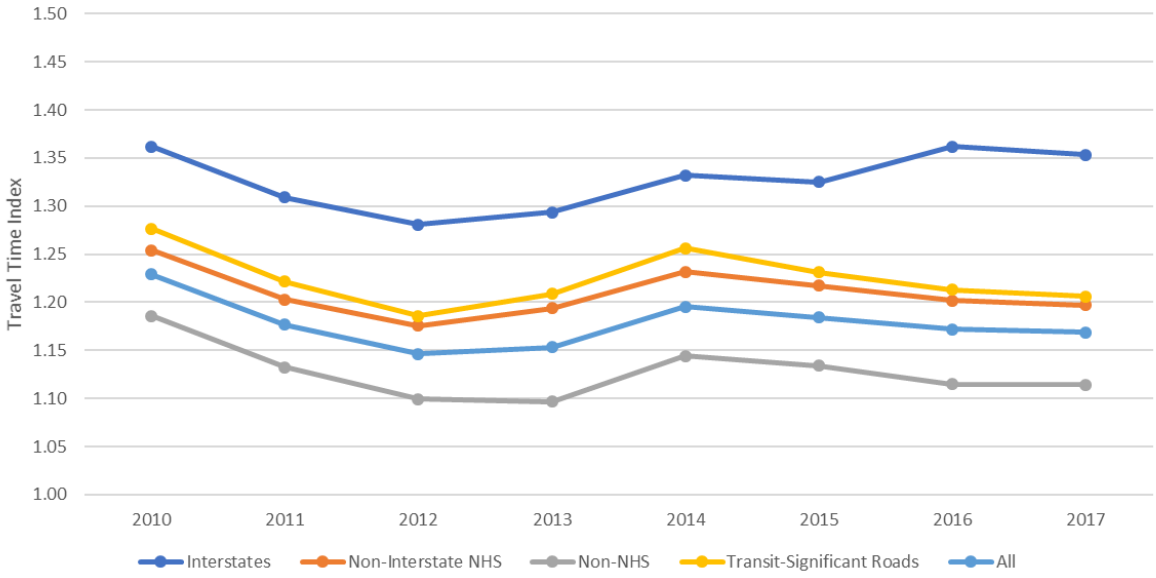


Figure 2-4 Annual Average Travel Time Index by Highway Category: AM Peak

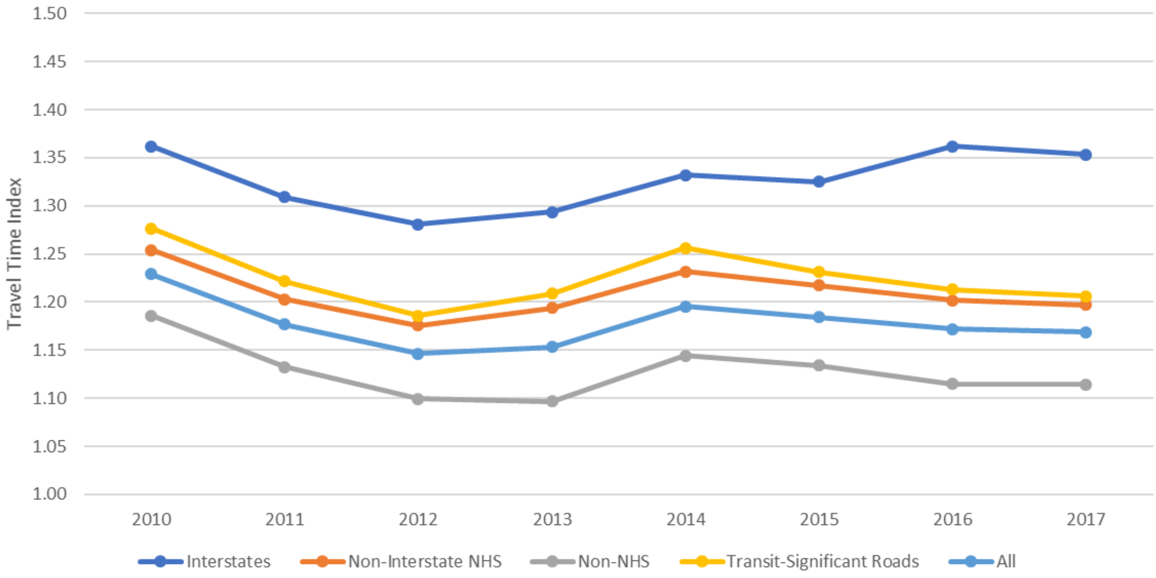
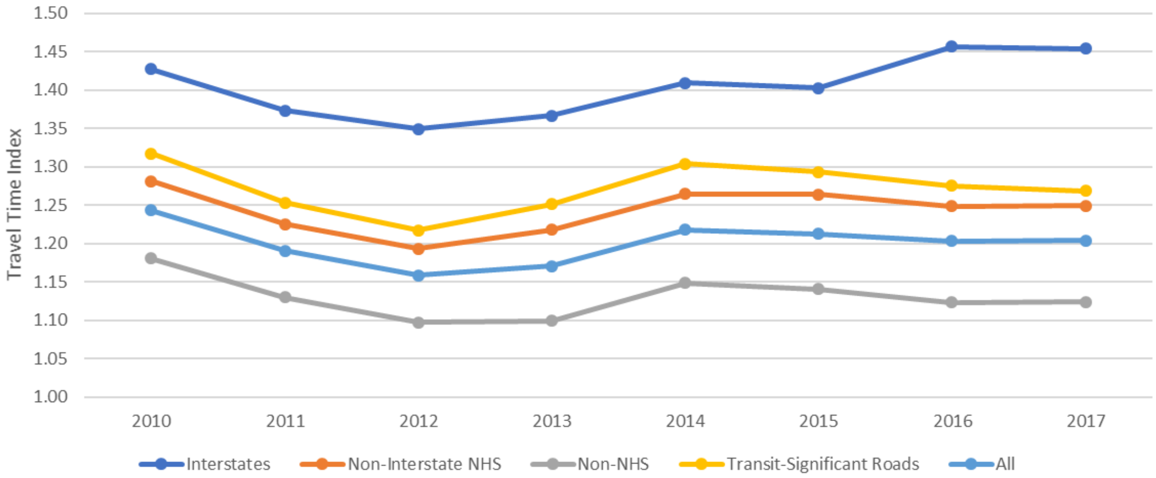


Figure 2-5 Annual Average Travel Time Index by Highway Category: PM Peak



2.2.1.2. Planning Time Index

To most travelers, everyday congestion, particularly peak period congestion, is common and they often adjust their schedules or plan extra time to allow for the expected delays; what troubles travelers most are unexpected or much-worse-than-expected delays, which can be caused by incidents, inclement weather, work zones, and the like. Travelers thus want travel time reliability - a consistency or dependability in travel times, as measured from day to day or across different times of day[11] - to avoid being late.

To quantify travel time reliability (or unreliability), this report adopts Planning Time Index (PTI), the ratio of 95th percentile travel time over free flow travel time. It expresses the extra time a traveler should budget in addition to free flow travel time in order to arrive on time 95 percent of the time. The difference between 95th percentile travel time and free flow travel time is called Planning Time. For example, a 30-minute free flow travel with a Planning Time Index of 2.00 requires 60 minutes in budget to ensure on-time arrival, and thus the Planning Time is 30 minutes.

The annual Planning Time Index on monitored highways in the TPB Planning Area is shown below. Figure 2-6 is the average PTI of total AM Peak (6:00-10:00 am) and PM Peak (3:00-7:00 pm) on all weekdays in a year, Federal holidays excluded. Figure 2-7 is the PTI for the AM Peak, and Figure 2-8 is the PTI for the PM Peak. The PTI is reported by the five highway categories described above in the Travel Time Index section.

Observations from examining the regional annual average PTI for 2010-2017 include:

- On average, this region’s travelers should budget 1.42 times of their free-flow travel times to arrive destinations on-time 95% of the time, a little less budget if traveling in the AM peak and a little more in the PM peak. If traveling mostly on freeways, the budgeted time should be about two times of the free-flow travel time – 1.7 times in the AM peak and 2.2 times in the PM peak. These numbers are based on all directions of travel, therefore for those who traveling in the peak direction would need to even budget more.

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[11] Federal Highway Administration, *Travel Time Reliability Measures*, http://ops.fhwa.dot.gov/perf_measurement/reliability_measures/index.htm

- Overall, the Peak Period travel time reliability in the region improved by about 10% between 2010-2012, but has almost gone back to the 2010 level in 2014, 2016, and 2017.

- Among all highway categories, the Interstate was the most unreliable and the Non-NHS was the most reliable. The Transit-Significant Roads system was the second most unreliable category, highlighting the reliability challenges facing transit bus operations.

- The region's PM Peak Period was less reliable than the AM Peak Period over the years, especially on Interstates. Only on the Non-NHS roads, the difference between the two peak periods seemed minimal. The differences in congestion among the five highway categories were more pronounced in the PM peak than the AM peak.

The 2017 weekday (Monday through Friday) peak hour (8:00-9:00 am; 5:00-6:00 pm) Planning Time Index on the Interstate System and other monitored roads were visualized by the "Trend Map" tool in the VPP Suite, as provided in Appendix B.

Figure 2-6 Annual Average Planning Time Index by Highway Category: Total AM and PM Peaks

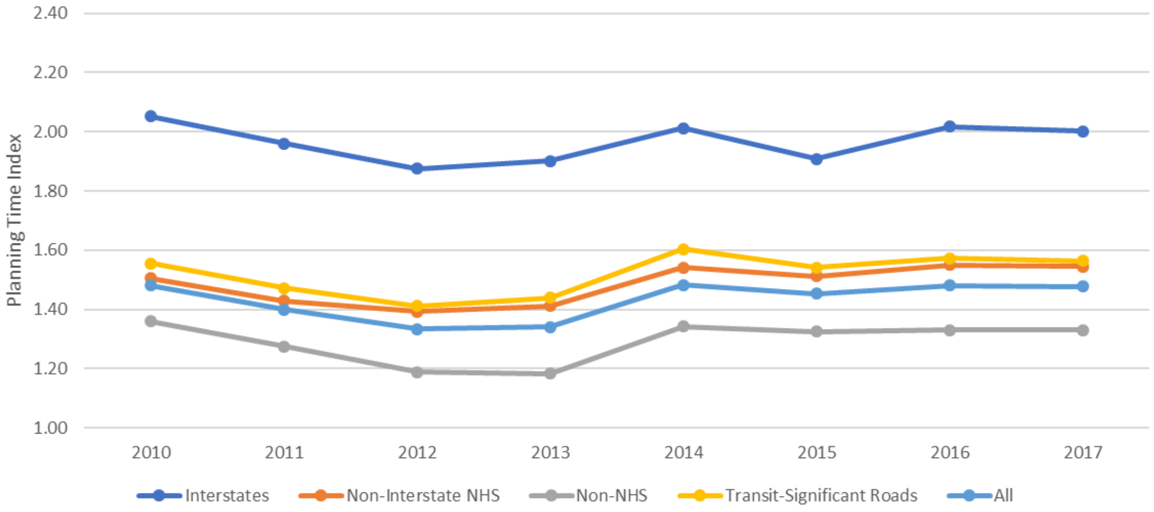


Figure 2-7 Annual Average Planning Time Index by Highway Category: AM Peak

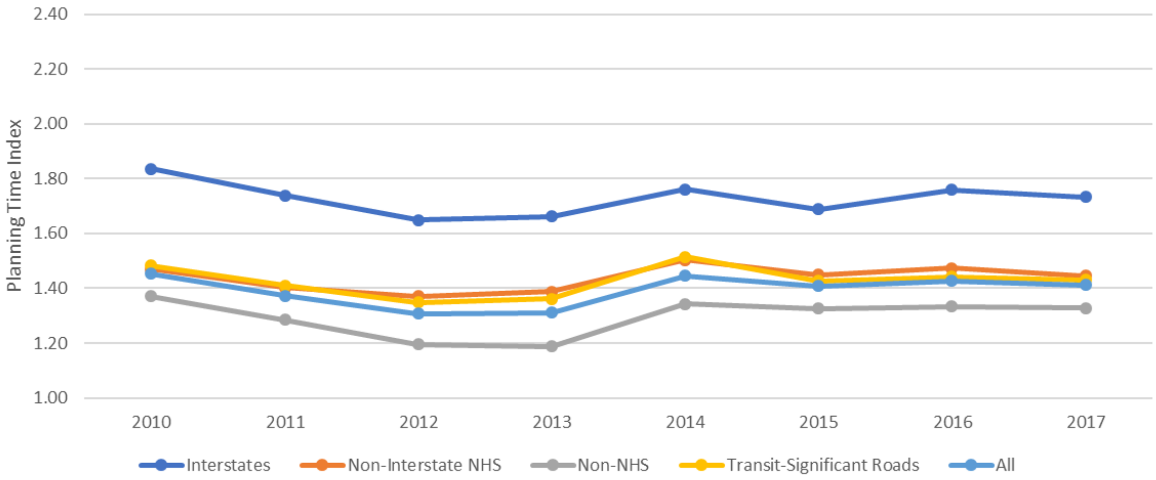
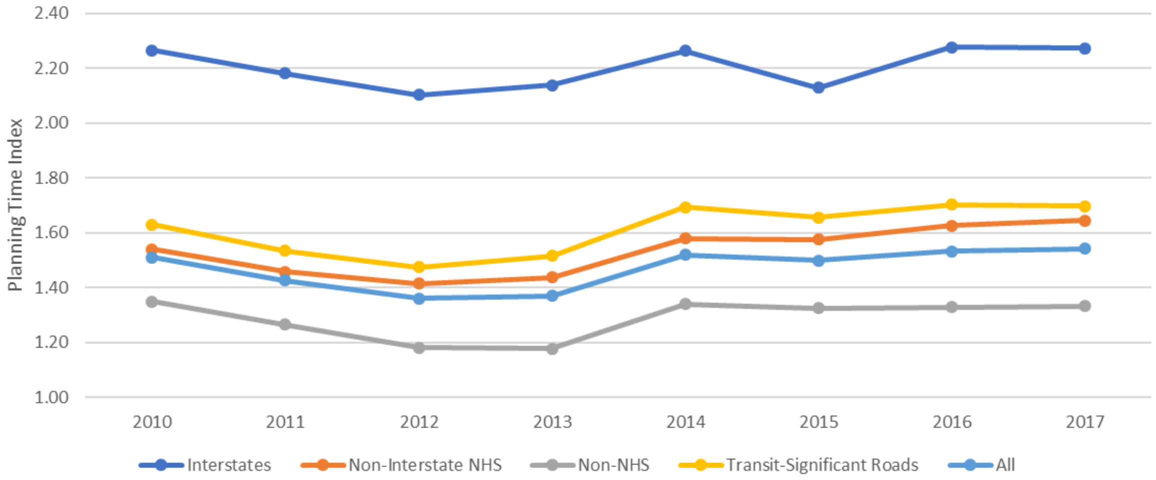


Figure 2-8 Annual Average Planning Time Index by Highway Category: PM Peak



2.2.1.3. Percent of Congested Miles

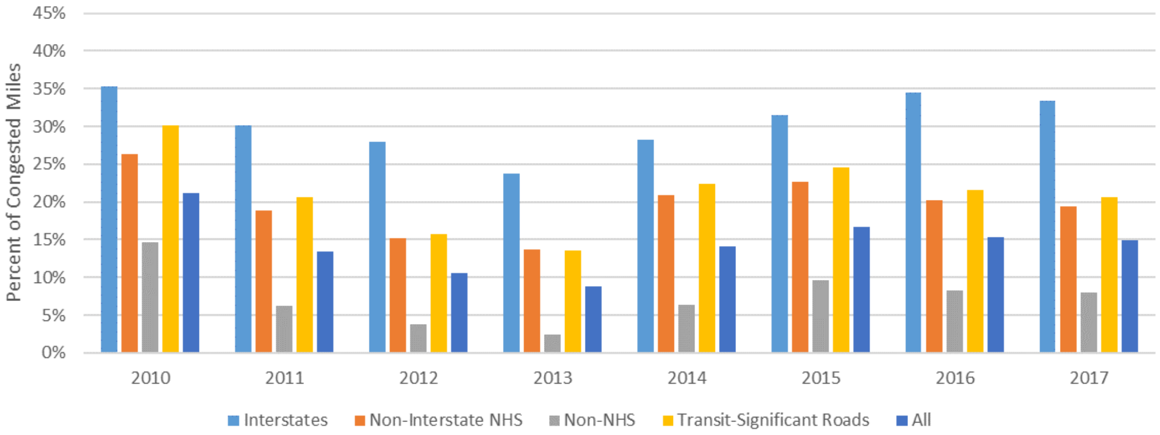
Percent of Congested (Directional) Miles is a system-wide measure that captures the spatial extent of congestion. According to the National Transportation Operations Coalition, if actual travel time is 30% longer than the free-flow travel time, i.e., Travel Time Index > 1.3, congestion is defined[12].

The annual average Percent of Congested Miles on monitored highways in the TPB Planning Area is shown below. Figure 2-9 is the average percentage of both AM Peak (6:00-10:00 am) and PM Peak (3:00-7:00 pm) on all weekdays in a year, Federal holidays excluded, Figure 2-10 is the percentage for the AM Peak, and Figure 2-11 is the percentage for the PM Peak. The percentage is reported by five highway categories as described earlier.

Observations from examining the Percent of Congested Miles for 2010-2017 include:

- Overall congestion trends are similar to what was observed in the Travel Time Index as described earlier.
- On average, this region had 14% of roads congested during peak periods between 2010 and 2017. More specifically, 31% of Interstate, 20% of non-Interstate NHS, 7% of non-NHS, and 21% of transit-significant roads were congested
- There were fewer roads congested in the AM peak period than the PM peak period.

Figure 2-9 Annual Average Percent of Congested Miles by Highway Category: Total AM and PM Peaks



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[12] Pu, W. 2016 Congestion Management Process Technical Report - September 9, 2016, https://www.mwcog.org/file.aspx?D=2ImveGn/Cx0YzcTZw4SndBDawdpf0vW/vVMMaBtGenk=&A=XfI1zIhdo6z4tFaDiQNw1RGvrd5XFhf866oGEZyx7Yo=

Figure 2-10 Annual Average Percent of Congested Miles by Highway Category: AM Peak

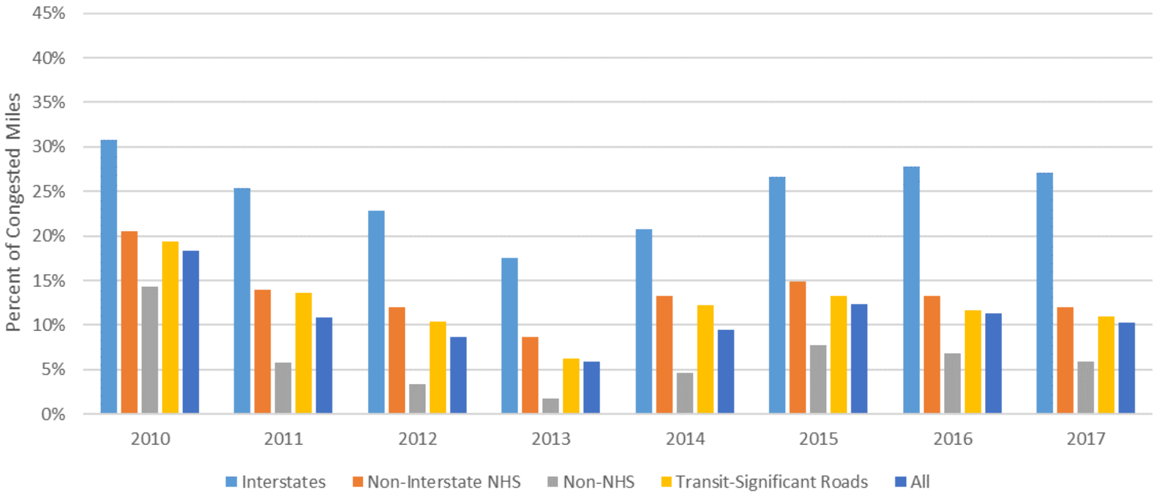
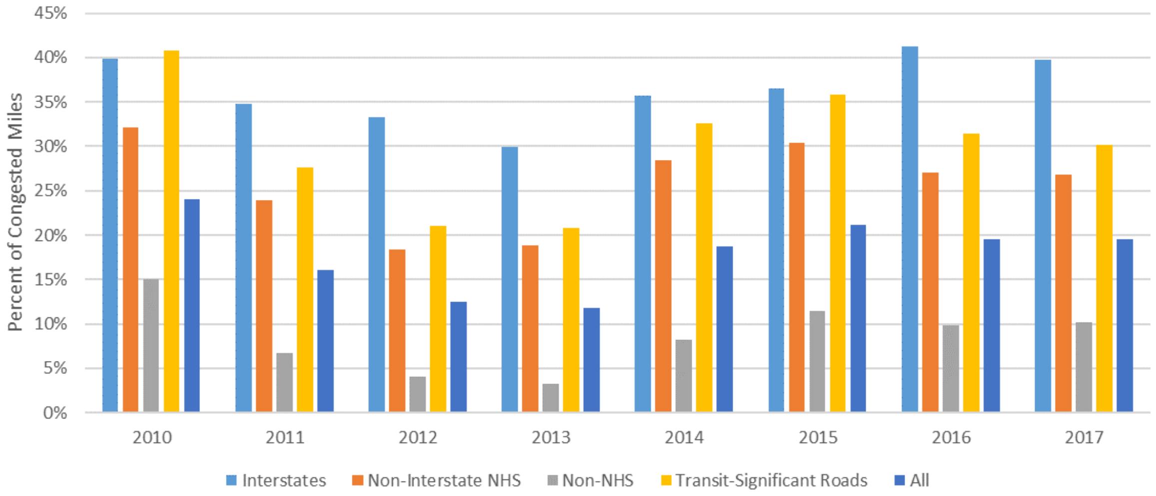


Figure 2-11 Annual Average Percent of Congested Miles by Highway Category: PM Peak



2.2.1.4. Congestion Monthly Variation in 2017

Congestion varies from month to month within a year, as shown in Figure 2-12 (total AM and PM peaks), Figure 2-13 (AM Peak), and Figure 2-14 (PM Peak). Monthly variation of congestion in 2017 had the following characteristics in the Washington region:

- Monthly variations of congestion were most pronounced on the Interstate System, followed by the Transit-Significant Roads, the Non-Interstate NHS, and the Non-NHS had the least fluctuations.

- The region overall had increasing congestion from January to May, then decreasing congestion through August. October had the highest level of congestion, after that, congestion kept decreasing for the rest of year. Four of the five investigated highway categories followed this trend. The only exception was the Interstates, on which congestion kept increasing from February (the least congested month), to June, reaching the highest level.

- Congestion showed a great deal of variation between the AM Peak and PM Peak on the Interstate System during the second half of the year. For the AM Peak, August represented the undoubtedly “low” month (even lower than January) and October was the “high” month; for the PM Peak, the “low” month was February and the “high” was June.

Figure 2-12 Monthly Variation of Congestion in 2017: Total AM and PM Peaks

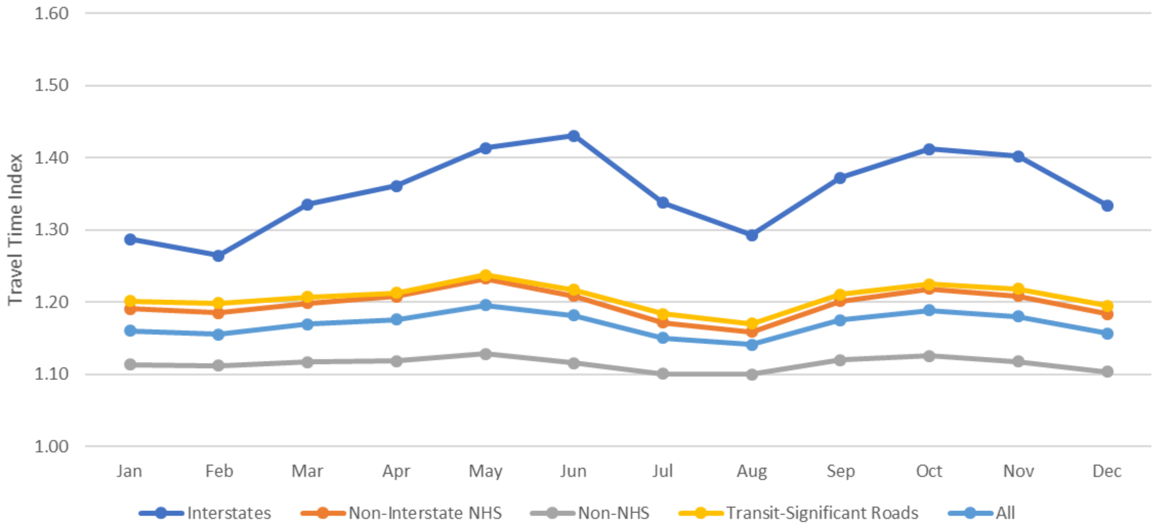


Figure 2-13 Monthly Variation of Congestion in 2017: AM Peak

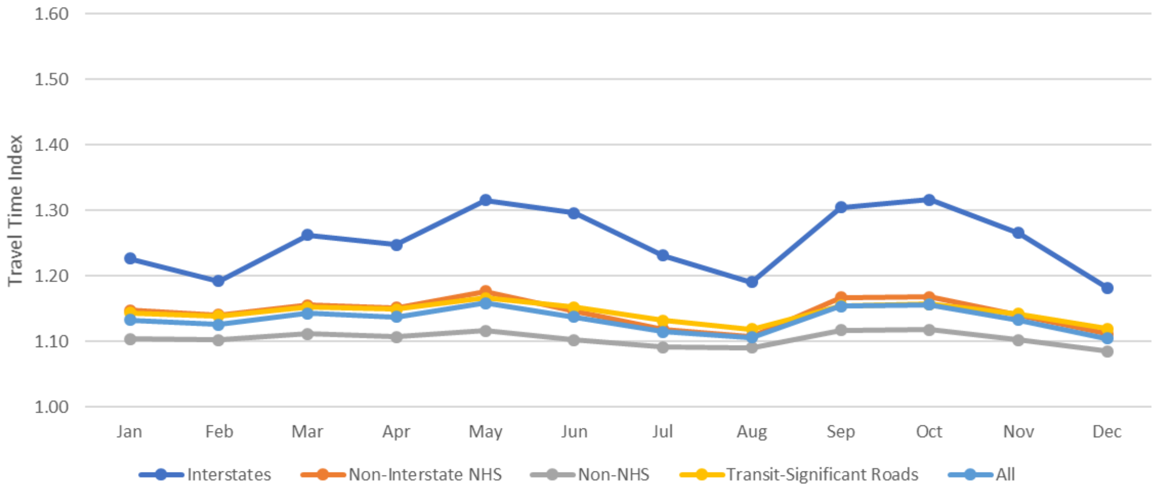
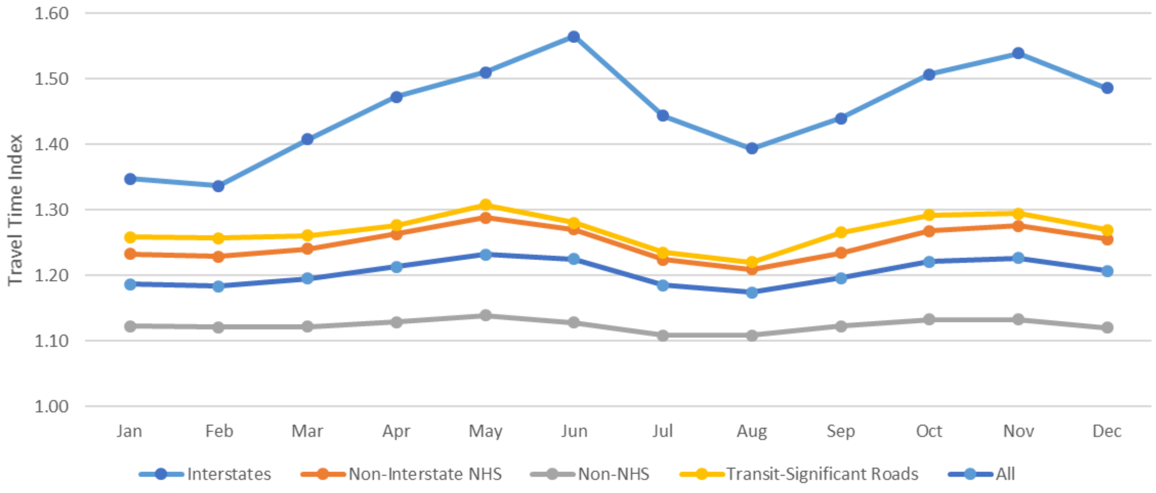


Figure 2-14 Monthly Variation of Congestion in 2017: PM Peak



2.2.1.5. Congestion Time of Day, Day of Week Variation in 2017

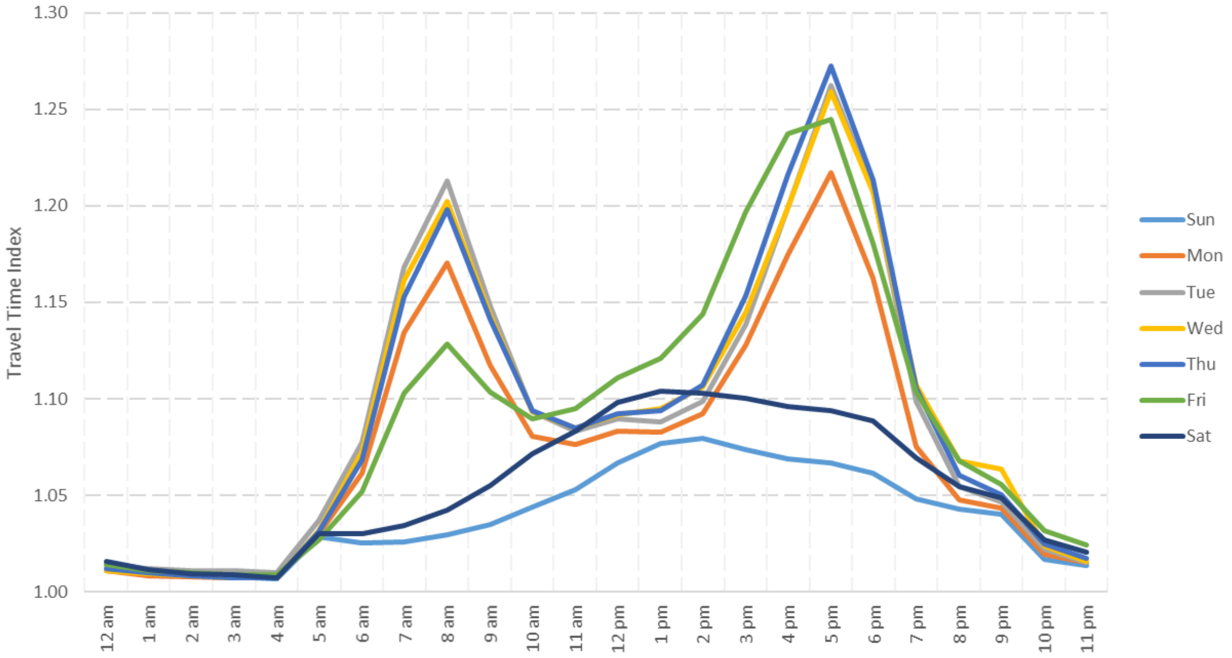
Congestion also varies within a week, as shown in Figure 2-15. The day of week variation of congestion on the Washington region in 2017 had the following trends. Note that these trends are a summary of all the 6,525 directional miles of roads in the region; different areas, highway facilities and routes may vary differently.

- Middle weekdays – Tuesday, Wednesday and Thursday – were the most congested days of a week. During these three weekdays, the AM Peak had almost identical congestion while the most congested PM Peak occurred on Thursday, followed by Wednesday and Tuesday.

- Monday and Friday had unique traffic patterns. Monday morning's traffic was lower than that of the middle weekdays but higher than Friday; Monday afternoon had the least congestion in all weekdays. Friday morning had the least congestion in all weekdays; Friday afternoon's congestion was almost as bad as the middle weekdays, but it came about one hour earlier without ending earlier – expanded congested time period.

- Weekend days had the lowest traffic in a week and Sunday was even lower than Saturday with no pronounced AM and PM peaks. During these two days, mid-day traffic (12:00 – 3:00 pm) was the highest.

Figure 2-15 Time of Day and Day of Week Variation of Congestion in 2017



2.2.1.6. Top Bottlenecks

This report takes advantage of the vehicle probe data, which provides continuous minute-by-minute speed information for more than 6,525 directional miles of both freeways and arterials in the region, presents both “all time” and “peak periods” top bottlenecks, regardless of roadway function class. The “all-time” – 24/7/365 – top bottlenecks are provided in Table 2-1 and Figure 2-16, and the “peak periods” – non-holiday weekday 6:00-9:00 am and 4:00-7:00 pm – top bottlenecks are presented in Table 2-2 and Figure 2-17.

The Travel Time Index – an indicator of the intensity of congestion and the ratio of actual travel time to free flow travel time – is used as the essential factor in ranking the bottlenecks. This method is in line with the TPB’s long-standing, density-based methodology adopted in the aerial photography survey of the region’s freeway system. From a traveler’s perspective, the length of a congested road section also matters, therefore the product of TTI and length was used in the ranking. From a system’s perspective, the number of vehicles affected by a bottleneck also has a role in decision making, so the Annual Average Daily Traffic volume (AADT) is added as another factor for the second ranking list[13].

Table 2-1 2017 Top Bottlenecks – All Time

Location	State	Ave. TTI	Length (miles)	TTI*Miles	Rank by TTI*Miles	AADT	AADT*TTI* Miles	Rank by AADT*TTI *Miles
I-495 IL between Exit45/VA267 and Exit43/GW Pkwy	VA	1.89	3.25	6.16	1	158,932	979,612	2
I-95 SB between Lorton Rd/Exit 163 and Gordon Blvd/Exit 160	VA	1.78	3.36	5.97	2	199,147	1,188,452	1
DC-295 NB between Pennsylvania Ave SE and E Capitol St SE	DC	1.81	1.90	3.44	3	104,671	359,789	5
I-495 IL between Exit28/New Hampshire Ave and Exit 29/University Blvd E.	MD	1.52	1.71	2.59	4	210,814	546,526	3
I-495 IL between Exit 34/I-270 and Exit 33/Md-185	MD	1.52	1.55	2.35	5	212,690	500,565	4
I-495 OL around VA-241/TELEGRAPH RD/EXIT 2	VA	1.59	1.46	2.32	6	139,400	322,880	6
Interchange of Va-267 to I-495	VA	2.11	0.76	1.61	7	162,117	261,438	8
I-395 NB between Jefferson Davis Hwy and GW Pkwy	VA	1.76	0.88	1.56	8	182,964	285,010	7
N CAPITOL ST NE between H St NE and R St NW	DC	1.58	0.92	1.45	9	29,607	43,011	12
I-66 EB near Exit 69	VA	1.51	0.87	1.32	10	114,721	151,611	10
I-270 SPUR	MD	1.65	0.79	1.31	11	126,830	165,733	9
I-495/I-295 IL between New Jersey Ave SE and S Capital St SW	DC	1.59	0.61	0.97	12	91,316	88,479	11

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[13] The methodology used in this report is different from that of the VPP Suite.

US-1 between King St/Va-7 and Pendleton St	VA	1.84	0.40	0.73	13	22,182	16,239	15
Clara Barton Pkwy between Arizona Ave NW and N Glebe Rd	DC	1.54	0.46	0.71	14	17,059	12,150	16
Interchange From Va-286 to I-66 WB	VA	1.54	0.39	0.60	15	9,951	5,956	18

Table 2-2 2017 Top Bottlenecks – Peak Periods

Location	State	Ave. TTI	Length (miles)	TTI*Miles	Rank by TTI*Miles	AADT	AADT*TTI* Miles	Rank by AADT*TTI *Miles
I-495 IL between Va-650 and GW Pkwy	VA	3.53	4.29	15.15	1	158,932	2,408,117	3
I-495 OL between I-95 and Exit31/Md-97/Georgia Ave	MD	2.35	5.76	13.54	2	10,814	2,854,836	1
I-495 OL between I-395 and GW Pkwy	VA	2.28	5.93	13.50	3	39,400	1,881,587	4
I-95 SB between Va-286/Fairfax County Pkwy and Va-123/Gordan Blvd	VA	2.04	6.20	12.67	4	194,122	2,459,393	2
US-29/Lee Hwy intersets with Sudley Rd.	VA	2.06	4.90	10.09	5	9,939	100,300	17
Va-28/Centreville Rd between Va-234/Sudley Rd/Prescott Ave and Va-620/New Braddock Rd	VA	1.69	5.49	9.29	6	28,923	268,630	11
GW Pkwy SB between Va-123 and I-66	VA	1.67	8.08	8.12	7	71,067	576,943	9
Old Ox Rd/Va-606 between US-50/John S Mosby Hwy and Va-267/Dulles Greenway	VA	1.52	4.63	7.02	8	25,915	181,849	13
I-495 OL between Exit 174 and Exit 177/US-1	VA	2.44	2.69	6.56	9	152,943	1,003,174	5
Va-234/Sudley Rd between I-66 and Va-659/Gum Spring Rd	VA	1.72	3.34	5.75	10	11,919	68,532	20
Va-267/Dulles Toll Rd between I-495 and I-66	VA	1.91	2.87	5.48	11	47,860	262,276	12
Clara Barton Pkwy between Cabin John Pkwy and DC border	MD	1.91	2.77	5.29	12	21,391	113,243	16
I-66 EB between Exit 44/Prince William Pkwy and Exit 47/Sudley Rd	VA	2.02	2.55	5.14	13	119,414	614,107	9
I-495 OL between MD-210/Indian Head Hwy and Livingston Rd	MD	1.80	2.73	4.93	14	162,500	800,486	8
US-15/Leesburg Byp between N King St and Va-773/Fort Evans Rd NE	VA	2.37	2.03	4.80	15	26,386	126,711	15

Figure 2-16 2017 Top Bottlenecks – All Time

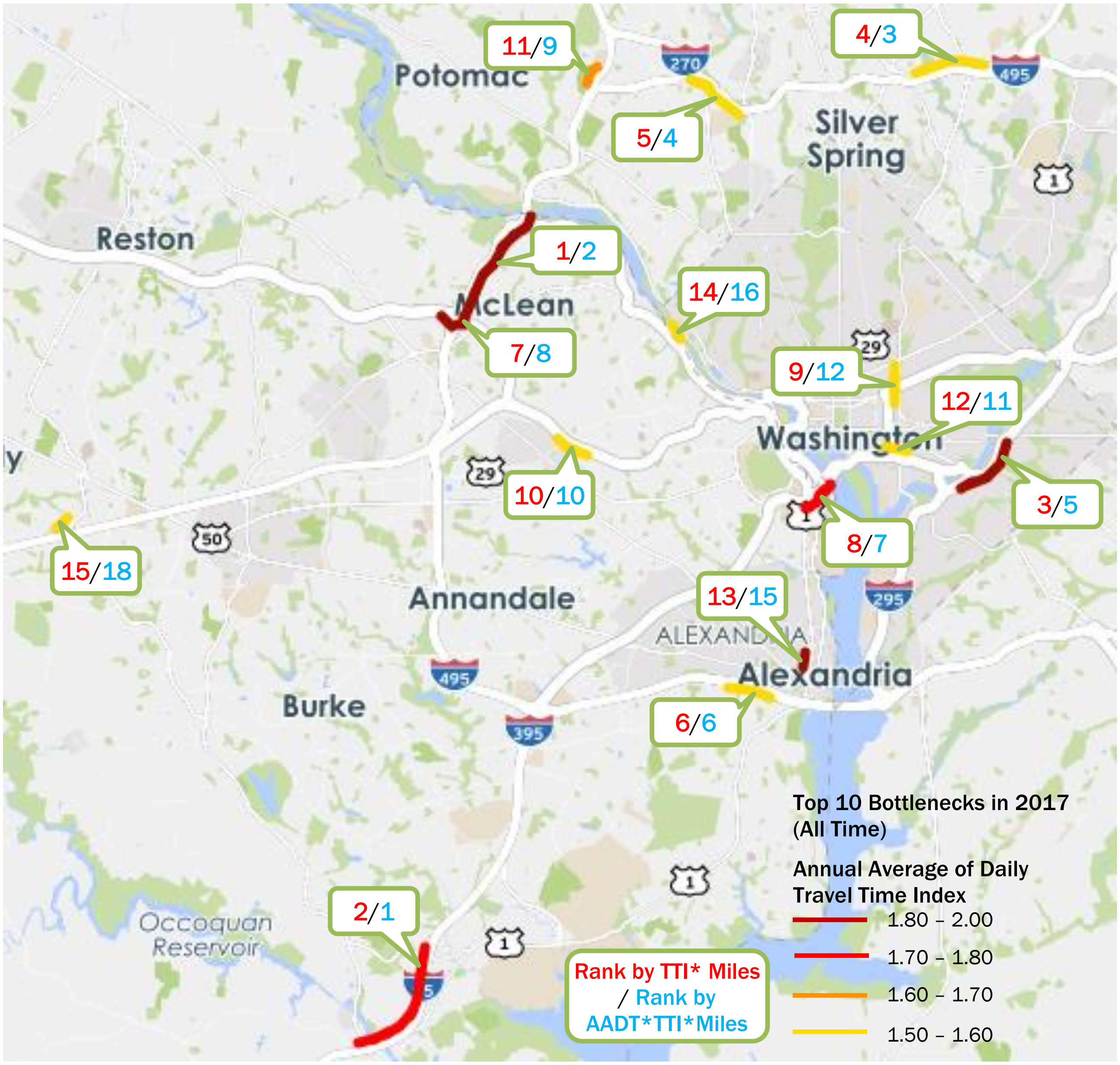
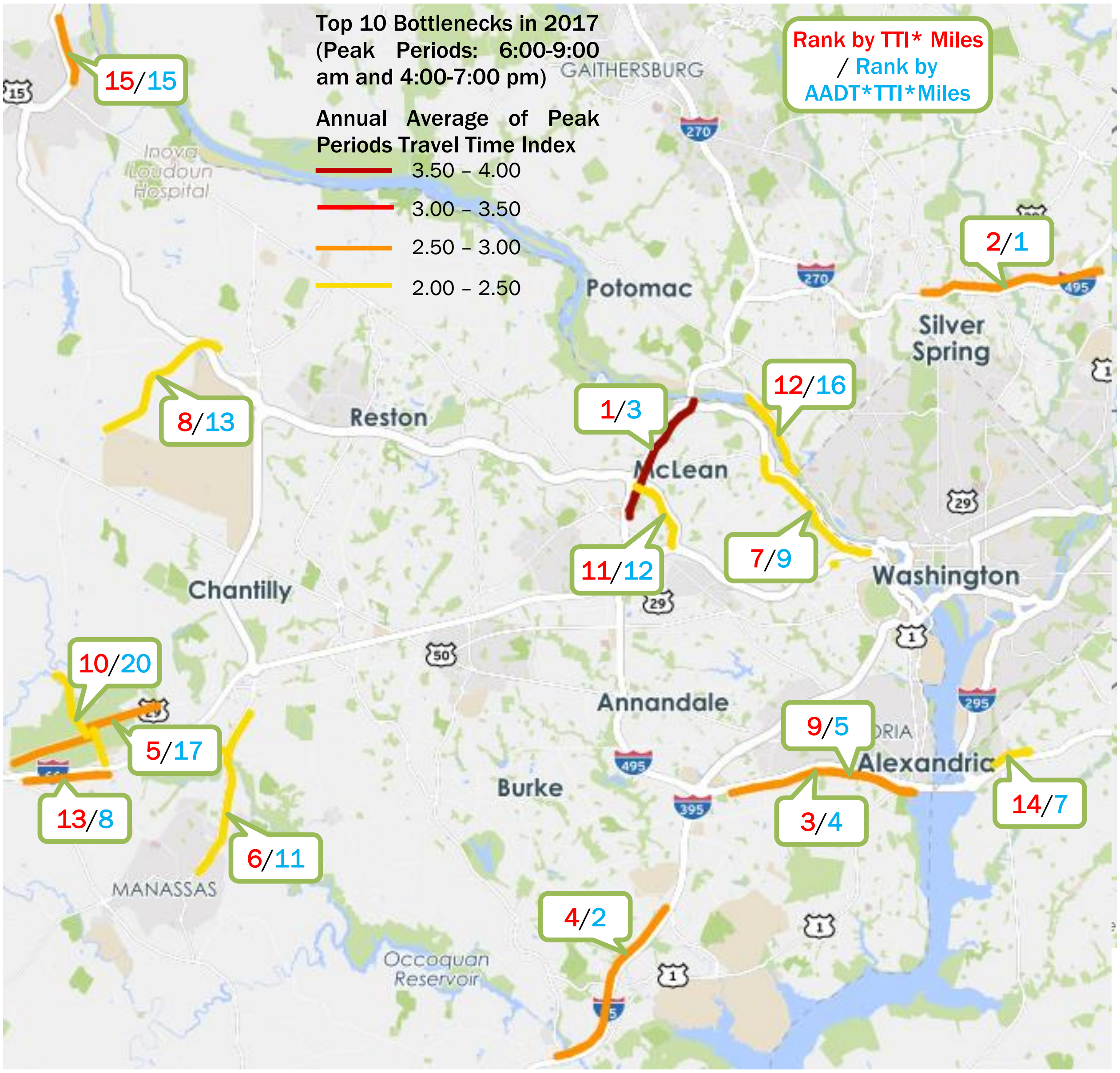


Figure 2-17 2017 Top Bottlenecks – Peak Periods



2.2.1.7. Travel Times along Major Freeway Commute Routes

In addition to the regional summaries as presented by the above performance measures, route- or corridor-specific analysis has also been carried out in this report. A total of 18 major freeway commute routes are defined between major interchanges and/or major points of interest, as shown in Table 2-3 and Figure 2-18.

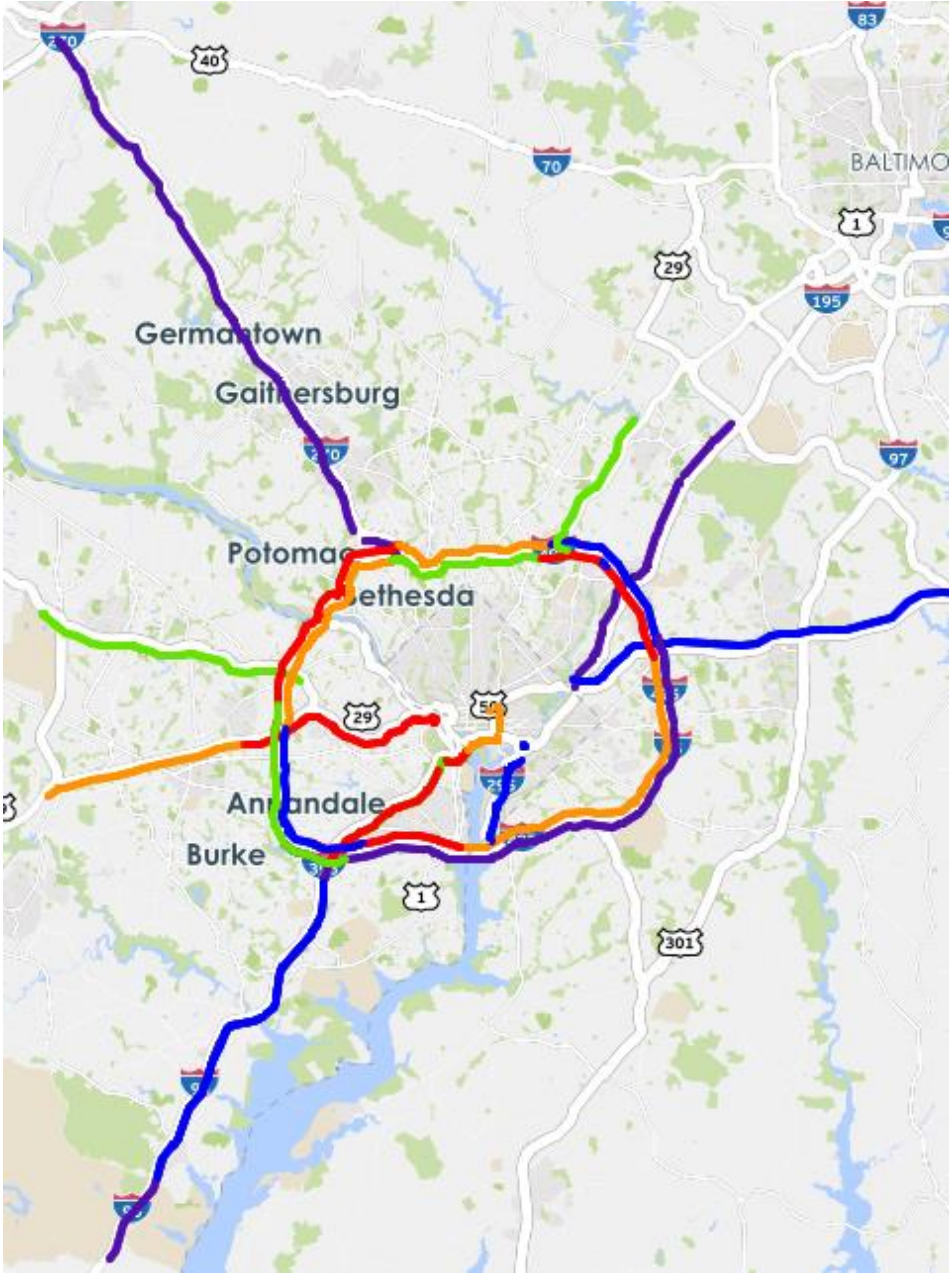
Travel times along the 18 major commute routes in both directions were plotted by the "Performance Charts" tool of the VPP Suite for every Tuesday, Wednesday and Thursday in 2010 and 2015-2017, as shown in Figure 2-19 below (one example) and Appendix C (all 18 corridors). The travel times and planning times (95th percentile travel times) during AM Peak Hour (8:00-9:00 am) and PM Peak Hour (5:00-6:00 pm) are also provided in Table 2-4 and Table 2-5.

One caveat of the method employed in the major commute route analysis is that the route travel time is calculated as *instantaneous travel time* other than *experienced travel time*. Instantaneous travel time is the travel time that would result if prevailing traffic conditions remained unchanged; in other words, the instantaneous route travel time is simply the sum of all segment travel times. The experienced travel time is the travel time of the user who has just completed the considered trip, and is generally not equal to the sum of segment travel times, especially during unstable traffic conditions. This caveat in the methodology merits future improvements.

Table 2-3 Major Freeway Commute Routes

Route Code	Description
C1	I-270 between I-370/Sam Eig Hwy/Exit 9 and I-70/US-40
C2	I-270 between I-370/Sam Eig Hwy/Exit 9 and I-495/MD-355
C3	VA-267 between VA-28/Exit 9a and VA-123/Exit 19
C4	I-66 between VA-28/Exit 53 and I-495/Exit 64
C5	I-66 between I-495/Exit 64 and Theodore Roosevelt Memorial Bridge
C6	I-95 between VA-234/Exit 152 and Franconia Rd/Exit 169
C7	I-95 HOV between VA-234/Exit 152 and Franconia Rd/Exit 169
C8	I-395 between I-95 and H St
C9	I-395 HOV between I-95 and US-1
C10	US-50 between MD-295/Kenilworth Ave and US-301/Exit 13
C11	MD-295 between US-50/MD-201/Kenilworth Ave and MD-198
C12	I-95 between I-495/Exit 27-25 and MD-198/Exit 33
C13	I-495 between I-270/Exit 35 and I-95/Exit 27
C14	I-495 between I-95/Exit 27 and US-50/Exit 19
C15	I-495 between US-50/Exit 19 and I-95/I-395/Exit 57
C16	I-495 between I-95/I-395/Exit 57 and I-66/Exit 9
C17	I-495 between I-66/Exit 9 and I-270/Exit 35
C18	I-295 between I-495 and 11th St. Bridge

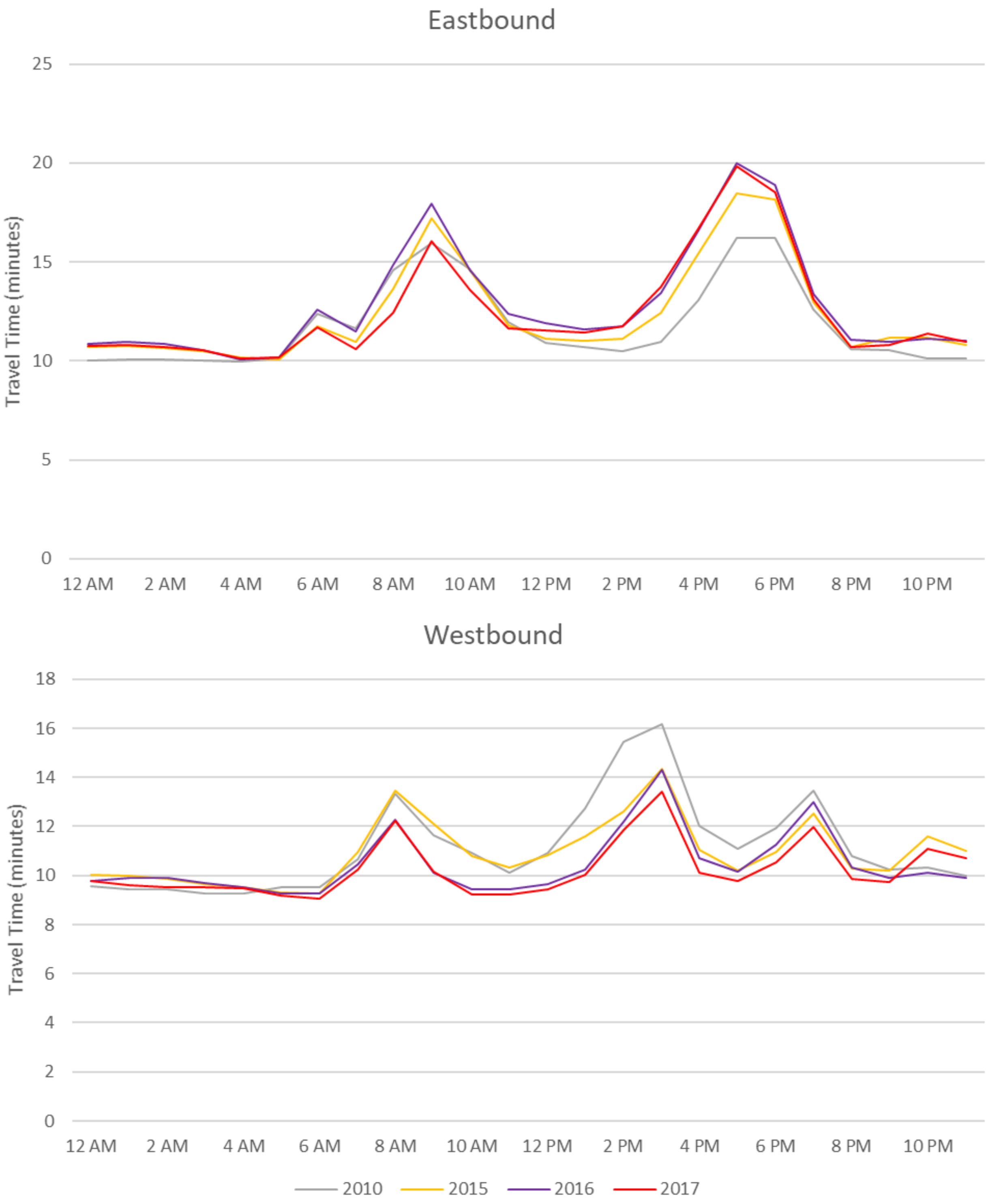
Figure 2-18 Major Freeway Commute Routes



(Screenshot was captured from vpp.ritis.org in Feb 2018)

Figure 2-19 Sample of Travel Times along Major Freeway Commute Routes

Travel time (minutes) for I-66 between I-495/Exit 64 and US-50/Arlington Memorial Bridge



NOTE: Travel time: time it will take to drive along the stretch of road (Distance traveled / Speed)

Table 2-4 Time on Major Freeway Commute Routes in AM Peak Hour (8:00-9:00 am)

Route	Length (miles)	Average Travel Time in AM Peak Hour 8:00-9:00 am (min)				Reliable (95th) Travel Time* in AM Peak Hour 8:00-9:00 am (min)				2017 Changes in Average Travel Time in AM Peak Hour (min)			2017 Changes in 95th Travel Time in AM Peak Hour (min)		
		2010	2015	2016	2017	2010	2015	2016	2017	vs. 2010	vs. 2015	vs. 2016	vs. 2010	vs. 2015	vs. 2016
C1: I-270 SB from I-70 to I-370	24	41	38	38	36	84	69	67	64	-5	-2	-2	-20	-5	-3
C2: I-270 SB from I-370 to I-495	11	25	22	23	22	47	46	49	41	-3	0	-1	-7	-6	-8
C3: VA-267 EB from VA-28 to VA-123	14	25	21	21	21	58	36	37	36	-5	0	0	-22	0	-1
C4: I-66 EB from VA-28 to I-495	13	29	23	24	24	61	37	39	39	-5	2	0	-22	2	0
C5: I-66 EB from I-495 to TR Bridge	10	27	19	22	18	50	33	42	29	-10	-1	-4	-21	-5	-14
C6: I-95 NB from VA-234 to Exit 169	19	28	23	24	25	66	40	41	43	-3	2	1	-23	3	2
C7: I-95 NB HOV from VA-234 to Exit 169	25	19	15	15	21	26	17	16	22	2	6	6	-4	6	6
C8: I-395 NB from I-95 to H St.	14	45	44	46	44	96	93	98	87	0	1	-2	-9	-6	-11
C9: I-395 NB HOV from I-495 to US-1	12	16	15	14	14	31	27	27	21	-2	0	0	-10	-6	-6
C10: US-50 WB from US-301 to MD-295	13	58	62	62	63	83	83	80	81	4	0	1	-2	-2	1
C11: MD-295 SB from MD-198 to US-50	16	29	29	30	28	65	49	51	45	0	0	-1	-20	-4	-7
C12: I-95 SB from MD-198 to I-495	8	13	13	14	14	28	24	24	25	1	1	0	-3	1	0
C13: I-495 IL from I-270 to I-95	10	14	13	13	13	22	20	20	20	-1	0	0	-2	0	0
C14: I-495 IL from I-95 to US-50	9	11	11	11	12	14	15	16	17	1	1	0	3	2	1
C15: I-495 IL from US-50 to I-95	28	30	41	42	43	47	77	76	78	14	2	1	31	1	1
C16: I-495 IL from I-95 to I-66	10	29	18	19	20	49	31	32	34	-9	2	1	-16	3	2
C17: I-495 IL from I-66 to I-270	14	19	26	27	27	31	47	47	47	8	1	-1	16	0	-1
C13: I-495 OL from I-95 to I-270	11	33	34	33	33	52	56	54	51	0	0	0	-2	-5	-3
C14: I-495 OL from US-50 to I-95	10	17	16	15	15	30	26	24	25	-2	0	0	-6	-2	0
C15: I-495 OL from I-95 to US-50	29	35	36	38	37	55	55	61	57	2	2	-1	2	2	-4
C16: I-495 OL from I-66 to I-95	10	11	11	11	11	12	13	14	14	0	0	0	2	0	-1
C17: I-495 OL from I-270 to I-66	13	17	15	17	18	26	21	24	27	1	3	1	1	6	3
C18: I-295 NB from I-495 to 11th St. Brdg.	6	14	15	17	16	35	37	41	33	2	1	-1	-2	-4	-9

* The majority (95%) of trips spent equal to or less than the reliable (95th) travel time on the specified route. On average, a traveler could successfully complete the travel on the specified route within the reliable travel time during 19 out of 20 trips (only 1 trip could exceed the reliable travel time).

Table 2-5 Travel Time on Major Freeway Commute Routes in PM Peak Hour (5:00-6:00 pm)

Route	Length (miles)	Average Travel Time in PM Peak Hour 5:00-6:00 pm (min)				Reliable (95th) Travel Time* in PM Peak Hour 5:00-6:00 pm				2015 Changes in Average Travel Time in PM Peak Hour			2015 Changes in 95th Travel Time in PM Peak Hour (min)		
		2010	2015	2016	2017	2010	2015	2016	2017	vs. 2010	vs. 2015	vs. 2016	vs. 2010	vs. 2015	vs. 2016
C1: I-270 NB from I-370 to I-70	24	23	23	22	23	26	24	24	24	0	0	0	-1	0	0
C2: I-270 NB from I-495 to I-370	11	15	12	12	12	29	18	19	17	-3	0	-1	-12	-1	-2
C3: VA-267 WB from I-66 to VA-28	14	17	15	15	15	25	19	19	20	-2	0	0	-6	0	1
C4: I-66 WB from I-495 to VA-28	13	15	16	14	14	24	25	20	18	-2	-2	0	-7	-7	-2
C5: I-66 WB from TR Bridge to I-495	10	22	23	26	26	36	36	41	42	4	3	0	6	6	1
C6: I-95 SB from Exit 169 to VA-234	19	20	19	20	19	25	27	31	30	0	0	0	5	3	0
C7: I-95 SB HOV from Exit 169 to VA-234	25	22	17	17	24	39	21	22	31	2	7	7	-8	10	8
C8: I-395 SB from H St. to I-95	14	22	25	29	31	40	49	59	59	9	6	2	18	9	0
C9: I-395 SB HOV from US-1 to I-495	12	12	12	13	14	16	19	17	18	2	2	1	2	0	2
C10: US-50 EB from MD-295 to US-301	13	49	53	54	54	54	60	59	59	5	1	0	5	-1	0
C11: MD-295 NB from US-50 to MD-198	16	20	26	26	25	32	45	44	41	5	-1	-1	9	-3	-3
C12: I-95 NB from I-495 to MD-198	8	8	12	11	11	18	19	19	19	3	-1	0	1	-1	0
C13: I-495 IL from I-270 to I-95	10	25	21	24	29	48	42	42	53	4	8	5	5	11	11
C14: I-495 IL from I-95 to US-50	9	17	23	22	21	31	38	37	35	4	-2	-1	4	-3	-2
C15: I-495 IL from US-50 to I-95	28	32	36	40	41	47	54	62	64	9	6	1	17	9	2
C16: I-495 IL from I-95 to I-66	10	13	10	10	10	26	11	12	11	-4	0	0	-15	0	-1
C17: I-495 IL from I-66 to I-270	14	42	44	47	51	93	86	89	90	9	7	4	-3	4	1
C13: I-495 OL from I-95 to I-270	11	21	14	14	14	50	27	30	24	-7	0	-1	-26	-3	-6
C14: I-495 OL from US-50 to I-95	10	16	15	17	19	30	25	27	30	3	3	2	-1	4	3
C15: I-495 OL from I-95 to US-50	29	34	47	53	58	61	91	98	105	24	10	5	44	15	7
C16: I-495 OL from I-66 to I-95	10	16	16	19	20	24	25	27	30	3	3	1	5	4	2
C17: I-495 OL from I-270 to I-66	13	35	31	36	38	69	56	62	66	3	7	2	-3	9	4
C18: I-295 SB from 11th St. Brdg. to I-495	6	6	6	6	6	7	7	7	6	0	0	0	0	0	0

* The majority (95%) of trips spent equal to or less than the reliable (95th) travel time on the specified route. On average, a traveler could successfully complete the travel on the specified route within the reliable travel time during 19 out of 20 trips (only 1 trip could exceed the reliable travel time).

2.2.1.8. Congestion on Arterials

Congestion Characteristics on Arterials

An arterial highway is defined as an interrupted flow roadway. Arterials are different than freeways in that they tend to have multiple ingress and egress points, intersections, fewer lanes, and lower speeds. Due to these characteristics, the congestion on arterials can be caused from reasons different from that of freeways.

As mentioned earlier, the TPB had carried out Arterial Floating Car Travel Time Studies from 2000 – 2011 on selected NHS arterial highways in the region. These studies had identified some common themes and trends about general arterial congestion:

- There are competing demands of traveler mobility and accessibility to adjacent land uses affecting arterial operations.
- Growth and development can contribute to rapid worsening of congestion at specific locations.
- Intersections and driveways can cause slow-downs and backups along arterials.
- Arterials often experience spillover from freeways.
- Arterials tend to be heavily traveled in densely developed corridors.
- Traffic engineering improvements, such as extending a turn lane or traffic signal timing, can help soften the impacts of growth.
- By nature of design and other factors, arterials can be a mix of speeds, depending on things such as number of traffic signals, intersections, and lanes.
- Since the Washington region has a limited number of freeway lane miles, the region is especially dependent upon its arterial highways for mobility.
- Cars share the road with transit and delivery vehicles with frequent stops.

Although congestion occurs on arterials throughout the region, there are also common trends that are generally associated with the land use and urban form surrounding the arterial. For the purposes of this report, we will classify these as metro core, inner suburban and outer suburban arterials.

Arterials in the Inner Core

The characteristics of the inner core of a region, by their urban nature, can greatly impact the flow of traffic on the core's arterials:

- Pedestrian and transit access to densely populated land uses are a major focus of inner core roadways. Traffic speeds must be at a level that ensures pedestrian safety.
- The flow of traffic is more frequently interrupted by a higher concentration of signaled intersections and driveways/alleyways in the inner core.
- Intersections tend to be close together. If traffic is stopped at an intersection, sometimes backups can occur through the intersection behind it. In addition, traffic blocking an intersection could impact the flow of traffic on the cross street.
- There are not always turn lanes present, so drivers may have to wait while a car in front of them makes a turn.
- On-street parking necessitates slower traffic speeds. In addition, some inner core arterials experience worse congestion in the off-peak period because two lanes of capacity are lost due to on-street parking during the day.

- In many older areas, a grid pattern of streets allows for multiple travel routes at moderate speeds.

For example, many of these inner core characteristics play a role in the congestion on Connecticut Ave NW, between K Street NW and Nebraska Ave NW. This segment of Connecticut Ave is a dense corridor of retail and commercial activity which attracts a large number of pedestrians and drivers searching for on-street parking.

Congestion management strategies that can help manage congestion on core arterials include operations management strategies such as optimized traffic signal timing and traffic engineering improvements. Relevant demand management strategies include robust transit services in these densely populated areas, employer outreach of alternative commute programs, as well as improved pedestrian and bicycle facilities.

Arterials in the Inner Suburbs

Arterials in the inner suburbs have characteristics combined from that of the inner core and outer suburban arterials.

- Signalized intersections, especially the intersections of major arterial roadways, have capacity limitations, especially when there are high percentages of turning movements at those intersections.
- Traffic from both nearby offices and residences can cause congestion.
- There can be spillover from adjacent congested freeways.
- Strip retail and other “destination” retail activities are often located along arterials. In the inner suburbs the density of these uses is likely higher than that of the outer suburbs, and ingress/egress points are closer together. This could cause disruptions in traffic flow during peak times.
- Inner suburban areas have been experiencing welcome increases in pedestrians and transit usage in recent years, which must be considered in operations planning for arterials in these areas.

For example, these inner suburban arterial qualities are true of US 29, which extends from Arlington, VA to Centreville, VA. The segment between M Street NW in DC and Harrison Street in Arlington is lined with several strip retail areas.

US 29 is also a major alternative commuting route of I-66, and it provides access to I-66 at several different locations. US 29 experienced spillover from several major freeways in the vicinity, including I-66 and the Beltway.

Georgia Ave, between Eastern Ave NW (DC boundary) and MD 28 also experiences situations typical of inner suburban arterials. Georgia Ave links Aspen Hill area to Silver Spring, serving as one of the major commuting routes to and from DC for the communities between I-270 and I-95 in Montgomery County in Maryland. The southern part of the corridor connects to US 29 in Silver Spring, a major arterial cross the region. Georgia Ave also experienced spillover from the Beltway in Silver Spring.

Congestion management strategies that can help inner suburban arterials include operational management strategies such as optimized traffic signals, operational management improvements on nearby freeways, and traffic engineering improvements. Often off-peak signal timing in inner suburban arterials can be worse than the peak hours, as a high number of people are moving in all directions and not with peak flow movement. Relevant demand management strategies include transit services, bus rapid transit, and Commuter Connections programs (especially employer-based programs).

Arterials in the Outer Suburbs

Arterials in the outer suburbs have their own unique characteristics:

- New development in the outer suburbs may quickly overwhelm the capacities of what were until recently lightly traveled rural roads.
- Because commute distances in the outer suburbs tend to be longer, peaking characteristics of traffic are much sharper.
- Transit services and pedestrian facilities are limited.
- Not unlike the inner suburbs, strip retail and other “destination” retail activities are likely to be located along outer suburban arterials. This could cause disruptions in traffic flow during peak times.
- Outer suburban arterials can also experience spillover from major freeways. This is especially expected during the morning and evening peak period when commuters drive to and from the inner core for work.

For example, MD144 between Waverly Road and Monocacy Boulevard in Frederick County experiences spillover from two major roadways that bypass in Frederick: I-70/I-270 and US 340/US 15 (Catoctin Mountain Highway).

The northern section of VA 7 between Georgetown Pike and VA 653 links Fairfax County to Leesburg. It is a major commuting route which connects to VA 28. The stretch of arterial from the Loudoun County line to Sterling has seen much commercial and retail development over the past several years.

Congestion management strategies that can help outer suburban arterials include operational management strategies such as bottleneck removal, dedicated turn lanes, and other traffic engineering improvements. Relevant demand management strategies include park-and-ride lots, commuter bus and rail services and Commuter Connections programs (especially employee-focused programs).

Congestion on Selected Arterials

Given the availability of the I-95 VPP/INRIX data, the TPB has adopted this third-party probe-based data for arterial travel time monitoring. This new data source enabled more detailed analysis of travels along arterials including travel time reliability. Appendices A and B provide the peak hour Travel Time Index and Planning Time Index on most of the region’s NHS arterials and other probe data monitored roadways for 2017.

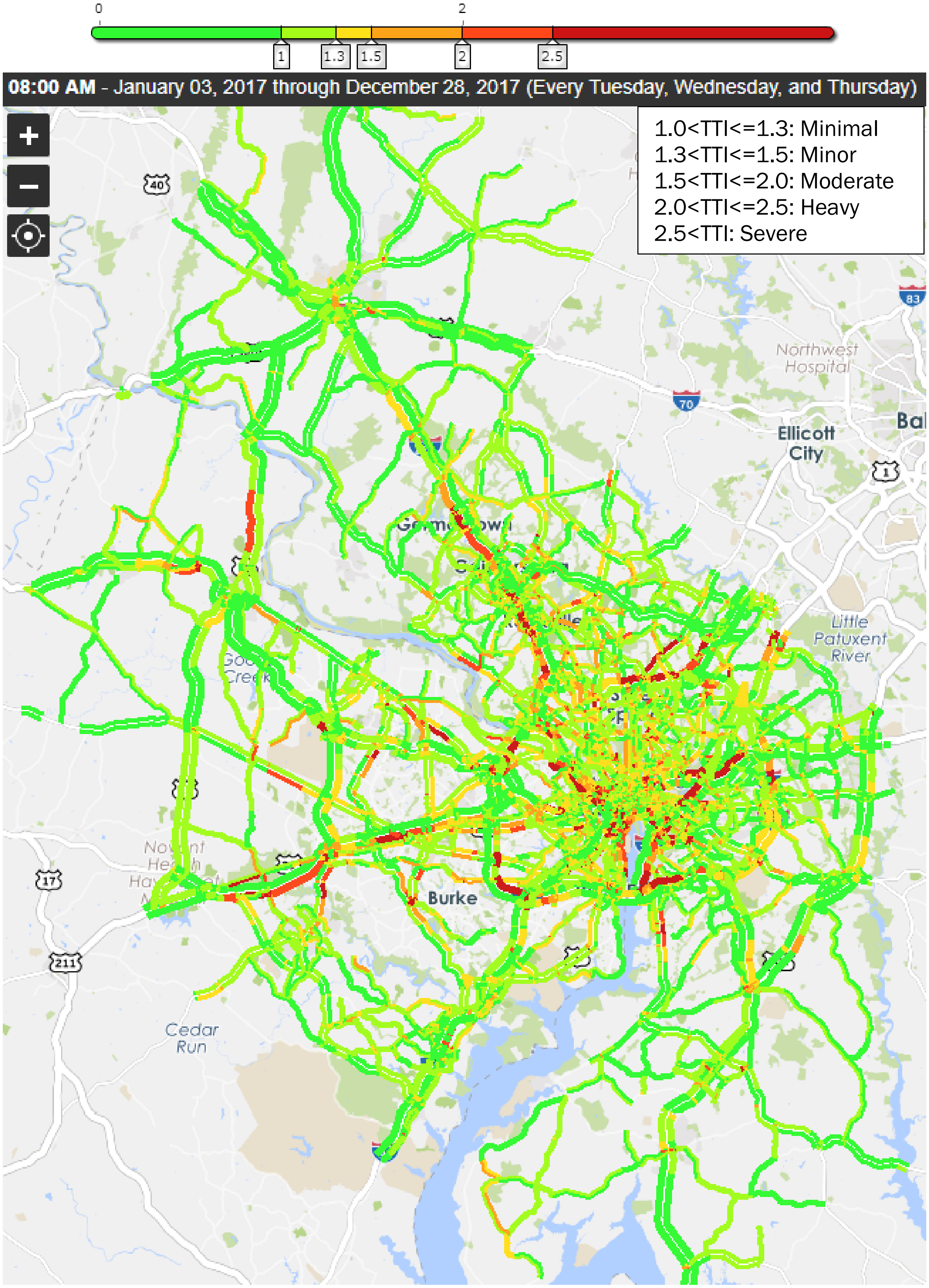
In addition to the regional summaries and congestion mapping on arterials that have been presented earlier in this chapter, this report also investigates the travel times along the study routes under the historical floating car surveys. This includes 58 routes shown in Table 2-6 below. Travel Time Index of the studied routes and other NHS arterials for middle weekday peak hours (8:00-9:00 am and 5:00-6:00 pm on Tuesdays, Wednesdays, and Thursdays) are mapped in Figure 2-20 and Figure 2 - 21.

Table 2-6 Arterial Travel Time Study Routes

State	Route	From/To	To/From	Length (miles)
DC	14th St	Independence Ave	K St	1.0
DC	16th St	K St	Eastern Ave	6.1
DC	17th St	Pennsylvania Ave	Independence Ave	0.5
DC	7th St/Georgia Ave Sec. 1	Independence Ave	New Hampshire Ave	2.8
DC	7th St/Georgia Ave Sec. 2	New Hampshire Ave	Eastern Ave	3.5
DC	Canal Rd/M St	30th St	Chain Bridge	3.7
DC	Connecticut Ave	K St	Nebraska Ave	4.0
DC	Constitution Ave	Louisiana Ave	14th St NE	1.5
DC	H St	Pennsylvania Ave	14th St NW	0.6
DC	Independence Ave	17th St	2nd St SE	1.9
DC	K St/New York Ave	21st St NW	Bladensburg Rd	4.2
DC	L St	Pennsylvania Ave	14th St NW	1.1
DC	Military Rd	Connecticut Ave	Georgia Ave	2.5
DC	Pennsylvania Ave	Constitution Ave	15th St NW	0.8
DC	Rhode Island Ave	7th St	Eastern Ave	3.5
DC	South Dakota Ave	Bladensburg Rd	Riggs Rd	3.0
DC	US 50	17th St	T. R. Bridge	0.9
DC	US 29	M St	Whitehurst Fwy	0.5
DC	Wisconsin Ave	M St	Western Ave	4.1
MD	MD 117	Muddy Branch Rd	Clarksburg Rd	6.8
MD	MD 193	Colesville Rd	Adelphi Rd	4.6
MD	MD 198	MD 650	Old Gunpowder Rd	5.2
MD	MD 210	Southern Ave	Livingston Rd	10.5
MD	MD 355 Sec. 1	MD 124	MD 547	10.1
MD	MD 355 Sec. 2	MD 547	Western Ave	5.3
MD	MD 4	Southern Ave	Dowerhouse Rd	7.0
MD	MD 450	US 301	B. W. Pkwy	12.1
MD	MD 586	MD 28	MD 193	5.0
MD	MD 193	US 29	MD 185	4.2
MD	MD 28	Veirs Mill Rd	New Hampshire Ave	9.0
MD	MD 5	Suitland Pkwy	Accokeek Rd	12.2
MD	MD 97 Sec. 1	Eastern Ave	University Blvd	4.2
MD	MD 97 Sec. 2	University Blvd	MD 28	5.3
MD	Randolph Rd	MD 355	Columbia Pike	9.1
MD	US 1 Sec. 1	MD 198	MD 193	8.1
MD	US 1 Sec. 2	MD 193	Eastern Ave	5.3
MD	US 29	East-West Hwy	Fairland Rd	7.1
VA	US 15	VA 7	Lovettsville Rd	12.6
VA	US 50 Sec. 1	VA 28	Nutley St	13.4
VA	US 50 Sec. 2	Nutley St	Fort Myer Dr	12.3

VA	US 1	15th St	VA 123	20.0
VA	US 29 Sec. 1	G.W. Pkwy	Gallows Rd	9.0
VA	US 29 Sec. 2	Gallows Rd	VA 236	8.8
VA	US 29 Sec. 3	VA 236	Bull Run PO Rd	7.5
VA	VA 120	I 395	Chain Bridge	8.3
VA	VA 123 Sec. 1	VA 193	VA 7	5.8
VA	VA 123 Sec. 2	VA 7	VA 236	7.1
VA	VA 123 Sec. 3	VA 236	US 1	14.8
VA	VA 234 Sec. 1	US 1	Hoadley Rd	10.2
VA	VA 234 Sec. 2	Hoadley Rd	US 29	13.2
VA	VA 28 Sec. 1	Wellington Road	Compton Rd	7.0
VA	VA 28 Sec. 2	Compton Rd	VA 7	17.0
VA	VA 7 Sec. 1	Braddock Rd	Gallows Rd	9.5
VA	VA 7 Sec. 2	Gallows Rd	VA 193	10.0
VA	VA 7 Sec. 3	VA 193	VA 28	8.0
VA	VA 286 Sec. 1	Sunrise Valley	US 50	6.2
VA	VA 286 Sec. 2	US 50	Rolling Rd	20.0
VA	Wilson Blvd	Roosevelt Blvd	Fort Myer Dr	4.7
	Total			402.7

Figure 2-20 Travel Time Index on Selected NHS Arterials during 8:00-9:00 am on Middle Weekdays in 2017

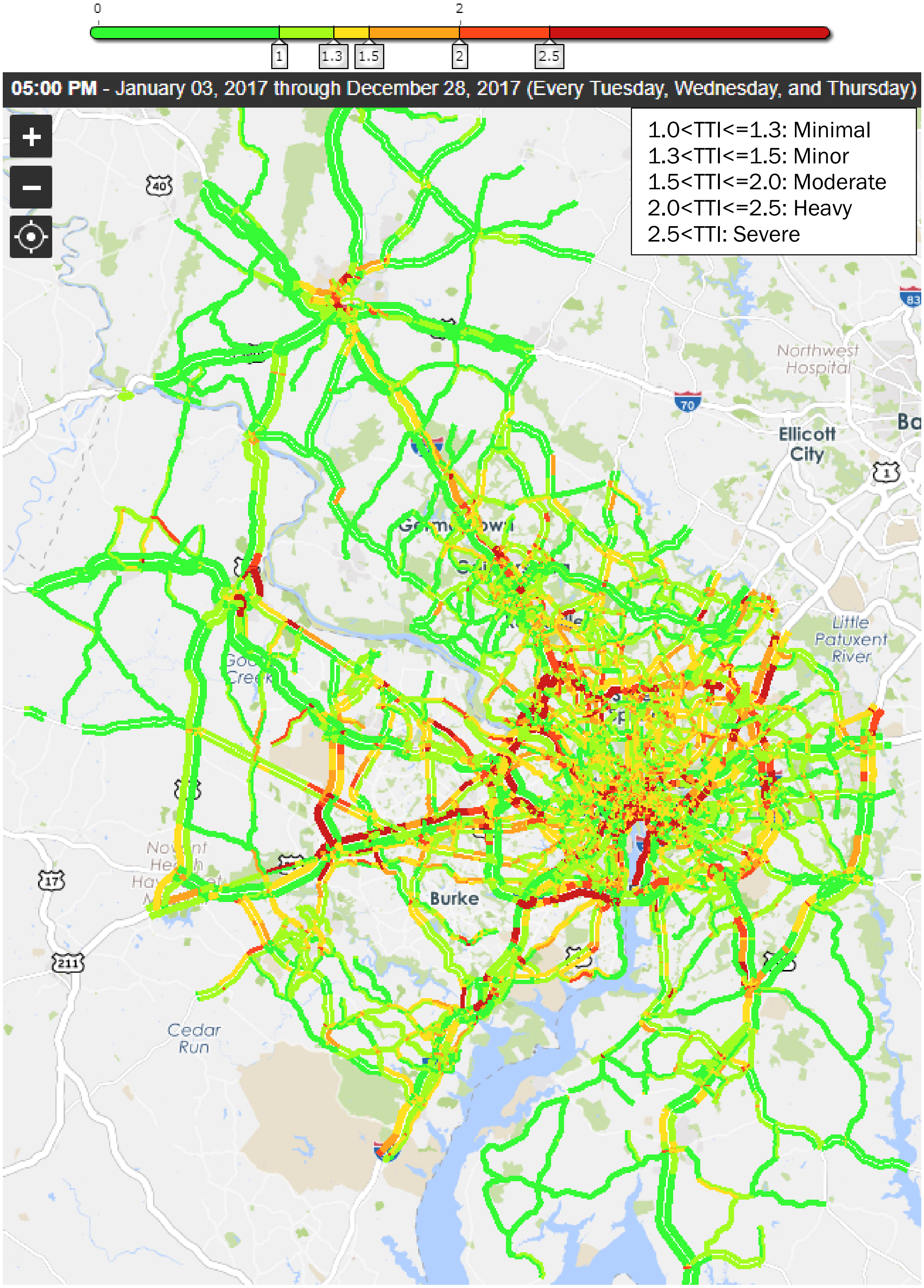


08:00 AM - January 03, 2017 through December 28, 2017 (Every Tuesday, Wednesday, and Thursday)

1.0<TTI<=1.3: Minimal
1.3<TTI<=1.5: Minor
1.5<TTI<=2.0: Moderate
2.0<TTI<=2.5: Heavy
2.5<TTI: Severe

Note: Congestion levels are categorized by the value of TTI: TTI = 1.0: Free flow

Figure 2 - 21 Travel Time Index on Selected NHS Arterials during 5:00-6:00 pm on Middle Weekdays in 2017



Note: Congestion levels are categorized by the value of TTI: TTI = 1.0: Free flow

Future Arterial Congestion Analysis

Using the VPP data for arterial congestion monitoring is considered by many practitioners a challenging task. One major concern is the validity of the data, especially on arterials on which traffic volumes were much less than that of freeways. Unlike the freeways, the VPP currently has no on-going third-party data validation tests to ensure data quality on arterials. The segmentation, based on which the probe data is reported, on arterials is also less straightforward than on freeways. Staff will continue to monitor the quality of arterial probe data and carry out additional studies as needed.

Improving Congestion on Arterials

Adding capacity on arterials to reduce congestion is seldom feasible, as many arterials are already built to capacity with development on either side. However, there are demand management and operational management strategies that could offer solutions. The addition of express bus or other types of public transportation along an arterial could decrease the amount of cars on the road. Pedestrian and bicycle improvements, such as the implementation of a new bike facility along the arterial can provide an alternative option for travelers. Operational improvements can include the addition of turn lanes, to reduce the amount of back-ups at an intersection, or the creation of additional lanes. Traffic signal timing optimization is also important in ensuring the appropriate movement of vehicles at intersections.

2.2.1.9. Quarterly National Capital Region Congestion Report

Inspired by various agency and jurisdictional dashboard efforts around the country (e.g., the Virginia Department of Transportation Dashboard), driven by the MAP-21 and FAST legislations and the emerging probe-based traffic speed data from the I-95 Corridor Coalition Vehicle Probe Project, this quarterly updated National Capital Region Congestion Report takes advantage of the availability of rich data and analytical tools to produce customized, easy-to-communicate, and quarterly updated traffic congestion and travel time reliability performance measures for the Transportation Planning Board (TPB) Planning Area. The goal of this effort is to timely summarize the region's congestion and the programs of the TPB and its member jurisdictions that would have an impact on congestion, to examine reliability and non-recurring congestion for recent incidents/occurrences, in association with relevant congestion management strategies, and to prepare for the MAP-21 and FAST performance reporting.

This quarterly report includes congestion and travel time reliability analysis, top 10 bottlenecks in a quarter, congestion maps, quarterly spotlight focusing on notable event(s) and its transportation impacts during that quarter, background and methodology information. This repot can be accessed via www.mwcog.cog/congestion. A screenshot of the first page of the 4th Quarter 2017 Report is shown in Figure 2-22.

Figure 2-22 National Capital Region Congestion Report (First Page)

CONGESTION – TRAVEL TIME INDEX (TTI)

Interstate System

TTI 4th Quarter 2017:	1.38	↑0.2% or 0.003[1]
TTI Trailing 4 Quarters:	1.35	↑0.1% or 0.001[2]

Transit-Significant[4]

TTI 4th Quarter 2017:	1.21	↓-1.4% or -0.02
TTI Trailing 4 Quarters:	1.21	↓-0.5% or -0.01

Non-Interstate NHS[3]

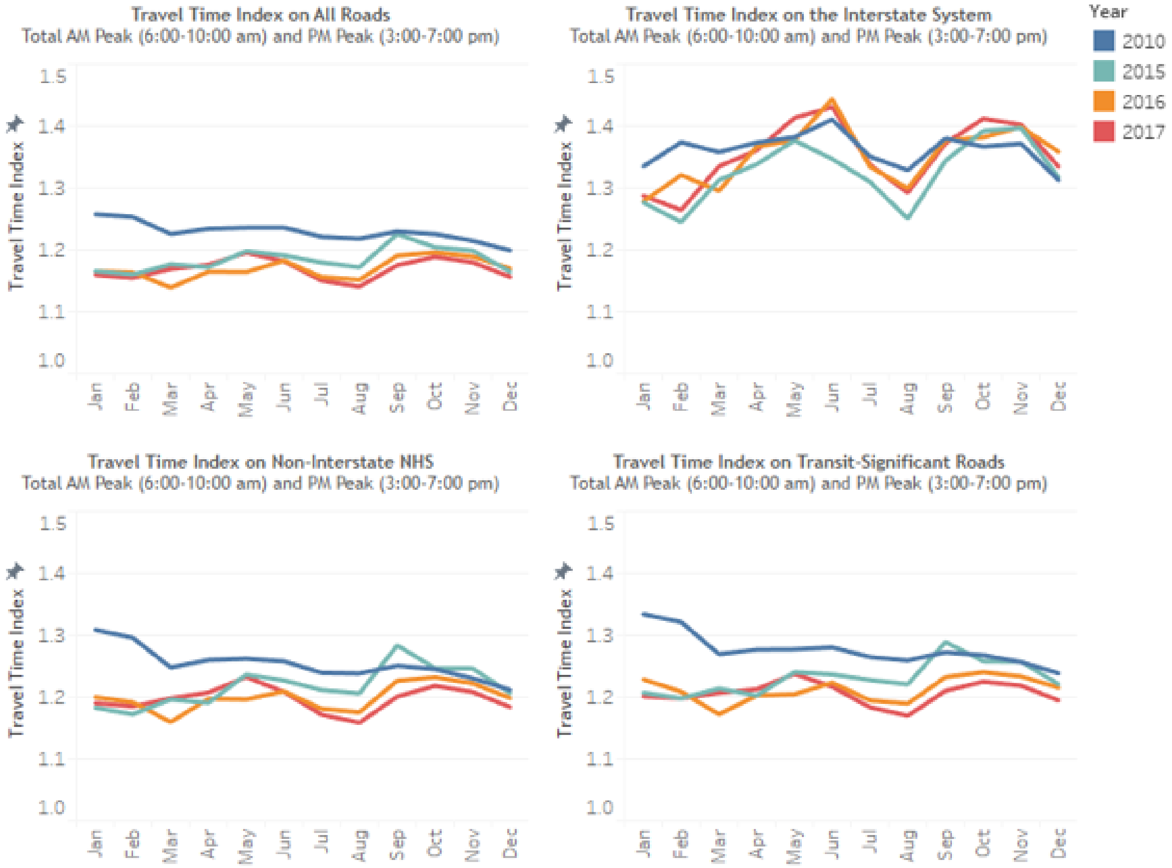
TTI 4th Quarter 2017:	1.20	↓1.2% or -0.014
TTI Trailing 4 Quarters:	1.20	↓0.2% or -0.002

All Roads

TTI 4th Quarter 2017:	1.17	↓0.8% or -0.01
TTI Trailing 4 Quarters:	1.17	0.0% or 0.00

[1] Compared to 4th Quarter 2016; [2]Compared to one year earlier;[3] NHS: National Highway System; [4] See "Background" section.

Figure 1 Monthly Travel Time Index for Total AM peak (6:00-10:00 am) and PM peak (3:00-7:00 pm)



> *Travel Time Index (TTI), defined as the ratio of actual travel time to free-flow travel time, measures the intensity of congestion. The higher the index, the more congested traffic conditions it represents, e.g., TTI = 1.00 means free flow conditions, while TTI = 1.30 indicates the actual travel time is 30% longer than the free-flow travel time.*

2.2.2. FREEWAY AERIAL PHOTOGRAPHY SURVEY

The TPB contracted with Skycomp, Inc. to conduct a systematic aerial study of regional freeway congestion beginning in 1993. The most recent survey was completed in Spring 2014 and the report can be downloaded online[14]. The Spring 2011[15] and Spring 2008[16] reports can also be found on COG/TPB's website.

In the aerial photography survey, peak period freeway congestion was monitored on a once-every-three-years cycle during the AM and PM peak periods. It provided a wealth of information on the region's freeways, including the overall conditions of the freeways, specific congested locations, trends over time, and identification of factors associated with the congested conditions.

During a survey period, aircraft followed designated flight patterns along the region's approximately 300 centerline miles of limited-access highways. Survey flights were conducted on weekdays, excluding Monday mornings, Friday evenings, and mornings after holidays, during the following time periods:

- Morning surveying times:
  - 6:00 AM – 9:00 AM outside the Capital Beltway;
  - 6:30 AM – 9:30 AM inside the Capital Beltway.
- Evening surveying times:
  - 4:00 – 7:00 PM inside the Capital Beltway
  - 4:30 – 7:30 PM outside the Capital Beltway

During the survey flights, overlapping photographic coverage was obtained of each designated highway, repeated once an hour over three morning and three evening commuter periods (this means that, altogether, there were nine morning and nine evening observations[17] of each highway segment).

Data were then extracted from the aerial photographs to measure average traffic flow density by link and by time period. The density was further converted to level of service (LOS) [18] using methods presented in the *Highway Capacity Manual 2000*. LOS "A" reflects generally free-flow conditions, and

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[14] *Traffic Quality on the Metropolitan Washington Area Freeway System*: *Spring 20014 Report*. Prepared by: Skycomp, Inc. (Columbia, Maryland). http://www.mwcog.org/uploads/committee-documents/YF1XV1db20150227142340.pdf

[15] *Traffic Quality on the Metropolitan Washington Area Freeway System: Spring 2011 Report.* Prepared by: Skycomp, Inc. (Columbia, Maryland). http://www.mwcog.org/store/item.asp?PUBLICATION_ID=436

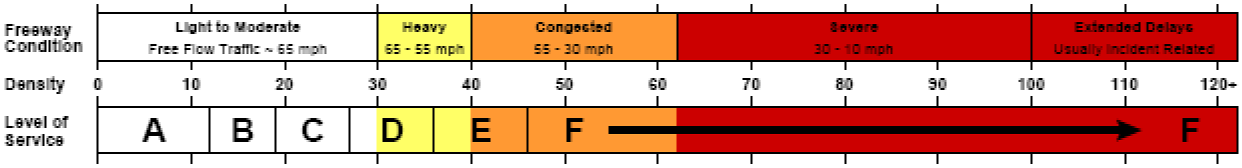
[16] *Traffic Quality on the Metropolitan Washington Area Freeway System: Spring 2008 Report.* Prepared by: Skycomp, Inc. (Columbia, Maryland). https://www.mwcog.org/uploads/news-documents/Clte20090521142505.pdf

[17] Prior to the 2014 survey, the total number of observations was 12 for each peak periods. Given the vast availability of the private-sector probe-based traffic data, e.g., the I-95 Vehicle Probe Project data and the National Performance Management Research Data Set (NPMRDS) data, the role of the aerial photography survey has transformed from being the major source of freeway congestion information to being an independent source that can be used to validate and supplement probe data; more importantly, it can provide unique visual imagery of congestion. Therefore a decision was made to reduce the sample size from 12 to 9 for the 2014 survey.

[18] There are generally six levels of service, A through F. Level of service "A" is the best, describing primarily free-flow conditions, while level of service "F" is the worst, describing flow as unstable and significant traffic delay.

levels “E” and “F” reflect the most severe congestion with extended delays, as illustrated in the following diagram (Figure 2-23).

Figure 2-23 Speed, Density and LOS Chart



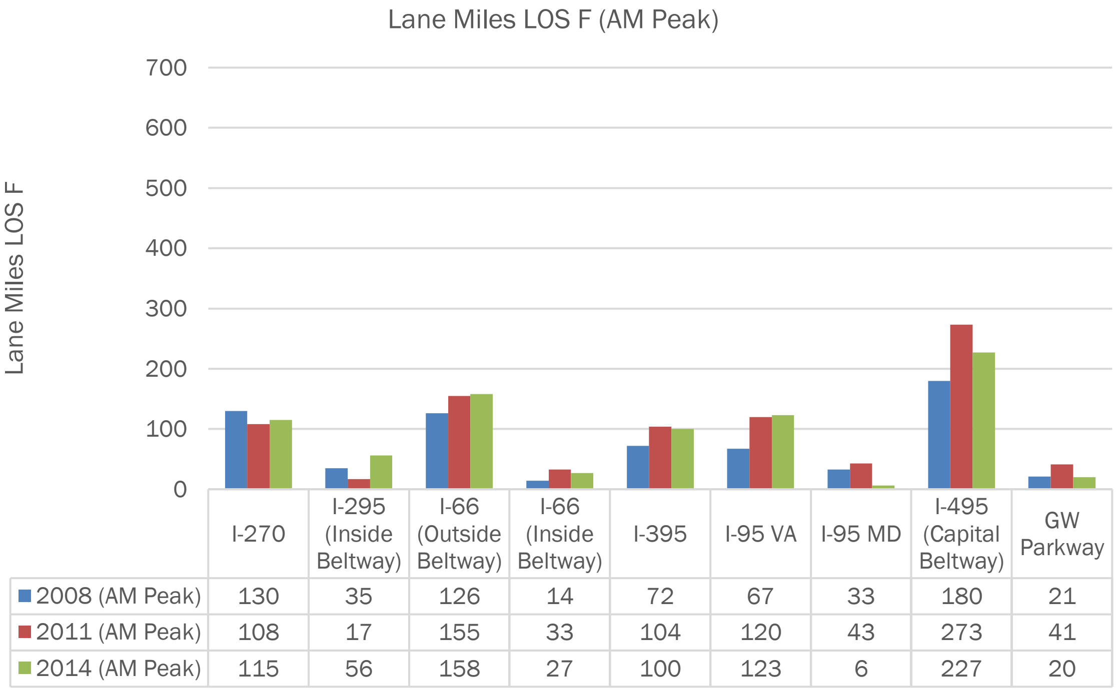
The most recent peak period survey was conducted in Spring 2014 and the following summarizes the highlights of the survey results.

2.2.2.1. Lane Miles of Congestion

Overall, the number of lane miles of congestion (LOS F) in the region in 2014 was 2,249, slightly less than that recorded during the 2011 survey, 2,369. The lane miles of congestion at selected facilities in the past three surveys are given in Figure 2-24 and Figure 2-25 for the AM and PM peak respectively.

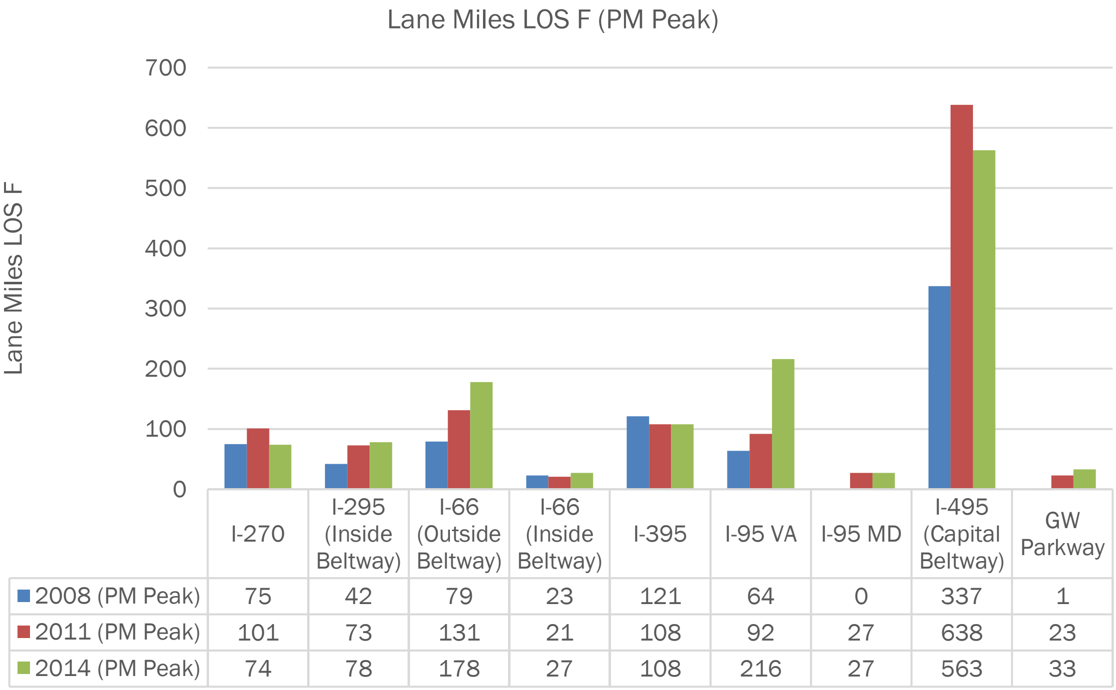
I-66 outside the Beltway and I-95 in Virginia experienced worsening congestion in the past three surveys in both AM and PM peak periods. The Beltway’s congestion was the worst during the Spring 2011 survey, a time when the I-495 Express Lanes were under construction; its 2014 congestion was better than 2011 but still worse than 2008.

Figure 2-24 Lane Miles at LOS F for AM Peak



	I-270	I-295 (Inside Beltway)	I-66 (Outside Beltway)	I-66 (Inside Beltway)	I-395	I-95 VA	I-95 MD	I-495 (Capital Beltway)	GW Parkway
🟦 2008 (AM Peak)	130	35	126	14	72	67	33	180	21
🟥 2011 (AM Peak)	108	17	155	33	104	120	43	273	41
🟩 2014 (AM Peak)	115	56	158	27	100	123	6	227	20

Figure 2-25 Lane Miles at LOS F for PM Peak



	I-270	I-295 (Inside Beltway)	I-66 (Outside Beltway)	I-66 (Inside Beltway)	I-395	I-95 VA	I-95 MD	I-495 (Capital Beltway)	GW Parkway
🟦 2008 (PM Peak)	75	42	79	23	121	64	0	337	1
🟥 2011 (PM Peak)	101	73	131	21	108	92	27	638	23
🟩 2014 (PM Peak)	74	78	178	27	108	216	27	563	33

2.2.2.2. Improvements Observed in the Spring 2014 Survey

Figure 2-26 and Figure 2-27 provide overview maps of significant changes in traffic congestion from 2011 to 2014.There were two major capacity increases to the highway system since the 2011 aerial survey.

The completion of Maryland Route 200, also known as the Intercounty Connector (ICC), linking Prince George's County and Montgomery County provided an alternate east-west route for commuters. Levels-of-service A and B were documented on the ICC throughout the morning and evening survey periods.

On I-495 in Virginia, the I-495 Express Lanes between the I-95/395 and VA 267 Interchanges was completed. This four-lane facility for the most part operated at levels of service A and B. Commuters in the general purpose lanes appeared to benefit to some degree as an improvement in levels of congestion along the corridor. In the evening, conditions on the outer loop along this corridor resembled those documented during the 2008 survey before construction began; severe congestion and extensive delays were found here during the 2011 survey while under construction.

2.2.2.3. Degradation Observed in the Spring 2014 Survey

Degraded levels of service were found on several of the major facilities during the morning and evening commuter periods. In most cases, the primary cause was likely an increase in the volume of traffic.

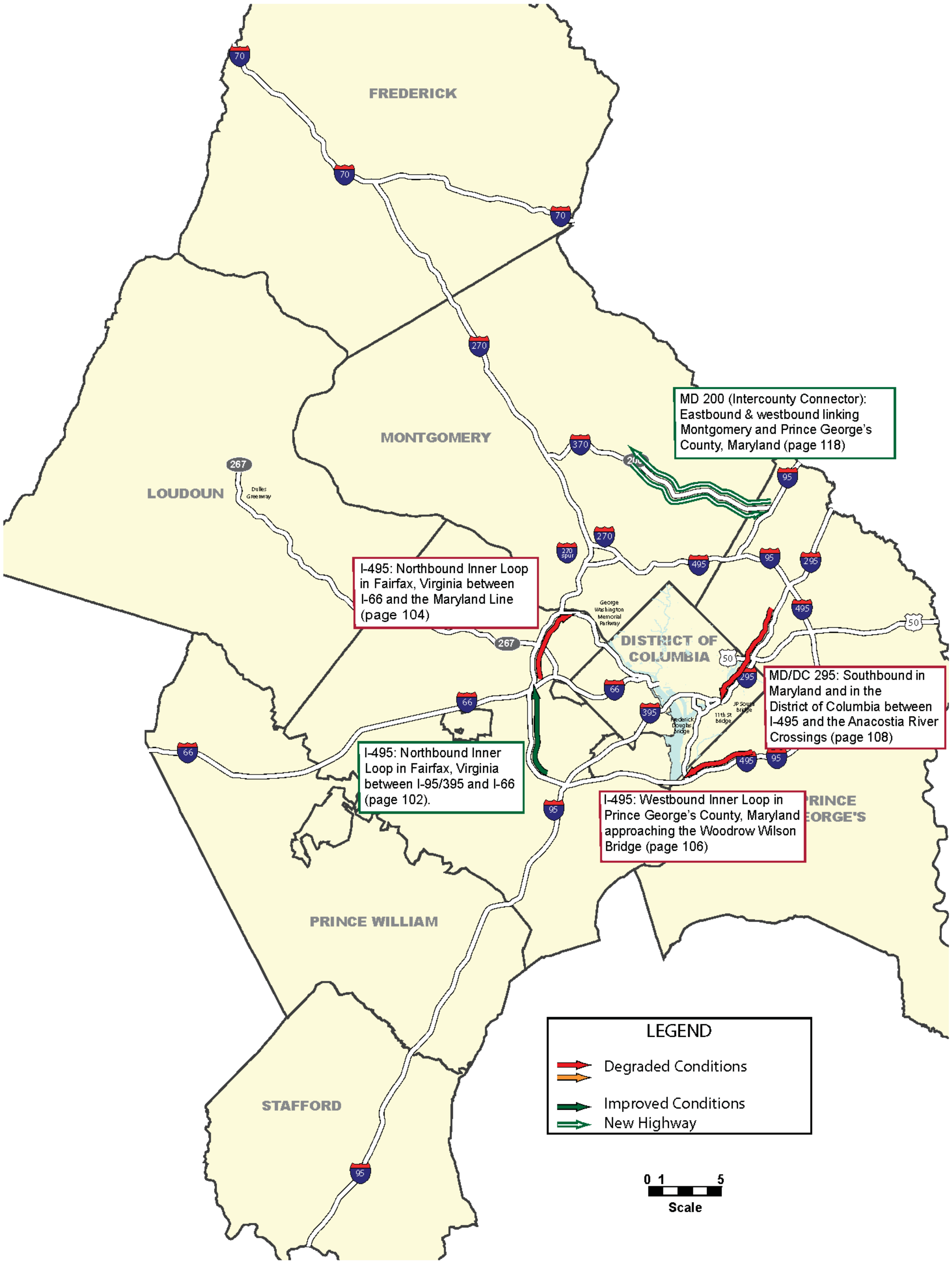
Morning / I-495 (Beltway): Traffic congestion on the northwest west side of the Beltway (Inner Loop) traveling from Virginia into Maryland was more severe. One factor contributing to the degradation was the left-side merge associated with the termination of the Express Lanes downstream of VA 267. Another significant increase in congestion on the Beltway was renewed congestion on the Inner Loop in Maryland approaching to the rebuilt Woodrow Wilson Bridge; however, the level of services showed less severe congestion in 2014 vs. 2008 levels. Congestion was not found along this section of the Inner Loop during the 2011 aerial survey.

Morning / MD-295, DC-295: A significant decrease in levels of service was found in the southbound direction on DC/MD-295 between Bladensburg and the Anacostia River crossing at Pennsylvania Ave. Improved flow along this section of DC-295 was documented in the 2011 report (attributed to completed construction improvement projects); the 2014 findings show the return of level-of-service F conditions for each of the 3-hours surveyed.

Evening / I-495 (Beltway): A new zone of congestion was found on the outer loop of the Beltway in Prince George's County, Maryland. After crossing into Maryland on the Woodrow Wilson Bridge, traffic flowed freely until encountering congestion in the vicinity of St Barnabas Rd; congestion typically persisted 4-6 miles downstream to MD-4 (Pennsylvania Ave).

Evening / I-95 Virginia: A significant degradation of level of service on I-95 in Virginia was documented during the evening surveys in 2014. This may have been partly attributable to a construction zone where the Express Lanes were being extended from Dumfries Blvd. to Garrisonville Rd. (approximately 10 miles); while all lanes were open during the evening commuter period, the presence of Jersey Barriers may have exacerbated the congestion. Farther south in Stafford County, recurring congestion on the approach to the Rappahannock River increased in both severity and extent since the 2011 survey.

Figure 2-26 Significant Changes (2018-2014) – Morning Peak Period



MD 200 (Intercounty Connector): Eastbound & westbound linking Montgomery and Prince George's County, Maryland (page 118)

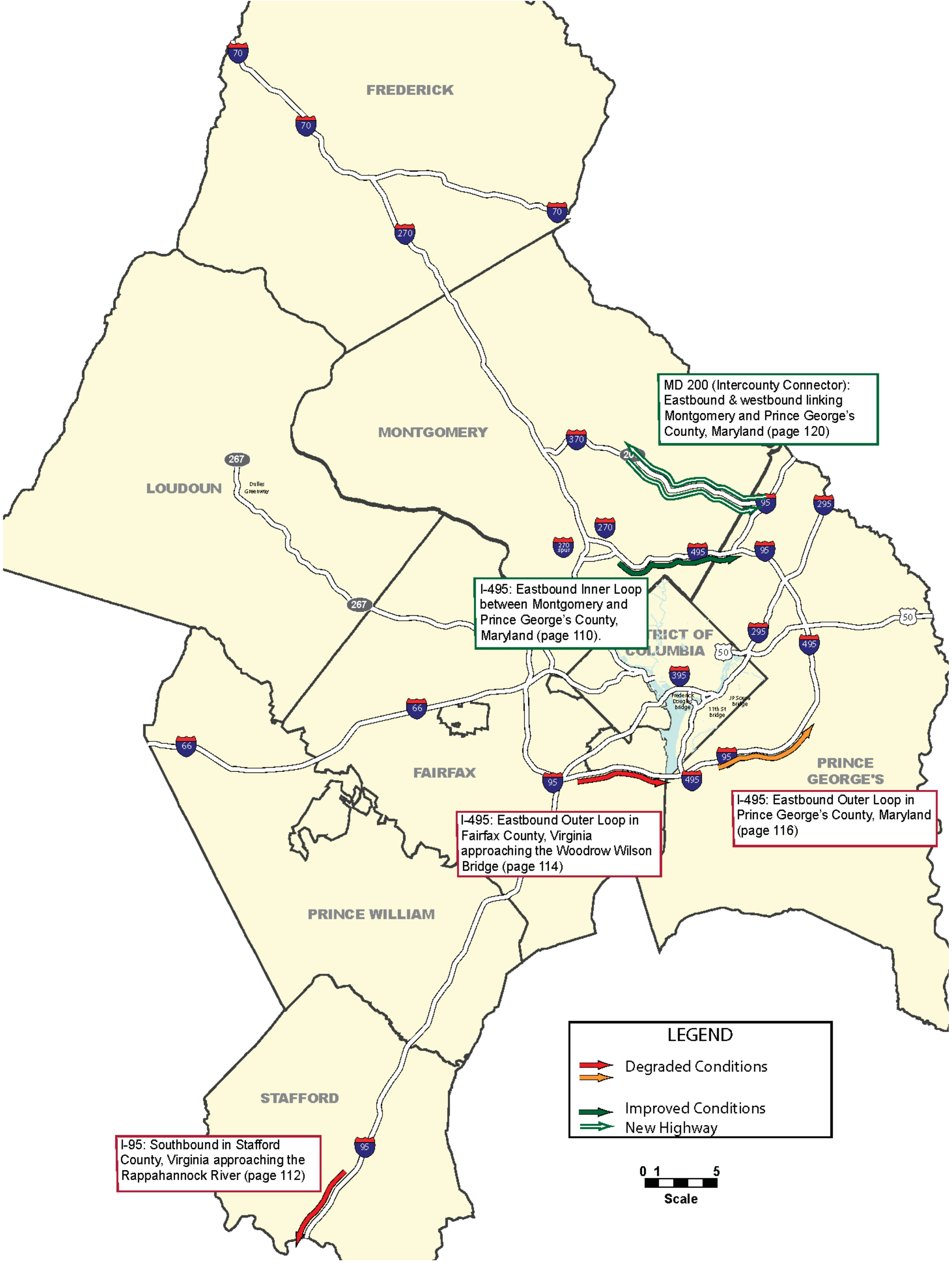
I-495: Northbound Inner Loop in Fairfax, Virginia between I-66 and the Maryland Line (page 104)

MD/DC 295: Southbound in Maryland and in the District of Columbia between I-495 and the Anacostia River Crossings (page 108)

I-495: Northbound Inner Loop in Fairfax, Virginia between I-95/395 and I-66 (page 102).

I-495: Westbound Inner Loop in Prince George's County, Maryland approaching the Woodrow Wilson Bridge (page 106)

Figure 2-27 Significant Changes (2008-2014) – Evening Peak Period



MD 200 (Intercounty Connector): Eastbound & westbound linking Montgomery and Prince George's County, Maryland (page 120)

I-495: Eastbound Inner Loop between Montgomery and Prince George's County, Maryland (page 110).

I-495: Eastbound Outer Loop in Prince George's County, Maryland (page 116)

I-495: Eastbound Outer Loop in Fairfax County, Virginia approaching the Woodrow Wilson Bridge (page 114)

I-95: Southbound in Stafford County, Virginia approaching the Rappahannock River (page 112)

2.2.2.4. Summary Congestion Maps of the Spring 2014 Survey

The summary maps of the AM and PM congestion of the Spring 2014 Survey are provided in Figure 2-28 and Figure 2-29.

Figure 2-28 Morning Peak Period Regional Congestion - Spring 2014

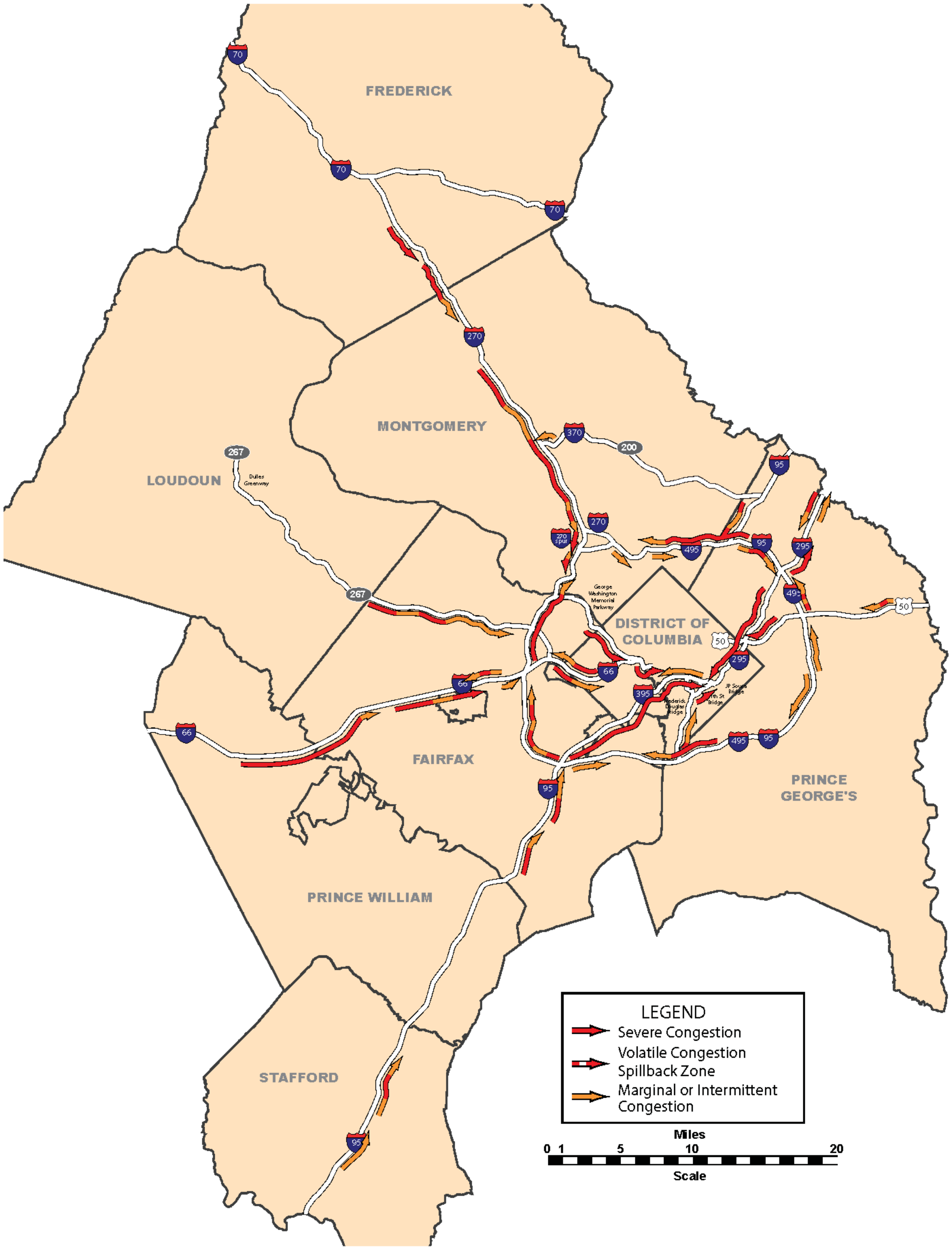
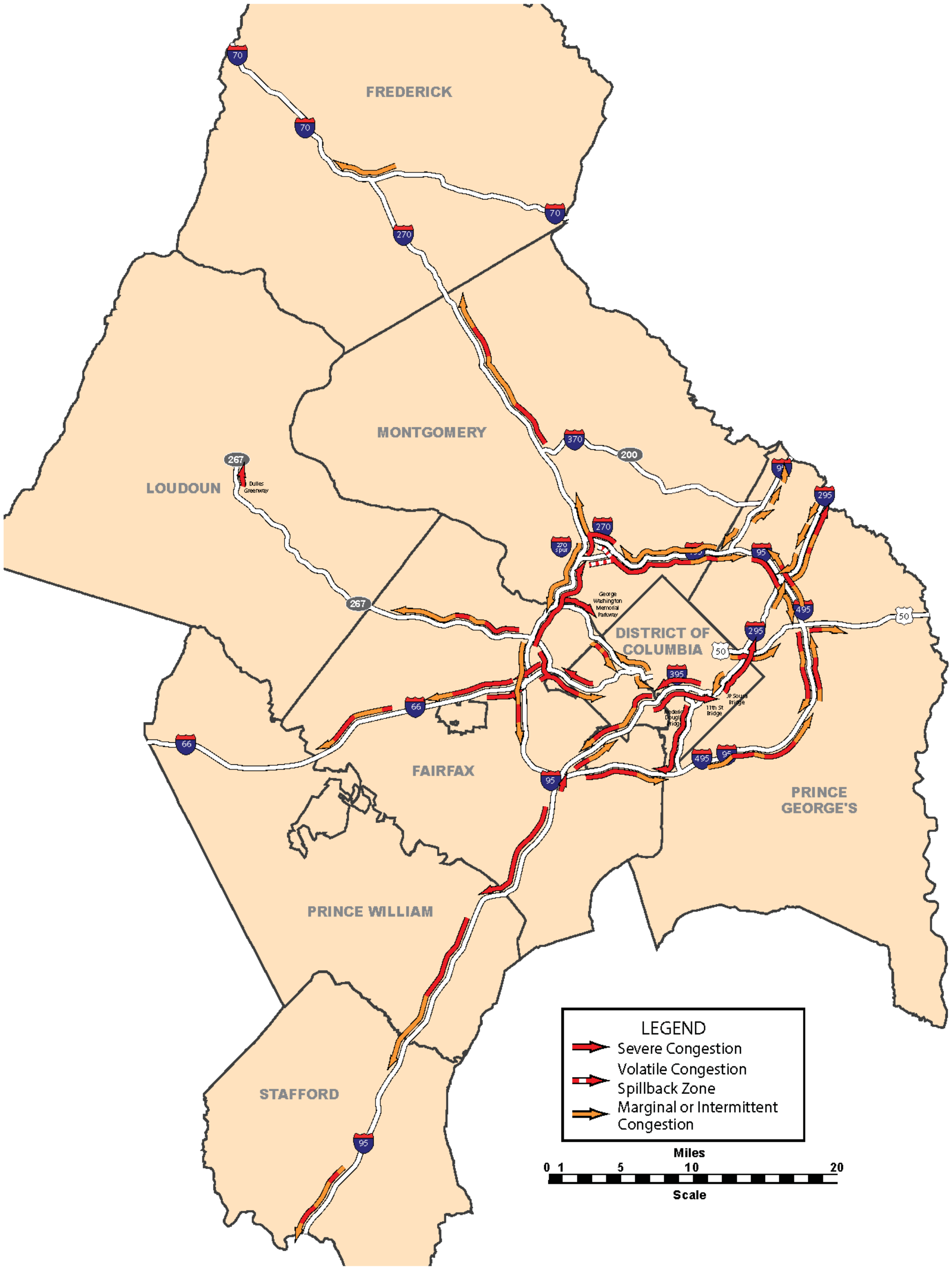


Figure 2-29 Evening Peak Period Regional Congestion – Spring 2014



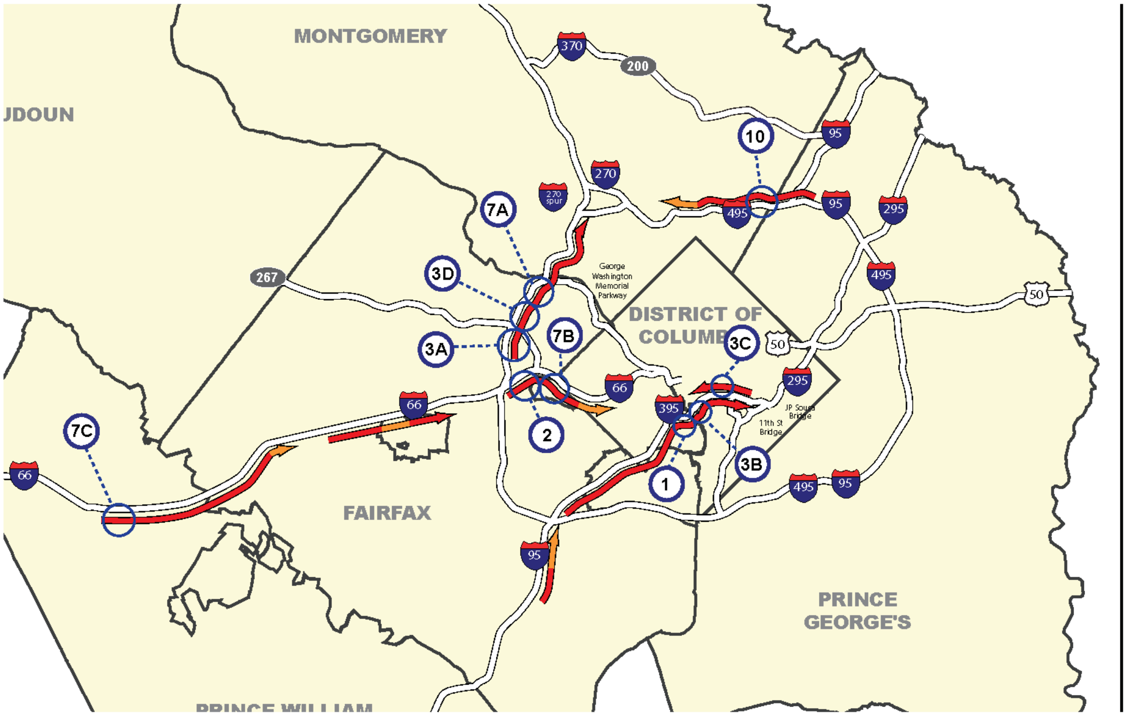
2.2.2.5. Top 10 Congested Locations in the Spring 2014 Survey

Figure 2-30 maps and lists the most congested locations on the region's freeway system. These locations were obtained by ranking the densities of all segments and picking the top ten irrespective of whether they are congested during the AM or PM peak period.

Figure 2-30 Top Ten Congested Locations – Spring 2014

Criteria for the top ten congested locations are as follows:

- A location is defined as a congested freeway segment, by direction, between interchanges; this congested location is typically within a larger queue.
- Rankings for the top ten are based on the average hourly density value which corresponds to a speed (see table below).
- Construction-related congestion was not included in the rankings unless the location was historically congested in the absence of construction.
- Congestion caused by traffic signals was not included in the rankings.



Top Ten Congested Segments on the Freeway System (2014)

Rank	Route	From	To	Density	Speed Range
1	NB I-395 (8:30-9:30 AM)	VA 27 (Washinton Blvd)	VA 110 (Jefferson Davis Hwy)	150	5 MPH
2	EB I-66 (6:00-7:00 PM)	VA 7 (Leesburgh Pike)	VA 267	140	5 MPH
3A	Inner Loop I-495 (4:30-5:30 PM)	VA 123 (Chain Bridge Rd)	VA 267	120	5-10 MPH
3B	NB I-395 (8:30-9:30 AM)	VA 110 (Jefferson Davis Hwy)	George Washington Memorial Pkwy	120	5-10 MPH
3C	SB I-395 (5:00-6:00 PM)	4th St	12th St	120	5-10 MPH
3D	Inner Loop I-495 (4:30-5:30 PM)	VA 267	VA 193 (Georgetown Pike)	120	5-10 MPH
7A	Inner Loop I-495 (5:30-6:30 PM)	VA 193 (Georgetown Pike)	George Washington Memorial Pkwy	110	10-15 MPH
7B	EB I-66 (6:00-7:00 PM)	VA 267	Westmoreland St	110	10-15 MPH
7C	EB I-66 (6:00-7:00 AM)	VA 234 Bypass	VA 234 (Sudley Rd)	110	10-15 MPH
10	Outer Loop I-495 (7:00-8:00 AM)	MD 650 (New Hampshire Ave)	MD 193 (University Ave)	105	10-15 MPH

Note: Due to construction at the terminus of the Southeast Freeway, eastbound densities along this corridor were not included in the Top Ten list above.

2.2.2.6. Longest Delay Corridors in the Spring 2014 Survey

Beginning in 2008, the freeway aerial survey introduced a new metric – Longest Delay Corridors. The purpose of this metric was to identify corridors which might not have bottlenecks in the “Top Ten Congested Locations” but were long congested corridors. Delay was calculated by estimating the additional travel time during congested conditions over the free flow travel time. Free flow speed was assumed to be 60 mph. Figure 2-31 and Figure 2-32 present the top five congested corridors in the AM and PM peak period.

Figure 2-31 Longest Delay Corridors - Morning Peak Period (Spring 2014)

Site Name	Road Name	Time	Direction	From	To	Queue Length (miles)	Estimated Travel Time (minutes)	Estimated Speed (mph)	Estimated Delay (minutes)
Site #1	I-66	7:30 – 8:30	Eastbound	US 29 (Lee Highway)	VA 243 (Nutley St)	18.8	43.3	26	24.5
Site #2	I-95 / I-395	7:00 – 8:00	Northbound	US 1 (Richmond Highway)	George Washington Parkway	18.0	38.2	28	20.2
Site #3	I-495	7:00 – 8:00	Outerloop	I-95	MD 185 (Connectiucut Ave)	7.0	21.7	19	14.7
Site #4	DC 295	8:00 – 9:00	Southbound	MD 450 (Annapolis Rd)	MD 4 (Pennsylvania Ave)	5.7	19.9	17	14.2
Site #5	I-270	7:30 – 8:30	Southbound	Father Hurley Blvd	I-270 Western Spur	13.1	24.6	32	11.5

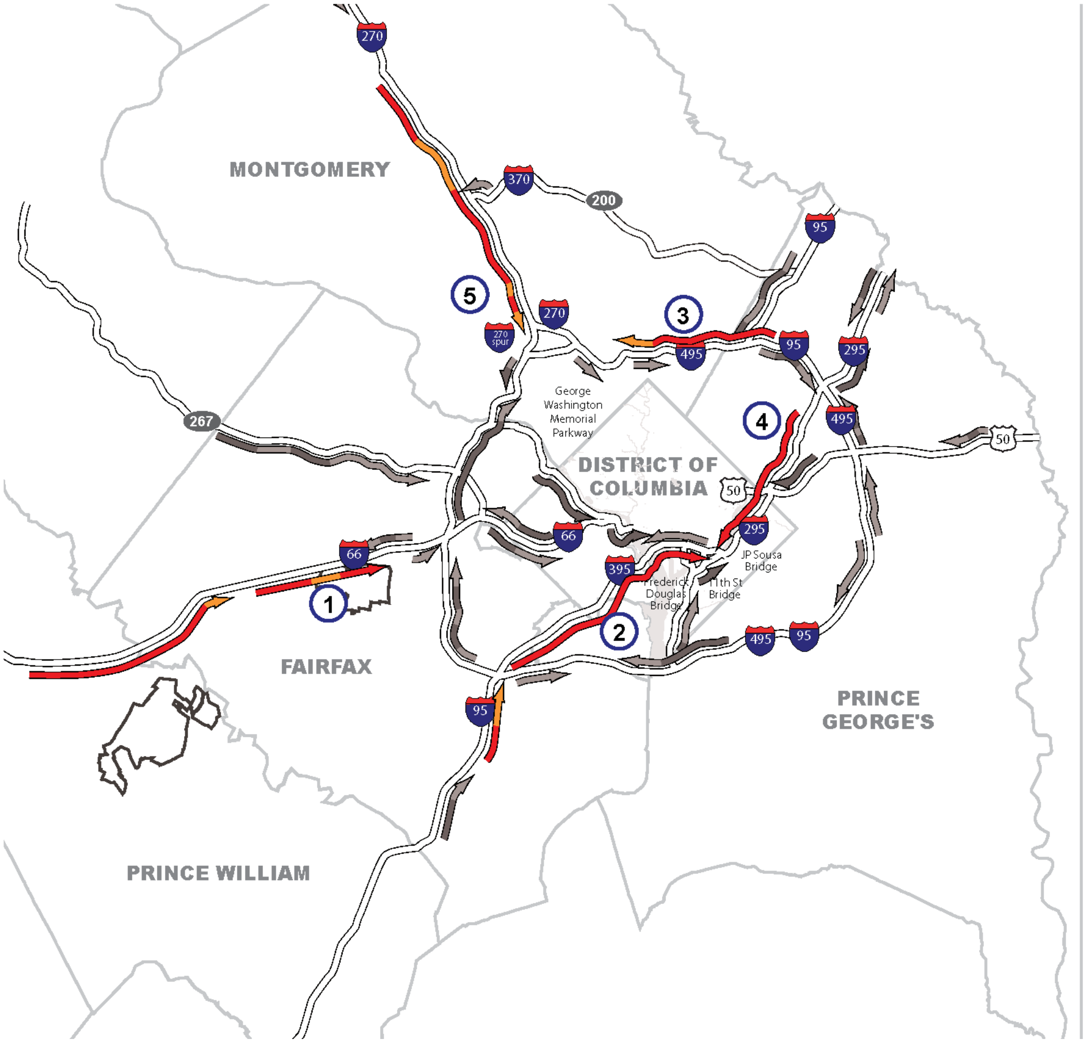
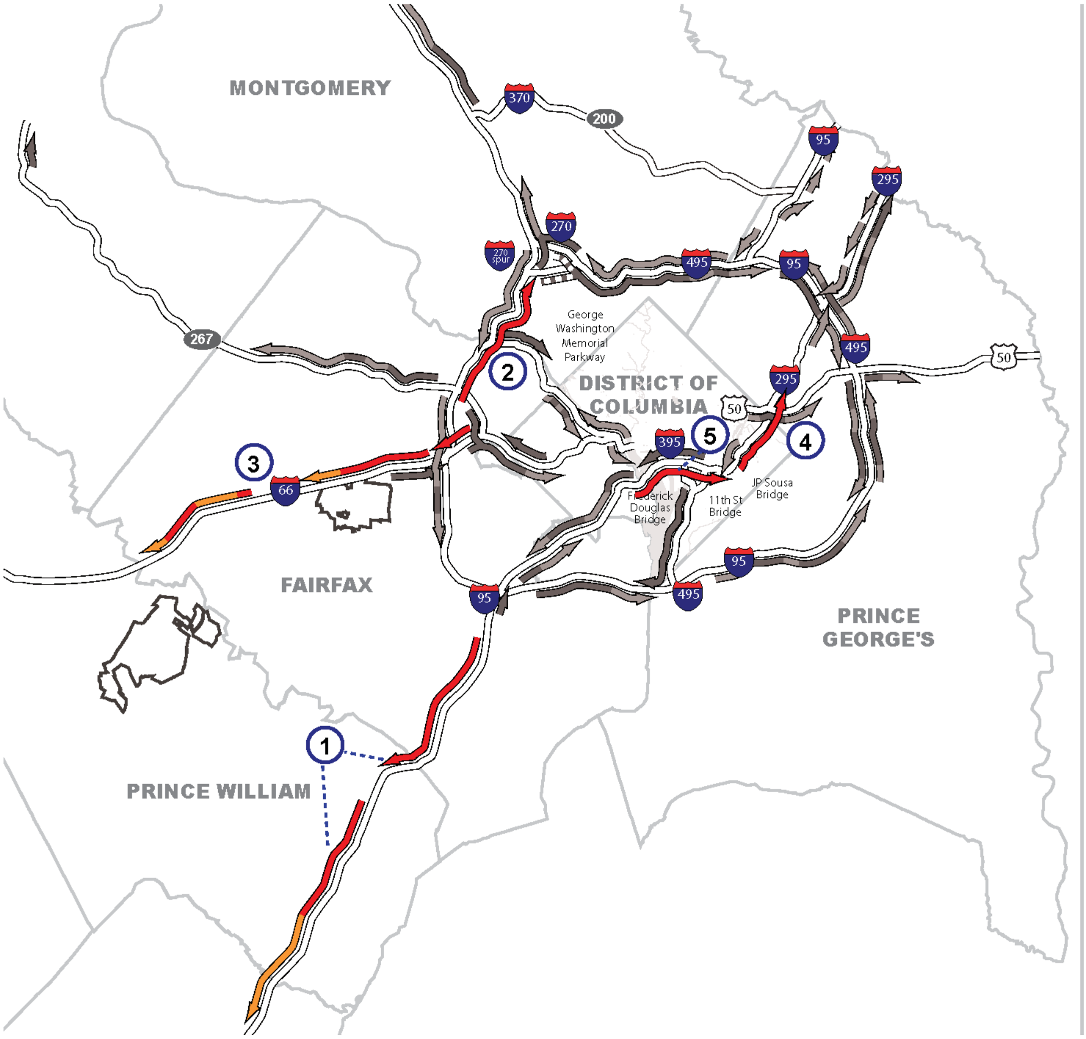


Figure 2-32 Longest Delay Corridors - Evening Peak Period (Spring 2014)

Site Name	Road Name	Time	Direction	From	To	Queue Length (miles)	Estimated Travel Time (minutes)	Estimated Speed (mph)	Estimated Delay (minutes)
Site #1	I-95	4:30 – 5:30	Southbound	Fairfax County Parkway	Garrisonvile Rd	23.0	51.5	27	28.5
Site #2	I-495	4:30 – 5:30	Innerloop	VA 7(Leesburg Pike)	I-270 Western Spur	8.4	35.1	14	26.7
Site #3	I-66	4:30 – 5:30	Westbound	VA 7 (Leesburg Pike)	VA 234 (Sudley Rd)	18.3	36.6	30	18.3
Site #4	DC 295	4:30 – 5:30	Northbound	11th Street Bridge	US 50	5.0	19.3	16	14.3
Site #5	I-395	5:00 – 6:00	Northbound	VA 110 (Jeff. Davis Hwy)	11th Street Bridge	3.7	17.5	13	13.8



2.2.3. ARTERIAL FLOATING CAR TRAVEL TIME STUDY

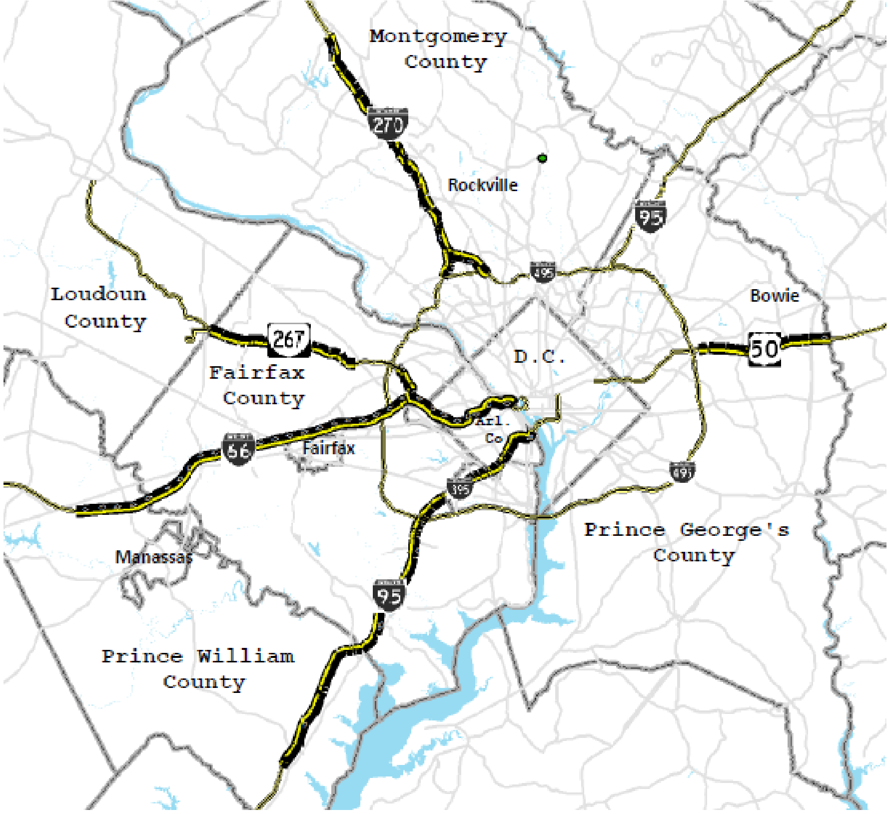
Before the existence of private sector probe-based traffic data, the TPB carried out Arterial Floating Car Travel Time Studies from 2000 – 2011 on selected NHS arterial highways in the region. Staff gathered data regarding travel time, speed, and delay using Geographic Positioning System (GPS) technology, with data collection occurring in three-year cycles (e.g., 2005 routes repeated in 2008 and 2011, etc.). Data were collected between the hours of 1:00 PM and 8:00 PM, on Tuesdays, Wednesdays and Thursdays, avoiding public holidays or the day after a public holiday. By 2011 the last year of this type of survey, 57 major arterial highway routes in the District of Columbia, Maryland, and Virginia, totaling 430 centerline miles were monitored. The level of service (LOS) was used to characterize the extent of congestion during the PM peak hour, PM peak period and PM off-peak period of travel[19]. Summary of the 2008-2011 studies can be found in the *2010 Congestion Management Process (CMP) Technical Report* and the *2012 Congestion Management Process (CMP) Technical Report.* In 2014, there are no plans to repeat or continue the Arterial Floating Car Travel Time Study as the I-95 VPP traffic monitoring covers the vast majority of arterials in the region with unprecedented spatial and temporal granularity.

2.2.4. HOV FACILITY SURVEYS

High occupancy vehicle (HOV) facilities are designed to offer several advantages over conventional lanes and roads, including the increase of person throughput during peak periods. In the Washington area, there are five high occupancy vehicle (HOV) facilities on highways functionally classified as freeways (Figure 2-33). These are:

- I-95/I-395 in the Northern Virginia counties of Prince William, Fairfax and Arlington, and the City of Alexandria (before conversion to I-95 Express Lanes);
- I-66, also in the Virginia counties of Prince William, Fairfax and Arlington (this HOV system includes a section of the Dulles Connector in McLean, connecting to VA 267's HOV lanes (see below));
- I-270 and the I-270 Spur in Montgomery County, Maryland;
- VA 267, connecting to I-66 via the Dulles Connector; and
- U.S. 50 in Prince George's County, Maryland.

Figure 2-33 HOV Facilities in the Washington Region (2014)



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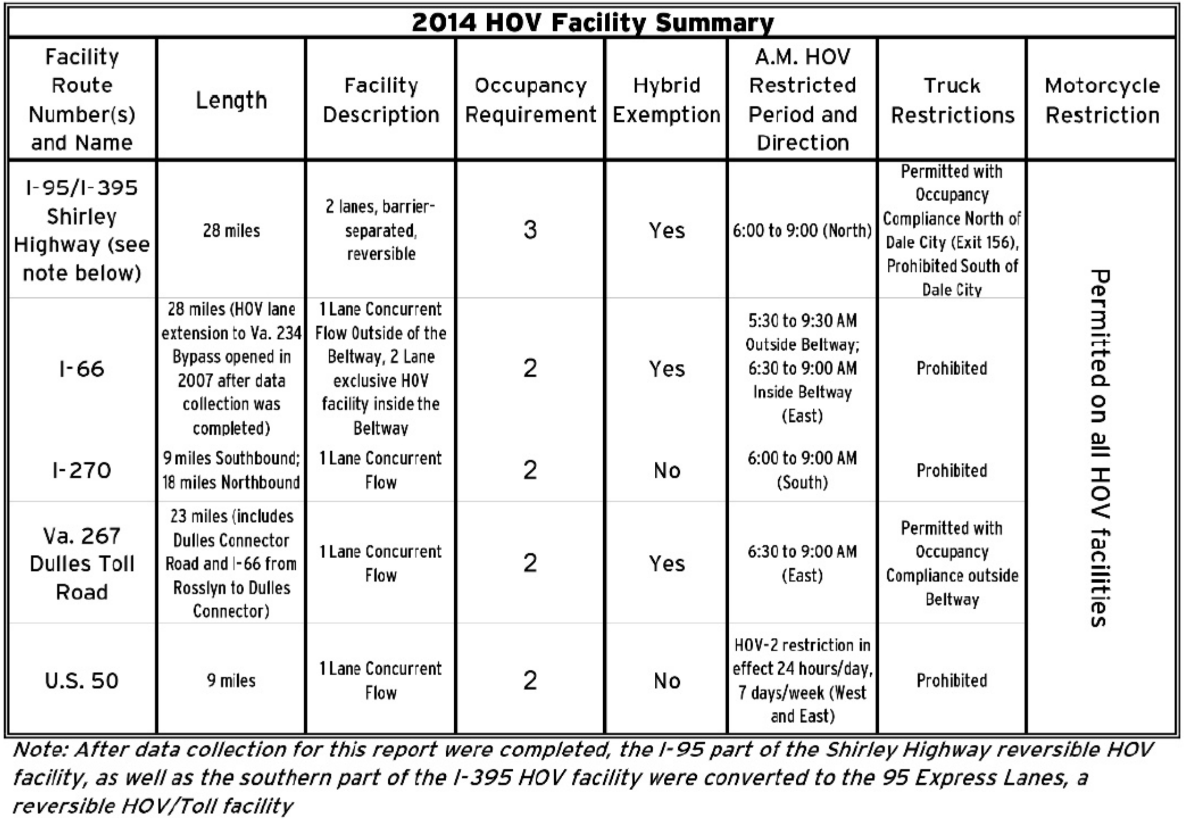
[19] PM peak hour is 5:00-6:00 pm, PM peak period is 4:00-7:00 pm, and PM off-peak period is 1:00-4:00 pm and 7:00 – 8:00 pm.

The I-95/I-395 and I-66 HOV facilities provide direct access to core employment centers of the region in Arlington County and the District of Columbia. I-270 and the I-270 Spur end at the Capital Beltway (I-495) and the U.S. 50 HOV lanes end just prior to the Beltway. VA 267's HOV system connects directly to I-66, providing access to the regional core from the Dulles Toll Road Corridor. There are arterial HOV lanes and bus only shoulder treatments in the region, but these facilities are beyond the scope of this study. More detailed information about the HOV facilities is provided in Table 2-7.

Table 2-7 2014 HOV Facility Summary



2014 HOV Facility Summary

Facility Route Number(s) and Name	Length	Facility Description	Occupancy Requirement	Hybrid Exemption	A.M. HOV Restricted Period and Direction	Truck Restrictions	Motorcycle Restriction
I-95/I-395 Shirley Highway (see note below)	28 miles	2 lanes, barrier-separated, reversible	3	Yes	6:00 to 9:00 (North)	Permitted with Occupancy Compliance North of Dale City (Exit 156), Prohibited South of Dale City	Permitted on all HOV facilities
I-66	28 miles (HOV lane extension to Va. 234 Bypass opened in 2007 after data collection was completed)	1 Lane Concurrent Flow Outside of the Beltway, 2 Lane exclusive HOV facility inside the Beltway	2	Yes	5:30 to 9:30 AM Outside Beltway; 6:30 to 9:00 AM Inside Beltway (East)	Prohibited	
I-270	9 miles Southbound; 18 miles Northbound	1 Lane Concurrent Flow	2	No	6:00 to 9:00 AM (South)	Prohibited	
Va. 267 Dulles Toll Road	23 miles (includes Dulles Connector Road and I-66 from Rosslyn to Dulles Connector)	1 Lane Concurrent Flow	2	Yes	6:30 to 9:00 AM (East)	Permitted with Occupancy Compliance outside Beltway	
U.S. 50	9 miles	1 Lane Concurrent Flow	2	No	HOV-2 restriction in effect 24 hours/day, 7 days/week (West and East)	Prohibited	

Note: After data collection for this report were completed, the I-95 part of the Shirley Highway reversible HOV facility, as well as the southern part of the I-395 HOV facility were converted to the 95 Express Lanes, a reversible HOV/Toll facility

COG/TPB has conducted surveys on the HOV system in 1997, 1998, 1999, 2004, 2007, 2010 and 2014. Some highlights of the most recent 2014 survey[20] were summarized below; more information can be found in Appendix D.

- All of the HOV lanes in spring 2014 were observed to carry more persons per lane during the HOV restricted periods than adjacent non-HOV lanes except on US 50;
- Most of the HOV lanes provide savings in travel times when compared to non-HOV alternatives, especially the barrier separated HOV lanes in the I-95/I-395 corridor in Northern Virginia;
- However, the performance of the concurrent-flow HOV lanes in the I-66 lanes (outside I-495) and along I-270 were at certain points between 10 and 25 MPH slower than adjacent non-HOV lanes, as well as sections of the exclusive I-66 HOV facility inside I-495 (staff examined data from the Vehicle Probe Project (VPP) and found recurring congestion along I-66 eastbound

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[20] *2014 Performance of High-Occupancy Vehicle Facilities on Freeways in the Washington Region*, October 2015. http://www.mwcog.org/uploads/committee-documents/bVxfWIZf20151013093838.pdf

from the Dulles Connector Road to a point between Sycamore Street and Va. 120 [North Glebe Road]); and

- Average auto occupancy in 2014 was little-changed from 2010, even though the HOV lanes in Northern Virginia continue to exempt vehicles with “Clean Air” registration plates from the HOV requirement.

HOV facilities are designed to provide faster travel times and more predictable speeds than parallel non-HOV facilities, which was the general conclusion of this study. It is clear that while HOV facilities aid in improving the operation of the region’s roadways, they can also influence traveler behavior and manage the demand of single-occupant travel.

In addition to the HOV facilities, the Washington region also operates three other managed facilities: the Inter-County Connector (MD 200) in Maryland, the I-495 Express Lanes on the Virginia side of the Capital Beltway, and the I-95 Express Lanes[21] in Virginia. Future congestion monitoring activities should also include these facilities.

2.2.5. AIRPORT GROUND ACCESS TRAVEL TIME STUDIES

The transportation linkage between airports and local activities is a critical component of the transportation system. The Washington region has two major airports – Ronald Reagan Washington National Airport (DCA) in Arlington, VA, and Washington Dulles International Airport (IAD) in Loudoun County, VA. The region is also served by the nearby Baltimore/Washington International Thurgood Marshall Airport (BWI) (Figure 2-34). The majority (92%) of those traveling to the region’s airports does so via the highway network (i.e. personal cars, rental cars, taxis, buses)[22]. Therefore, understanding ground airport access is important to congestion management for two primary reasons:

- Choice of airport to use and even the decision to fly in general can be based on the quality, cost, and travel time associated with the ground journey to the airport. Traffic conditions can have an impact on these decisions.

- Understanding airport ground access provides a basis for understanding overall congestion on major roadways at peak travel times.

    - Studying airport ground access can provide information on traffic patterns that may have not otherwise been considered, in particular the relationship between travel times and distances. For example, a study can examine and compare trips across the region (e.g. from Maryland to IAD), or shorter trips where the origin and destination are close together.

    - Passengers using the airports may be non-residents of the Washington region, so this airport access information can give us information on trips originating elsewhere.

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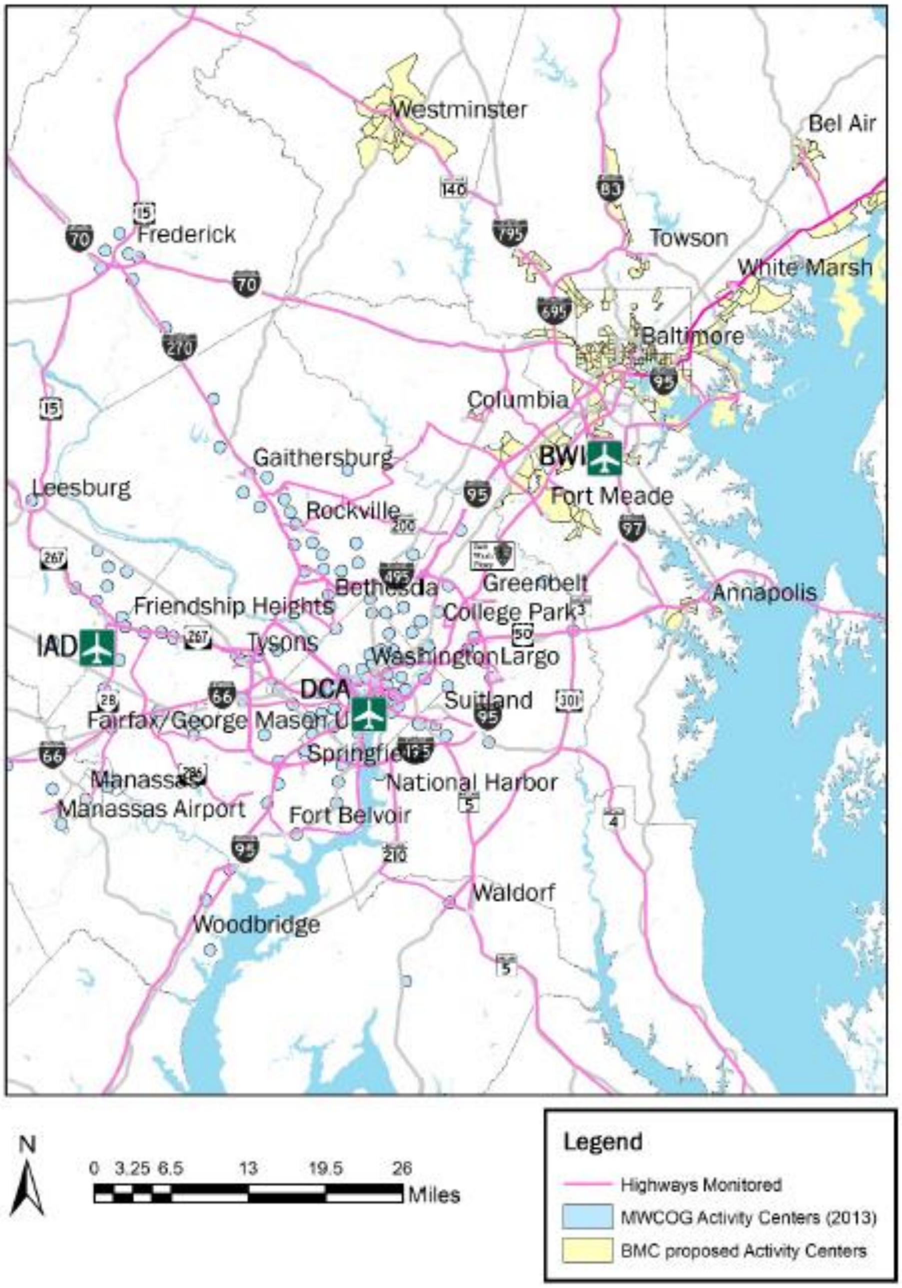
[21] Virginia Mega Projects, 95 Express Lanes, http://www.vamegaprojects.com/about-megaprojects/i-95-hov-hot-lanes/

[22] *2013 Washington-Baltimore Regional Air Passenger Survey Data Editing Process,* 2014-01-23 Aviation Technical Subcommittee: http://www.mwcog.org/uploads/committee-documents/b11ZXVpf20140131093313.pdf

Figure 2-34 Regional Airports and Highways Monitored in the 2015 Study



The region's Continuous Airport System Planning (CASP) program has so far conducted a total of five Regional Airport Ground Access Travel Time Studies in 1988, 1994, 2003[23], 2011[24] and 2015[25].

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[23] Abdurahman Mohammed, Washington-Baltimore Regional Airport 2003 Ground Access Travel Time Study Update, September 2004. http://www.mwcog.org/uploads/committee-documents/tFlcVIY20060622150454.pdf

[24] MWCOG/NCRTPB: 2011 Washington - Baltimore Regional Airport Ground Access Travel Time Study. http://www.mwcog.org/uploads/committee-documents/aF1eXlZW20120113141801.pdf

[25] C. Patrick Zilliacus and Richard Roisman, 2015 Washington-Baltimore Regional Airport Ground Access Travel Time Study, Draft. http://www.mwcog.org/uploads/committee-documents/ZlxeV1ha20160401084328.pdf

The latest (2015) study had important new features compared to previous ones. For the first time, highway travel between the three regional airports was also analyzed; previous studies only looked at highway travel to/from individual airport. Also for the first time, no field data collection was performed and only vehicle probe data from the I-95 Corridor Coalition Vehicle Project was used.

The 2015 study compared to two one-year periods: 2011/2012 (September 1, 2011 to August 31, 2012) and 2014/2015 (September 1, 2014 to August 31, 2015). Each of these days were classed as a midweek day (Tuesdays, Wednesdays, Thursdays), weekend day (Friday, Saturday, Sunday, Monday) or holiday (both secular holidays such as Independence Day and religious holidays such as Easter, Passover and Eid al-Fitr were categorized as holidays – if a day was classed as a holiday, it was excluded from midweek or weekend analysis).

The 2015 study findings include:

- In aggregate, travel times to the airports, as measured by Travel Time Index (TTI) has not changed substantially from the 2011/2012 period to 2014/2015.

- In aggregate, the highest TTI was observed for travel to Reagan National Airport (DCA) during the midweek morning peak period (6 A.M. to 9 A.M.). The highest TTI to Thurgood Marshall BWI airport was observed during weekday afternoon peak period (3 P.M. to 7 P.M.). Travel to Washington Dulles International Airport (IAD) was also during midweek morning peak, though not as high as to DCA.

- Use of new managed lanes that have opened since 2010 and certain HOV lanes can save time for travelers using the highway network to reach the airports. The highest travel time savings were observed for trips from Fredericksburg to IAD, at 25 minutes, using the 95 Express and 495 Express lanes in the midweek morning peak period. Travel from Rockville to BWI saved about 20 minutes by using MD-200 (Inter-County Connector) instead of I-270 and I-495.

- It is possible to reach all three airports by transit. Transit travel times ranged from about 16 minutes to reach DCA from downtown Washington, D.C. via Metrorail; 30 to 50 minutes from downtown Baltimore to BWI; to between 2 hours and 20 minutes and 3 hours and 30 minutes to reach the airports by way of transit from origins in Charles and St. Mary's Counties in Southern Maryland and Hagerstown, Washington County, Maryland.

- Congested highways continue to be a problem for travel to and between the three airports.

- Some of the more-congested parts of the Baltimore and Washington highway networks include Outer Loop of I-695 (Baltimore Beltway), both loops of I-495 (Capital Beltway) in Montgomery County and Fairfax County; I-270 and I-270 Spur in Montgomery County; the Baltimore-Washington Parkway in Anne Arundel County and Prince George's County; U.S. 50 (John Hanson Highway) in Prince George's County; the conventional lanes of I-95 in Prince William County; the conventional lanes of I-395 in Fairfax County, City of Alexandria and Arlington County; I-66 in Fairfax and Prince William Counties, DC-295, I-695 and I-395 in the District of Columbia.

2.2.6. FREIGHT MOVEMENT AND CONGESTION

In addition to congestion's impacts on person movement, congestion in and around major metropolitan regions such as Washington significantly impacts freight movements. While freight movements by other modes are not generally affected to the degree that trucks are by surface transportation congestion, the Washington region is also subject to freight rail bottlenecks and congestion.

Traffic congestion on the region's highways and arterials slows freight deliveries and impacts shippers and consumers. Shippers continually adjust their operations in response to congested conditions. Impacts of increased congestion to the freight industry include:

- A shrinking of the delivery area that one driver and vehicle can serve, causing firms to add smaller and more numerous trucks to their fleets to serve existing customers;
- A decrease in the size of the area that can be served from any given distribution facility, impacting the size, number, and dispersion of distribution facilities in the region;
- An increase in the proportion of deliveries scheduled for the very early morning due to increasing afternoon congestion;
- A decrease in delivery reliability, causing firms to increase "on hand" or "just in case" inventory, thereby eroding the economic efficiencies associated with just-in-time inventory systems; and
- An increase in shipper operating costs (time and fuel) which are eventually passed on to consumers.

According to MWCOG analysis of FHWA Freight Analysis Framework data (FAF), approximately 379 million tons of goods worth over $604 billion are transported to, from, within, and through the National Capital Region annually. Approximately 80 percent of this freight movement (by weight) is by truck. It is therefore critical for freight movement to be considered as part of regional and local transportation and land use planning activities.

Employment in the professional and business services, trade and transportation, federal government, and state and local government sectors drives the economy of the Washington region. Because the regional economy is service-based, the region is primarily a consumer rather than a producer of goods. Consumers depend upon trucks to deliver needed goods. This demand puts pressure on the regional surface transportation system as trucks maneuver across the transportation network to make their deliveries on time.

Both national and regional freight forecasts predict significant growth in freight tonnage and value across most transportation modes. Trucks are more flexible than trains, ships, or airplanes; operate on a broader transportation network than any other mode; and are usually required to haul goods shipped by other modes to their final destination. Because of this, trucks will capture much of the projected growth in the freight market. According FAF, the Washington metropolitan region is projected to see the amount of tonnage moving to, from, and within the region increase by 44% and the corresponding value to increase by 146% by 2040.

The Panama Canal Expansion was completed in 2016. Much larger "Post-Panamax" ships from Asia are now able to serve some East Coast ports, including the port facilities in Baltimore and the Hampton Roads, Virginia area. Over time, some portion of container traffic between Asia and the United States will likely shift from West Coast to East Coast ports. This would alter trucking routes by reducing the demand for long hauls from the West Coast and increasing demand for regional hauls on the East Coast. Some portion of these new truck hauls will likely pass through the National Capital Region more freight is moved between East Coast ports and inland destinations.

COG/TPB has established a Freight Program with a Freight Subcommittee as a major component of this program. The Freight Subcommittee provides a forum for discussion of freight issues and concerns within the Metropolitan Washington Region. This gives freight stakeholders the opportunity to share concerns and information with the TPB and other decision-makers. The Freight Subcommittee meets regularly to share information and interact with special guest speakers.

Trucks impact congestion and compete for limited space on roadways in congested corridors. Similarly, competition for curb space along streets in urban environments for goods delivery is also a challenge. Discussions with freight movement stakeholders revealed that they are already going to great lengths to schedule deliveries at off-peak hours or to move goods by rail where practicable and economically feasible. Full consideration of non-highway means of freight movement will be continued. However, the projected robust growth in all modes ensures that trucks will remain a major presence on the region's roadways.

Freight congestion is concentrated in urban areas and is most apparent at bottlenecks on highways - especially those serving major international gateways, major domestic freight hubs, and in major urban areas where important national truck flows intersect congested urban areas. In fact, the American Transportation Research Institute (ATRI) ranked congestion in the Washington, DC metropolitan area as sixth in the nation in terms of its contribution to increased operating costs for the trucking industry (see Table 2-8 below).

Table 2-8 Cost of Congestion for Trucking by Metropolitan Area - 2015

Rank	Metropolitan Area	Cost to the Trucking Industry (millions of dollars)
1	New York-Newark-Jersey City, NY-NJ-PA	4,598.5
2	Chicago-Naperville-Elgin, IL-IN-WI	2,129.4
3	Miami-Fort Lauderdale-West Palm Beach, FL	2,089.0
4	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	1,612.4
5	Dallas-Fort Worth-Arlington, TX	1,309.9
6	**Washington-Arlington-Alexandria, DC-VA-MD-WV**	**1,294.4**
7	Los Angeles-Long Beach-Anaheim, CA	1,264.2
8	Houston-The Woodlands-Sugar Land, TX	1,157.4
9	Boston-Cambridge-Newton, MA-NH	1,041.3
10	Nashville-Davidson-Murfreesboro-Franklin, TN	957.8

Source: ATRI

Figure 2-35 shows truck percentages of total Annual Average Daily Traffic (AADT) on the region's freeway network[26]. The percentages are truck counts averaged from both directions. The congestion on the freeways is for the morning peak period conditions from the spring 2008 TPB aerial survey.

In 2013, the FHWA procured the National Performance Management Research Data Set (NPMRDS) from HERE, LLC[27]and the data can be used by MPOs and state DOTs to conduct performance analysis on the NHS. This data source contains valuable truck speeds information and could be a source for future freight movement analysis for this region.

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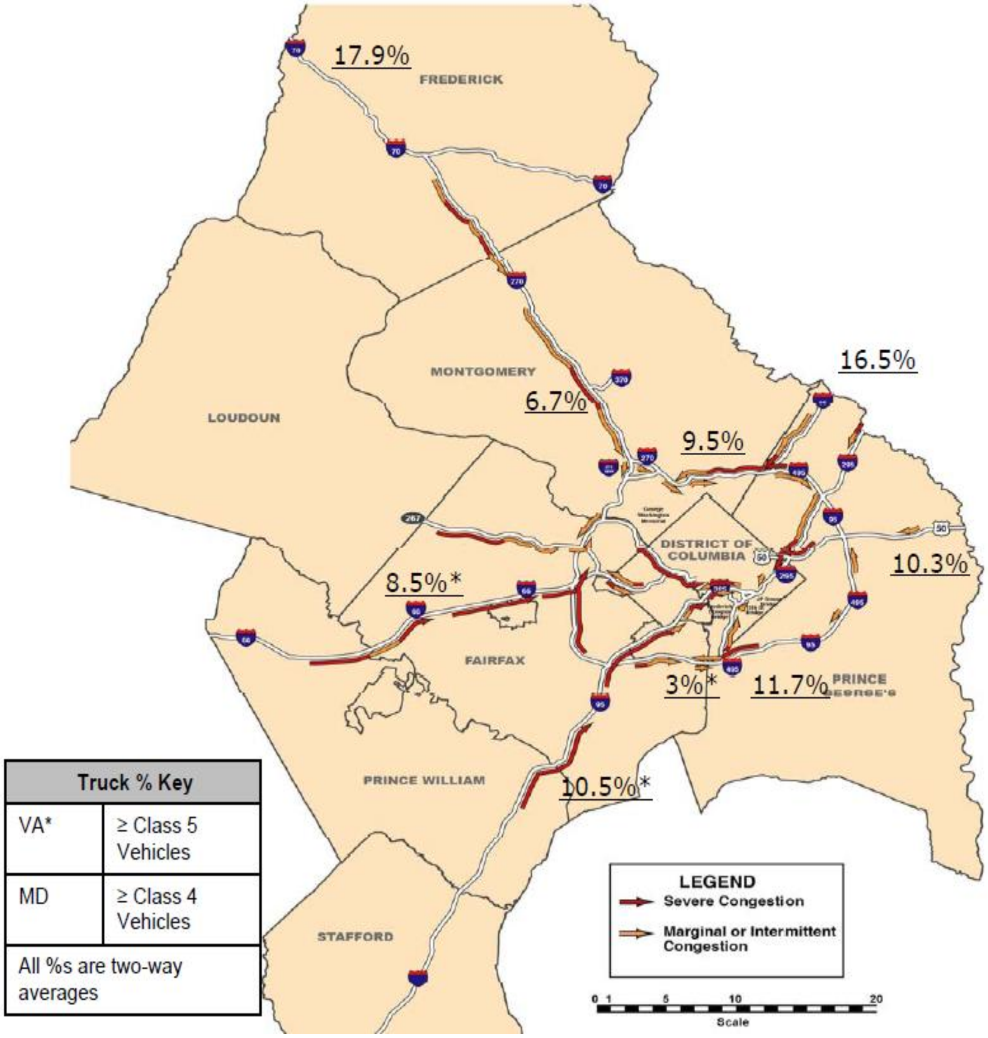
[26] *Integrated Freight Report*, July 2009. http://www.mwcog.org/uploads/committee-documents/kV5aXl1a20091020140842.pdf

[27] FHWA, National Performance Management Research Data Set (NPMRDS) Technical Frequently Asked Questions. http://www.ops.fhwa.dot.gov/freight/freight_analysis/perform_meas/vpds/npmrdsfaqs.htm

Figure 2-35 Percentages of Truck Counts on the Region's Morning Peak Period Network



2.2.7. TRAFFIC SIGNALS

2.2.7.1. Traffic Signal Timing Optimization

Delays occurred at signalized intersections accounted for a significant portion of overall arterial and urban street delays. Improving traffic signal timing has been identified as a CLRP priority area.

The TPB has conducted three surveys of the status of signal optimization in 2005[28], 2009[29], and 2013[30]. The 2013 survey found that of the total 5,500+ signalized intersections in the region, 76 percent were retimed/optimized, 22 percent not retimed/optimized, and no report received for 2 percent. This was a similar but slightly reduced level of optimization compared to the last such survey in 2009, in which 80 percent signals were retimed/optimized.

This result, however, should be interpreted within the context of the comments below: 1) Regional results overall held to a similar albeit lower level to that of three years ago, in the context of widespread budgetary belt-tightening by involved transportation agencies; it was anticipated that some upcoming anticipated investments will improve the regional picture; 2) DDOT had a five-year signal re-timing project. This included a phased approach, with the intent to touch all signals based on areas of concern. DDOT had also identified three corridors for possible deployment of an adaptive system; 3) signal optimization can help get an arterial closer to its design capacity but cannot increase capacity; 4) techniques are often combined; signals can be optimized using computer software followed by active field management for validation purposes; 5) active management is particularly useful to address non-recurring congestion caused by incidents and special events; and 6) signal equipment must be properly maintained for signal timing to be effective.

TPB member jurisdictions have been actively conducting signal timing optimizations, exploring and implementing the latest technologies to improve the operations of traffic signals. By the end of 2016, DDOT will complete a citywide signal optimization project that initiated in 2012 and will enhance the District's entire traffic signal network of more than 1,650 signals. The central goal of the optimization project is to make DC traffic signals safer and friendlier for pedestrians, improve bus running times, and reduce traffic congestion and vehicular traffic emissions. A project status update[31] in September 2015 found that more than 60% of the signalized intersections had been completed by that time, and the before-and-after studies showed significant improvements.

2.2.7.2. Transit Signal Priority

Under the TPB's Transportation Investments Generating Economic Recovery (TIGER) grant for Priority Bus Transit in the National Capital Region, in 2015 and 2016 WMATA, City of Alexandria and DDOT implemented Transit Signal Priority (TSP) at intersections along VA-7 (Leesburg Pike), the Van Dorn-Pentagon corridor, and in the District of Columbia.

On the VA-7 corridor, 25 TSP signals were installed in locations in Fairfax County, the City of Alexandria, and the City of Falls Church. A WMATA fleet of 8 Metrobuses was equipped with the onboard equipment and the project has been in operation since June 2015. The DDOT TSP Project was implemented at 195 locations throughout the District and has been in operation since December 2016. Onboard bus equipment was installed by WMATA on 116 Metrobuses. The City of Alexandria implemented TSP at

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[28] Andrew J. Meese, *Briefing on the Implementation of Traffic Signal Optimization in the Region*, a presentation to the TPB on November 10, 2005. http://www.mwcog.org/uploads/committee-documents/tVtXWIY20051110144208.pdf

[29] Edward D. Jones, *Status Report on Traffic Signal Optimization in the Washington Region*, a presentation to the TPB on March 11, 2009. http://www.mwcog.org/uploads/committee-documents/bV5cXFhc20090312161527.pdf

[30] Ling Li, *Briefing on Traffic Signal Timing/Optimization in the Washington Region*, a presentation to the TPB on February 19, 2014. http://www.mwcog.org/uploads/committee-documents/al1ZXFpb20140212133426.pdf

[31] A. Wasim Raja, *District of Columbia Traffic Signal Timing Optimization – Status Update*, a presentation to the TPB Technical Committee on September 4, 2015. http://www.mwcog.org/uploads/committee-documents/alxfXFlX20150904130354.pdf

nine locations along the Van Dorn-Pentagon corridor in July 2016. WMATA installed onboard equipment on 8 Metrobuses for this project.

The three implementing agencies as well as TPB continue to monitor the implementation and assess the effectiveness of the TIGER TSP projects. TPB contractors are completing a series of one-year after and two-year after reports to summarize the outcomes of the TIGER projects.

2.2.7.3. Traffic Signal Power Back-Up

Traffic signal power back-up systems are critical in the event of an emergency, particularly if the event involves a lack of power. Since late 2011, the TPB's Traffic Signal Subcommittee has conducted six regional surveys on traffic signals power back-up systems[32]. The last survey was conducted by June 30, 2015 and found that about 27% of the region's 5,500+ signals are already equipped with battery-based power back-up systems, and 58% are equipped with generator-ready back-up systems (most battery-based systems also have generator-ready features). These power back-up systems can improve the resiliency of the transportation network, and are expected to be further enhanced in the future with projects funded by Urban Areas Security Initiative (UASI) grants.

2.2.8. SAFETY AND CONGESTION

2.2.8.1. Overview

The correlation between highway safety and congestion is complex. In general, crash frequency is directly related to congestion levels and inversely related to crash severity. Sources indicate that approximately half of all congestion is caused by non-recurring congestion[33]. Non-recurring congestion refers to congestion resulting from construction activities, inclement weather, crashes, disabled vehicles, and/or special events.

Engineering and operational management activities can mitigate congestion and improve safety. Many transportation agencies in the region employ active incident management programs to quickly respond to incidents, reduce their duration, and thereby lessen the likelihood of secondary crashes[34] resulting from traffic backups. These programs are further integrated into the Metropolitan Area Transportation Operations Coordination (MATOC) program[35], to undertake day-to-day, real-time multi-agency coordination and information sharing on transportation systems conditions in the National Capital Region.

The TPB addresses transportation safety through the following programs and activities:

- Transportation safety is encouraged through the ***Transportation Improvement Program (TIP)***, which provides information on projects programmed for completion within the next six years. The TIP contains projects whose primary purpose is to enhance safety, and explains how other projects will support transportation safety.

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[32] Marco Trigueros, *Update on COG Incident Management and Response (IMR) Action Plan Recommendations: Back-Up Power for Traffic Signals*, a presentation to the TPB's Traffic Signal Subcommittee on December 8, 2015. http://www.mwcog.org/uploads/committee-documents/k1xeX1xa20151208095114.pdf

[33] Describing the Congestion Problem, Federal Highway Administration: http://www.fhwa.dot.gov/congestion/describing_problem.htm.

[34] crashes due to congestion created by an earlier crash or incident or to drivers distracted by the previous incident scene

[35] See www.matoc.org for more information.

- The TPB's ***Transportation Safety Subcommittee***[36]***,*** complies and reviews regional highway safety, shares this data among member jurisdictions, and identifies the top highway safety problems in the Region. The subcommittee advises the Technical Committee and the Transportation Planning Board (TPB) on regional highway safety issues and on the various federal requirements for MPOs to follow related to transportation safety.

- The ***Street Smart Pedestrian and Bicycle Safety*** campaign is an annual region-wide education effort to raise public awareness on pedestrian and bicycle safety[37]. The campaign, created by the TPB's Bicycle and Pedestrian Subcommittee in 2002, uses methods such as radio, newspaper, and transit advertising, public awareness efforts, and law enforcement with an overall goal of changing driver, pedestrian, and bicyclist behavior to reduce fatalities and serious injuries of pedestrians and bicyclists.

2.2.8.2. Traffic Safety Facts

The TPB Transportation Safety Subcommittee compiles, summarizes, and reports safety and other information about the region's transportation system. Some of these traffic safety facts observed may help in illustrating the relationship of safety and congestion.

- The rate of decline in the number of fatalities and serious injuries in the National Capital Region has plateaued in recent years;
- Total traffic fatalities in the National Capital Region have declined from 412 in 2006 to 275 in 2016;
- The fatality rate per 100 million vehicle miles travelled (VMT) for the National Capital Region has declined from 0.97 in 2006 to 0.62 in 2016.
- Total pedestrian and bicyclist fatalities in the National Capital Region have declined from 87 in 2006 to 77 in 2016;

2.2.8.3. New Safety Performance Management Final Rules[38]

The Federal Highway Administration (FHWA) published the Highway Safety Improvement Program (HSIP) and Safety Performance Management Measures (Safety PM) Final Rules in the Federal Register on March 15, 2016, with an effective date of April 14, 2016. These rules require the TPB to track five safety performance measures and set targets for each of them every year. The five performance measures, along with proscribed data sources, are described in Table 2-9 below.

Table 2-9 Highway Safety Performance Measures Summary

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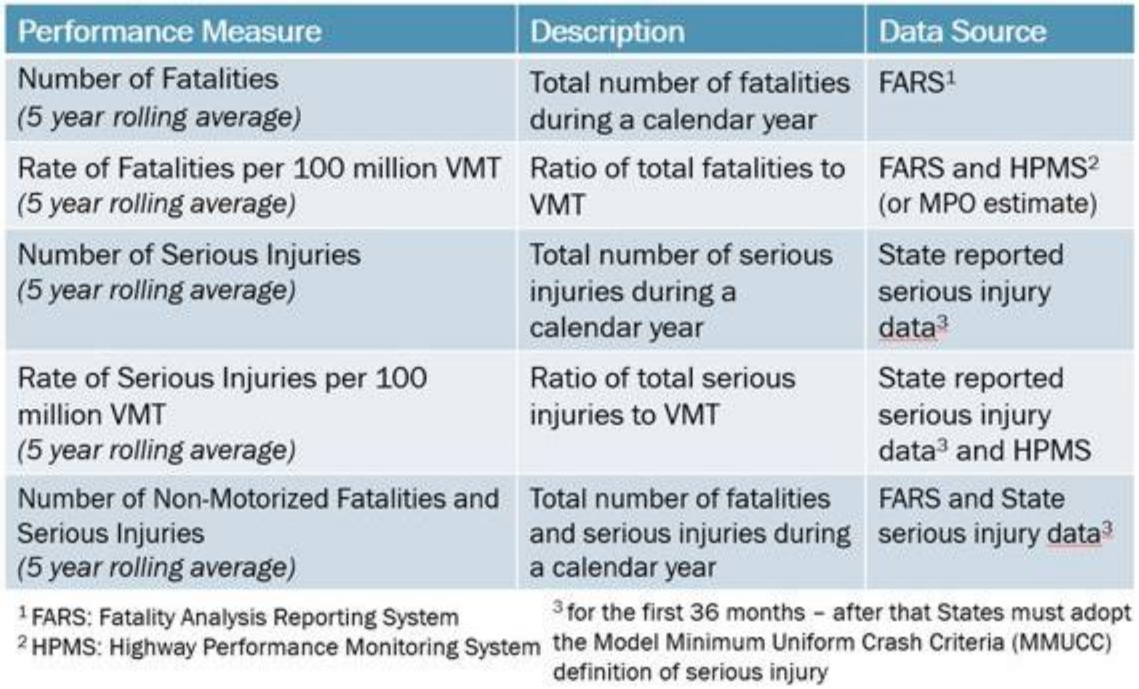
[36] a subcommittee of the TPB Technical Committee

[37] http://www.bestreetsmart.net/

[38] FHWA, HSIP and Safety Performance Management Measures Final Rules Overview, http://safety.fhwa.dot.gov/hsip/spm/measures_final_rules.cfm, Accessed June 28, 2016.



Performance Measure	Description	Data Source
Number of Fatalities *(5 year rolling average)*	Total number of fatalities during a calendar year	FARS[1]
Rate of Fatalities per 100 million VMT *(5 year rolling average)*	Ratio of total fatalities to VMT	FARS and HPMS[2] (or MPO estimate)
Number of Serious Injuries *(5 year rolling average)*	Total number of serious injuries during a calendar year	State reported serious injury data[3]
Rate of Serious Injuries per 100 million VMT *(5 year rolling average)*	Ratio of total serious injuries to VMT	State reported serious injury data[3] and HPMS
Number of Non-Motorized Fatalities and Serious Injuries *(5 year rolling average)*	Total number of fatalities and serious injuries during a calendar year	FARS and State serious injury data[3]

[1] FARS: Fatality Analysis Reporting System
[2] HPMS: Highway Performance Monitoring System
[3] for the first 36 months – after that States must adopt the Model Minimum Uniform Crash Criteria (MMUCC) definition of serious injury

While these safety performance measures are not specifically related to congestion, the fatalities and serious injuries resulting from congestion-related crashes are part of the overall regional safety picture and will have an impact on whether or not the National Capital Region meets its highway safety targets.

2.2.8.4. New Safety Performance Management Final Rules[39]

The Federal Highway Administration (FHWA) published the Highway Safety Improvement Program (HSIP) and Safety Performance Management Measures (Safety PM) Final Rules in the Federal Register on March 15, 2016, with an effective date of April 14, 2016. The HSIP Final Rule updates the HSIP regulation under 23 CFR Part 924 to be consistent with MAP-21 and the FAST Act, and clarifies existing program requirements. The Safety PM Final Rule adds Part 490 to title 23 of the Code of Federal Regulations to implement the performance management requirements in 23 U.S.C. 150.

The Safety PM rule supports the HSIP, as it establishes safety performance measures to carry out the HSIP and to assess serious injuries and fatalities on all public roads. Together, these regulations will improve data; foster transparency and accountability; and allow safety progress to be tracked at the national level. They will inform State DOT and MPO planning, programming, and decision-making for the greatest possible reduction in fatalities and serious injuries.

The Safety PM Final Rule supports the data-driven performance focus of the HSIP. The Safety PM Final Rule establishes five performance measures to carry out the HSIP: the five-year rolling averages for: (1) Number of Fatalities, (2) Rate of Fatalities per 100 million VMT, (3) Number of Serious Injuries, (4) Rate of Serious Injuries per 100 million VMT, and (5) Number of Non-motorized Fatalities and Non-motorized Serious Injuries.

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[39] FHWA, HSIP and Safety Performance Management Measures Final Rules Overview, http://safety.fhwa.dot.gov/hsip/spm/measures_final_rules.cfm, Accessed June 28, 2016.

These safety performance measures are applicable to all public roads regardless of ownership or functional classification. The Safety PM Final Rule also establishes a common national definition for serious injuries.

MPOs will establish targets for the same five safety performance measures for all public roads in the MPO planning area within 180 days after the State establishes each target. The targets will be established in coordination with the State, to the maximum extent practicable. The MPO can either agree to support the State DOT target or establish a numerical target specific to the MPO planning area. MPOs' targets are reported to the State DOT, which must be able to provide the targets to FHWA, upon request.

2.3. Congestion on Transit Systems

2.3.1. IMPACTS OF HIGHWAY CONGESTION ON TRANSIT SYSTEMS

2.3.1.1. Transit-Significant Roads

Often the region's highway congestion will have an impact on transit systems, such as rail and bus. To some extent, transit operations are concentrated in areas of high-density land uses, where traffic congestion may be expected. Bus schedules generally are designed to anticipate and accommodate highway congestion whenever possible. However, there are instances when congestion is unpredictable and can not only impact the timing of one bus, but of the entire bus system and other transit systems the bus connects to (such as commuter rail).

In order to track the differential congestion conditions, between regional overall congestion and transit-significant routes congestion, the TPB identified a Transit-Significant Road Network in 2014[40] and its performance is now monitored in the quarterly updated National Capital Region Congestion Report and the CMP Technical Report as a separate highway category.
Any road segments with at least 6 buses in the AM Peak Hour (equivalent to one bus in either direction in 10 minutes) are considered as "transit-significant". By this criteria, there is a total of 1,397 miles of transit-significant road segments, as shown in Figure 2-36.

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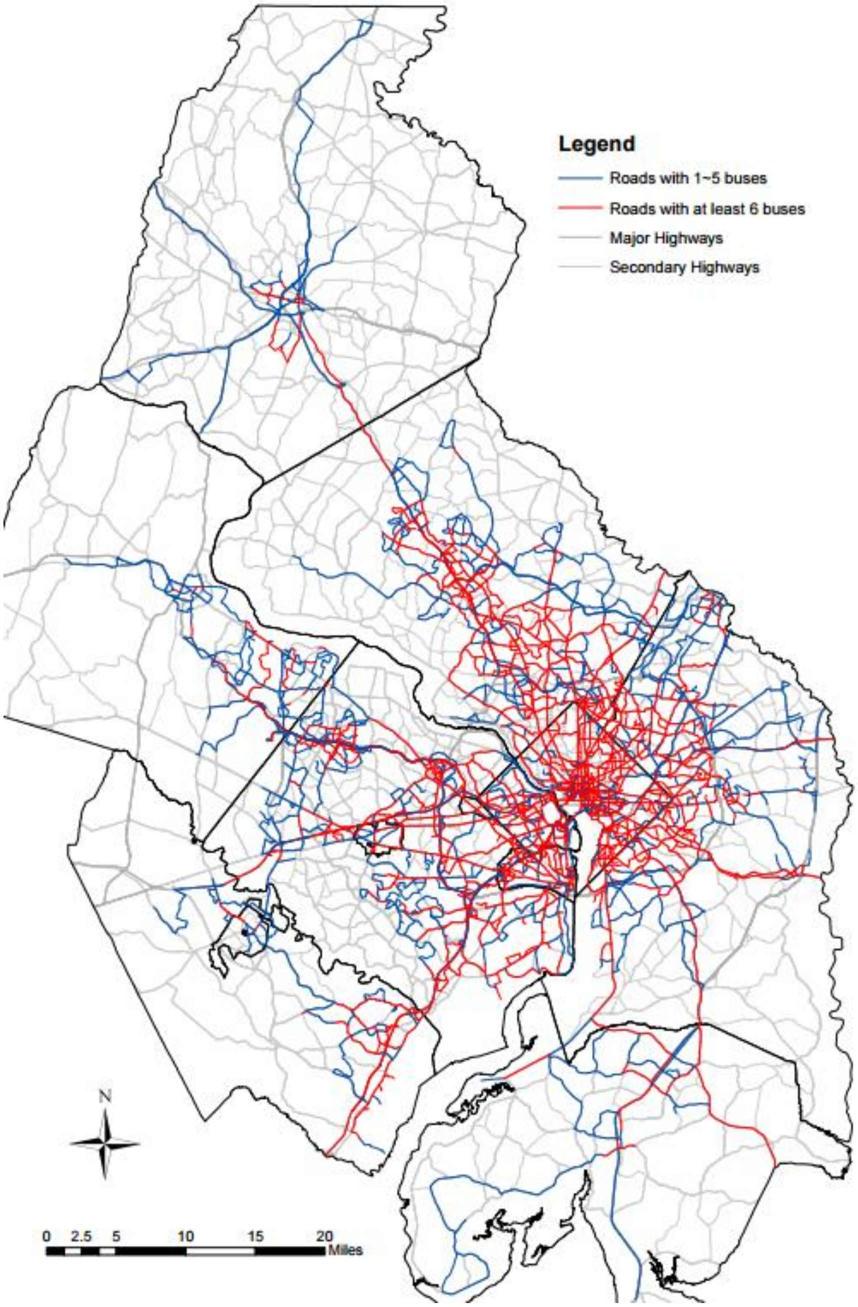
[40] Wenjing Pu, Update on "Transit-Significant Highway Network" Identification, Presentation to the Regional Public Transportation Subcommittee, November 25, 2014. http://www.mwcog.org/uploads/committee-documents/al1XXV1Z20141125094736.pdf

Figure 2-36 Transit-Significant Roads in the TPB Planning Area



A performance analysis[41] revealed that the Transit-Significant Roads was more congested and more sensitive to change compared to the regional average of all roads.

The transit network's congestion, expressed as annual average Travel Time Index, was 3 to 5 percent worse than the regional average of all roads throughout 2010 -2014 during peak periods, i.e., 6:00-10:00 am and 3:00-7:00 pm (Figure 2-37 a. and Figure 2-38 a.). It is not unexpected that the transit-

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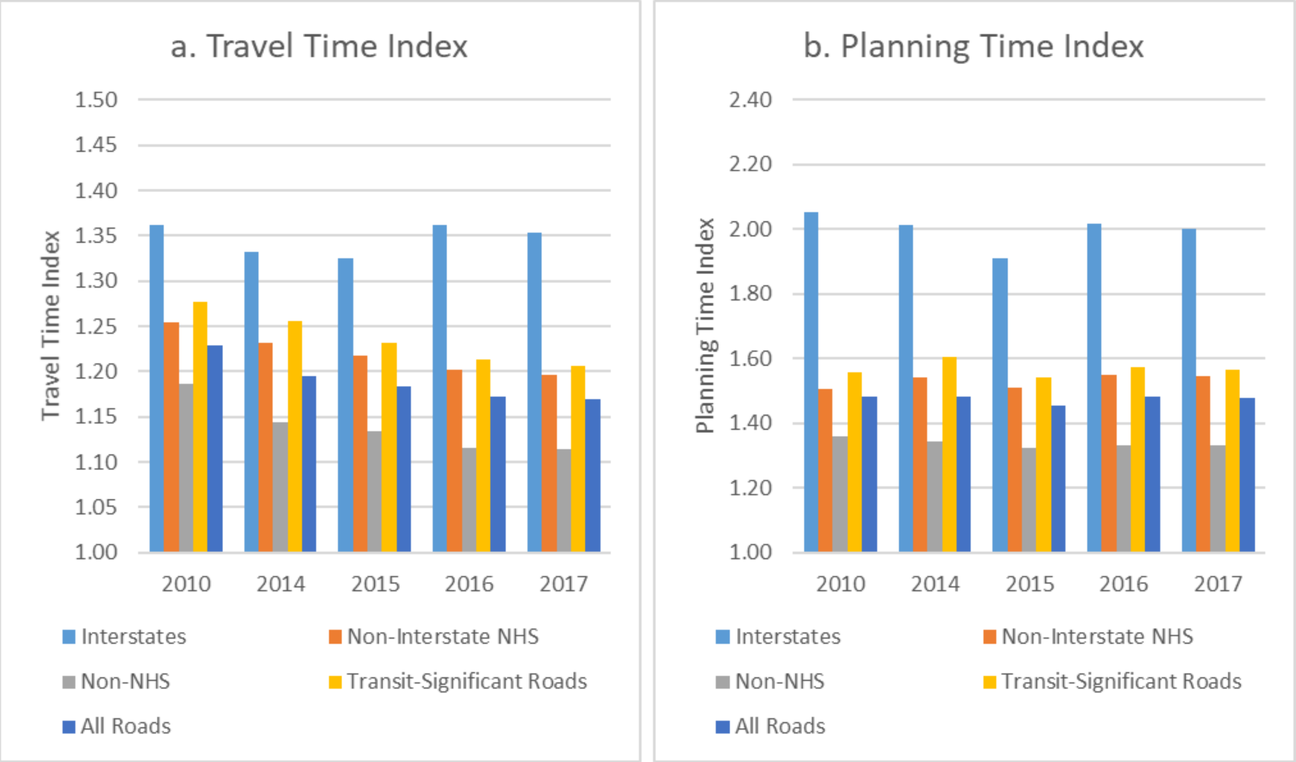
[41] Wenjing Pu, Performance of Transit-Significant Highway Network in the Washington Region, Presentation to the Regional Public Transportation Subcommittee, April 28, 2015. http://www.mwcog.org/uploads/committee-documents/aF1WWV1c20150428073637.pdf

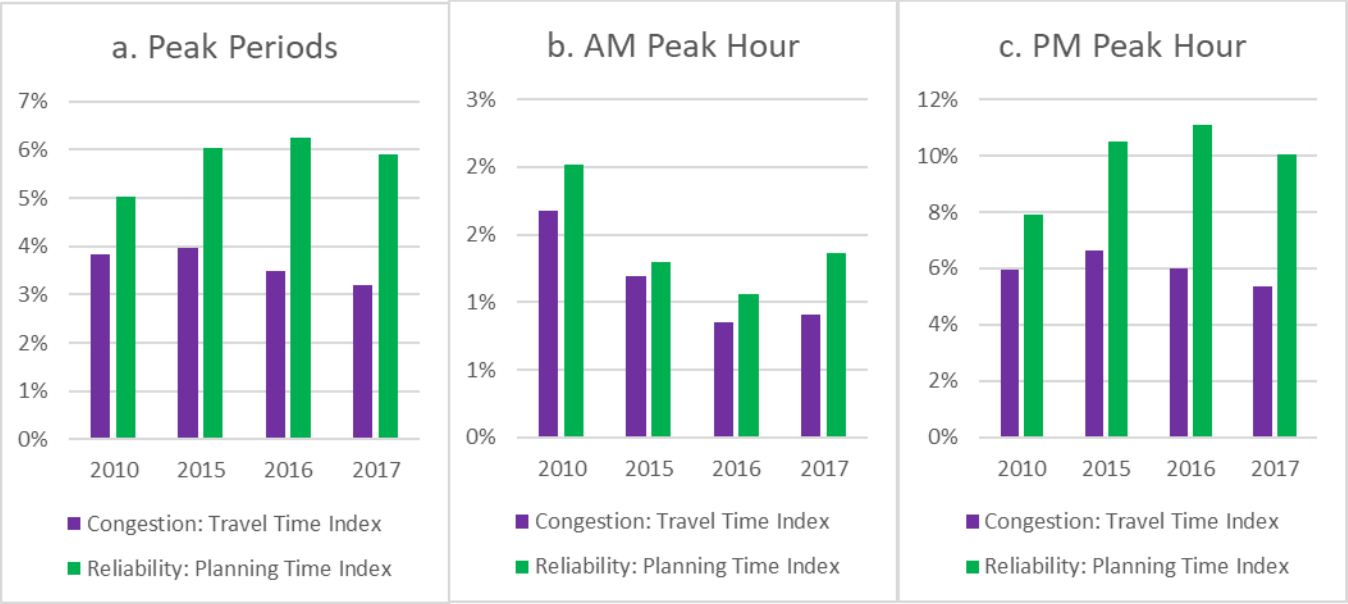
significant network is congested, since buses are often routed in dense, urban corridors as a part of multi-modal transportation strategies. This network was also more congested than the non-Interstate National Highway System (NHS) and the non-NHS roads, but less congested than the Interstate System, which was still the most congested highway category (Figure 2-37 a.).

Figure 2-37 Peak Period Travel Time Index and Planning Time Index of Transit-Significant Roads



The difference in congestion between the transit network and the regional average was more pronounced during PM peak hour, with 6-8 percent difference, compared to the AM peak hour's 2-3 percent divergence (Figure 2-38 b. and c.).

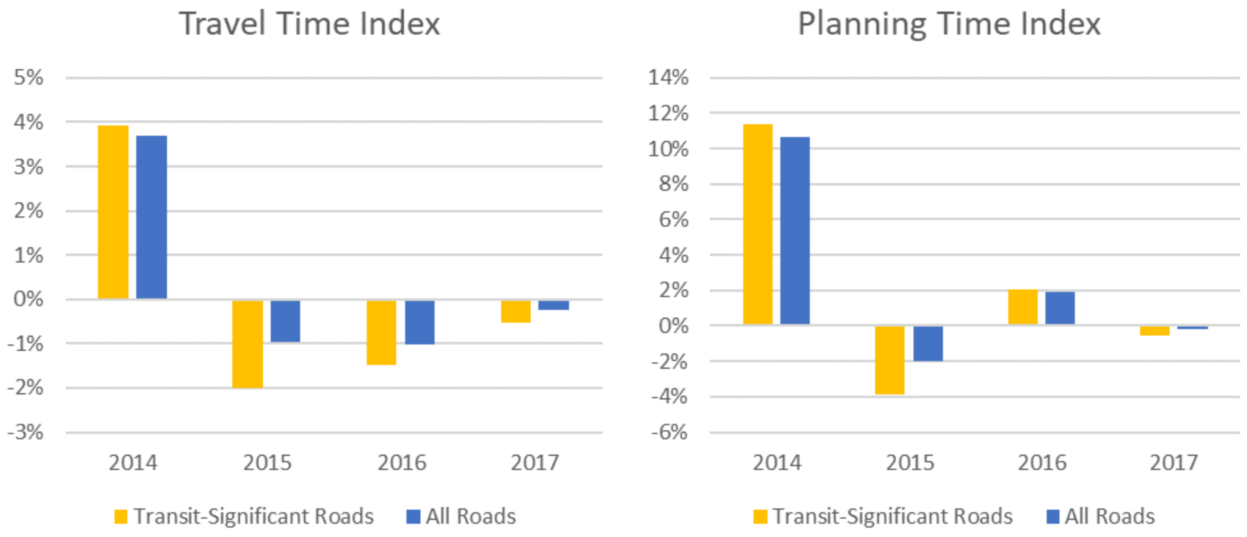
Figure 2-38 Transit-Significant Roads Compared to All Roads



In terms of travel time relibility, expressed as Planning Time Index, mixed results were found between the transit network and the regional average (Figure 2-38). The transit bus network was 4-6 percent more reliable than the regional average in the AM peak hour, but 2-7 percent less reliable in PM peak hour.

Performance of the Transit-Significant Network varied in accordance with regional average; but the year-to-year changes in the transit network tended to be slightly larger than that of the regional average (Figure 2-39).

Figure 2-39 Congestion and Reliability Year-to-Year Changes of Transit-Significant Roads



2.3.1.2. Bus Travel Speeds

Another way to assess the impacts of highway congestion on transit is to directly investigate bus travel speed along roads carrying both buses and other vehicles. Figure 2-40, Figure 2-41, and Figure 2-42 show region-wide bus speeds observed in the TPB's Multimodal Coordination for Bus Priority Hot Spots Study[42] carried out in 2011-2012. These maps report average bus travel speeds for 28,172 roadway segments in the region (2,330 miles of roadway). The lines shown on the maps indicate the slower of the two directions during the given period. With few exceptions, this represents "outbound" buses during the PM peak (3:00-6:00 pm) and "inbound" buses during the AM peak (6:00-9:00 am).

The results of this study show that there are numerous roadway segments within the region with average transit operating speeds of less than 10 mph and several with speeds of under 5 mph. The vast majority of these locations are within the District, but some fall in Maryland and Virginia suburban areas (particularly around Silver Spring and several Arlington County locations). These heavy traffic conditions create a challenge for buses, especially in the District. For example, WMATA's average bus speed is 10 miles per hour, and this has been falling gradually over the last 15 years.[43] The analysis, as shown on the maps, also shows that PM speeds are generally lower than AM speeds, though the differences are small in most cases. For instance, the bridges over the Anacostia River in the District all show a noticeable decline in travel speed during the PM peak. The differences between the peak periods and the all-day speeds are smaller than might typically be expected. This indicates that mid-day congestion is heavy on many routes in the service areas. In addition, because most bus trips occur during the peak periods the all-day averages are naturally weighted toward the peaks.

In general, the results of the analysis show that bus operating conditions vary greatly by location throughout the region. Many locations, particularly in the downtown core, have operating speeds below 10 mph, indicating high amounts of bus delay. Moreover, many of the slowest corridors shown on the map carry very high bus volumes (e.g., H and I Streets NW in downtown DC has 3,000 daily WMATA and DC Circulator buses, with a total ridership of 62,300) suggesting that priority improvements on these corridors could provide significant transportation benefits. In fact, a 2013 study found bus lanes on these two streets would provide excellent returns on investment, with benefits outweighing costs by a 9- to 32-to-1 margin.[44] In particular, WMATA's work to develop a network of priority bus routes, and the completion of COG/TPBs' federal Transportation Investment Generating Economic Recovery (TIGER) grant award to implement some of this network, provides a unique opportunity to address the challenges of congestion-related bus delay. In such efforts, support and collaboration from state DOTs and local agencies are vital.

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[42] COG/TPB, Publications, http://www.mwcog.org/store/item.asp?PUBLICATION_ID=445

[43] *Two Business Challenges Facing Metrobus,* PlanItMetro, https://planitmetro.com/2015/09/02/two-business-challenges-facing-metrobus/

[44] H/I Streets Bus Improvements, Final Technical Report, October 2013.
https://www.wmata.com/initiatives/plans/upload/H_I-Final-Technical-Report-FINAL-100913.pdf

Figure 2-40 Region-wide Bus Speeds – All Day

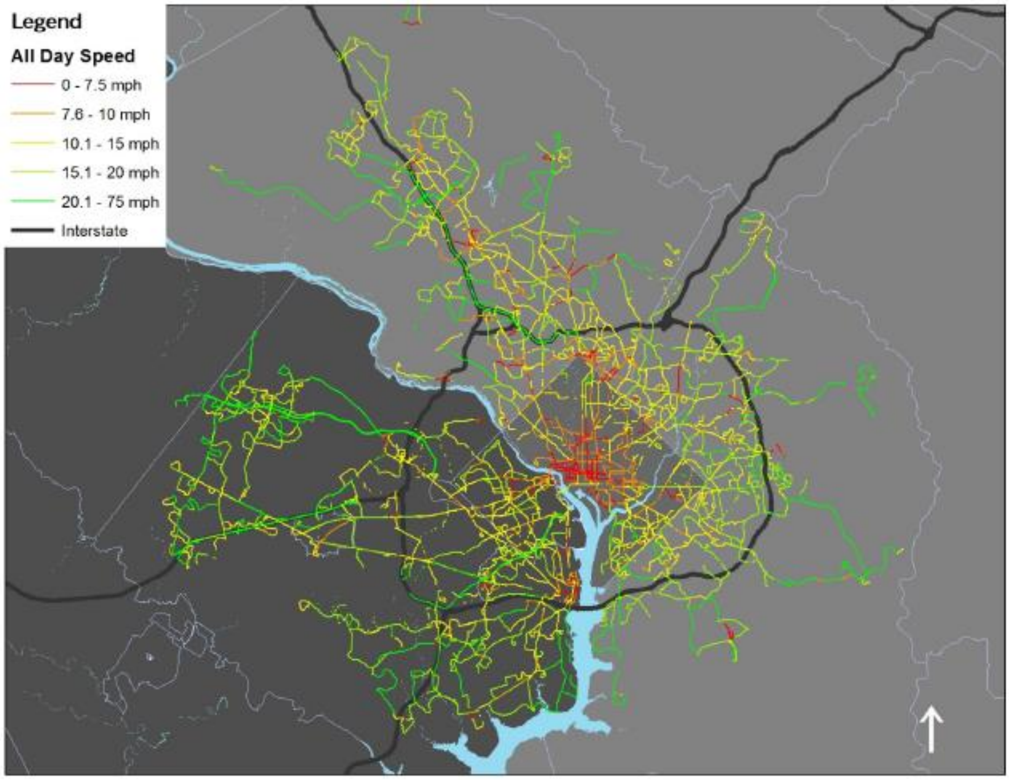


Figure 2-41 Region-wide Bus Speeds – AM Peak

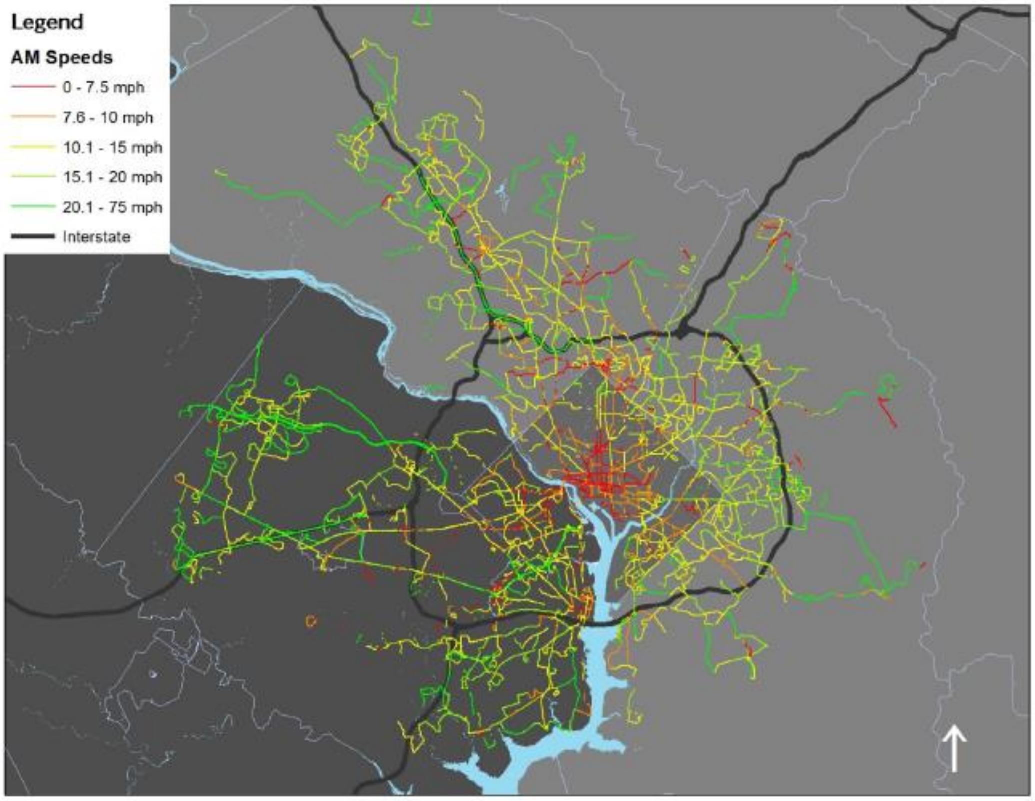
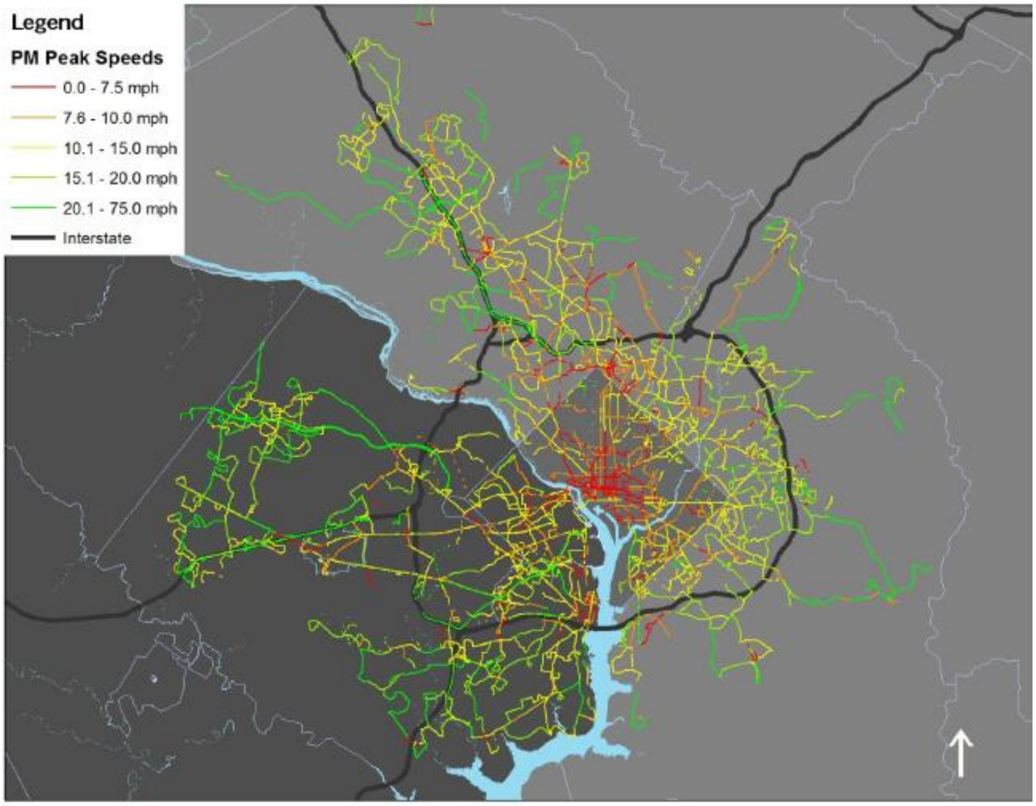


Figure 2-42 Region-wide Bus Speeds – PM Peak



2.3.1.3. Connections to Transit

The impact of highway congestion on transit systems can also be assessed by identifying and analyzing the key linkages between transit and other modes. In 2014 Metro conducted a Regional Bus Survey[45] throughout our region. This survey found about 44% of the region's bus trips accessed the bus via autos or other buses. These passengers were subjected to the impact of highway congestion if it occurs on pertinent routes.

In 2014, WMATA released a three-part series blog, "Solving the Region's Congestion Woes – One Step at a Time", suggesting ways to increase the walkability and connectivity around Metrorail stations[46]. The blog says that "walkable station areas result in fewer motorized trips, fewer miles driven, fewer cars owned, and fewer hours spent traveling. And when we improve the pedestrian and bicycle access and connectivity to Metrorail station areas, ridership goes up, putting a major dent in congestion by taking trips off the roadways."

In August 2016, WMATA published the Metrorail Station Investment Strategy Summary Report[47]. The report states

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[45] 2014 Metrobus Survey, https://planitmetro.com/2015/10/26/three-tidbits-what-the-metrobus-2014-survey-can-tell-us/

[46] Shyam, Solving the Region's Congestion Woes – One Step at a Time, http://planitmetro.com/tag/one-step-at-a-time/

[47] https://planitmetro.com/uploads/MISIS_Report_August_2016.pdf

> "Improving bicycle and pedestrian access to Metrorail stations helps stabilize rail ridership and reduce growth in public subsidy to Metro. In late 2014, as Metro's Planning office began to study the relationship between ridership and station walk access, staff developed walksheds for each Metrorail station, identifying the actual walkable area relative to a ½ mile "as the crow flies" distance using network analysis in GIS. With help from researchers at the University of Maryland, staff has been able to calculate the number of riders walking to Metro that can be expected when jobs and housing are connected the walkshed. The exact numbers vary by station, but, on average, for every ten households connected to the station, Metro sees about seven weekday Metrorail trips."

In short, improved transit accessibility will attract travelers to the rail system, reducing the demand on the highway network.

2.3.2. CONGESTION WITHIN TRANSIT FACILITIES OR SYSTEMS

Congestion can also be an issue within transit. If the demand for rail and buses is high and the capacity cannot keep up with that demand, then transit becomes too crowded. Just as incidents can cause non-recurring incidents on roadways, the same can occur on transit facilities. Even a minor bus or train incident can cause back-ups and delays.

In addition, certain transit facilities may experience more congestion that others. Union Station in the District of Columbia is a station that accommodates Metrorail, Metrobus, DC Circulator buses, Maryland Area Rail Commuter (MARC) trains, Virginia Railway Express (VRE) trains, and AMTRAK. With these various transit options, Union Station has become a primary connection point for commuters/visitors, and the busiest station in the Metrorail system, with nearly 60,000 passengers entering and exiting daily (a passenger congestion simulation can be found on http://planitmetro.com/data)[48]. In response, WMATA and DDOT jointly completed the Union Station Access and Capacity Improvement Study in early 2011[49], and identified improvements that would fit compatibly with Union Station and benefit all transportation service providers and customers.

The TPB's Central Employment Core Cordon Count of Vehicular and Passenger Volumes[50] could be used to measure transit crowding at count stations. Section 2.4.1 will provide more information about the cordon count.

Bus vehicles also experience crowding, which operators must address by adding more buses, longer buses, and more resources on a route. For example, in late 2017 the top 30 most crowded routes on the WMATA Metrobus system all reported load factors between 1.6 and 2.0, indicating continuous crowding and uncomfortable conditions for all passengers at peak times.[51]

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[48] Washington Metropolitan Area Transit Authority, Data Visualization, Union Station Simulation http://planitmetro.com/data

[49] WMATA and DDOT, Union Station Access and Capacity Improvement Study Project Report, February 18, 2011. http://www.wmata.com/about_metro/docs/Final%20Union%20Station%20Project%20Report%20Feb182011.pdf

[50] *2013 Central Employment Core Cordon Count of Vehicular and Passenger Volumes*, Draft, December 30, 2013. http://www.mwcog.org/uploads/committee-documents/k11ZXV5e20140127094130.pdf

[51] WMATA Vital Signs, https://www.wmata.com/about/records/scorecard/upload/Vital-Signs_Q1-FY2018.pdf#page=15

Congestion can not only result on transit vehicles themselves, but on station platforms and around the station. In 2013, WMATA published Momentum, its strategic vision for the future.[52] This plan laid out seven Metro 2025 initiatives, including a program of capital improvements needed to ensure safe and efficient operations and facilitate passenger movements within rail stations.[53] The proposed stations, most of which are in the system's core, already experience crowding or would reach capacity by 2025. Proposed improvements vary from adding escalators and stairs, to building pedestrian passageways connecting platforms within stations and between stations. The Momentum has also listed a schedule of core station capacity improvements as shown in Table 2-10.[54]

Table 2-10 Future Station Capacity Improvement Plan

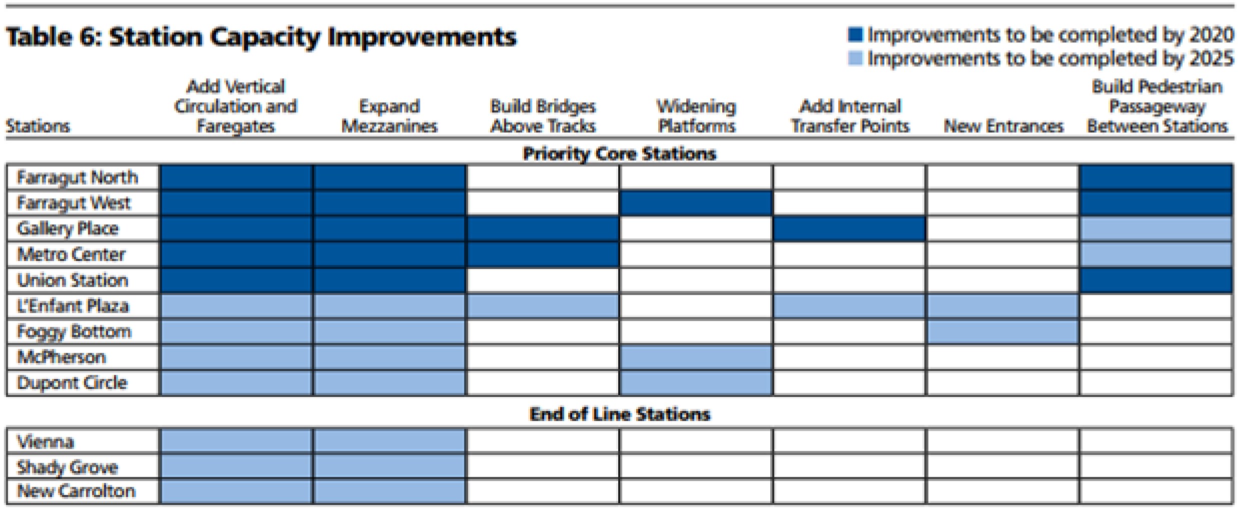

Table 6: Station Capacity Improvements

■ Improvements to be completed by 2020
▨ Improvements to be completed by 2025

Stations	Add Vertical Circulation and Faregates	Expand Mezzanines	Build Bridges Above Tracks	Widening Platforms	Add Internal Transfer Points	New Entrances	Build Pedestrian Passageway Between Stations
Priority Core Stations							
Farragut North	■	■					■
Farragut West	■	■		■			■
Gallery Place	■	■	■		■		▨
Metro Center	■	■	■				▨
Union Station	■	■					■
L'Enfant Plaza	▨	▨	▨		▨	▨	
Foggy Bottom	▨	▨				▨	
McPherson	▨	▨		▨			
Dupont Circle	▨	▨		▨			
End of Line Stations							
Vienna	▨	▨					
Shady Grove	▨	▨					
New Carrolton	▨	▨					

Source: WMATA, 2013, Momentum, Core Station Improvements.

According to Metro's Office of Planning, more than two-thirds of Metrorail daily ridership occurs during the morning and evening peak periods[55]. The graphic (Figure 2-43) provided by this Office shows the AM peak hour (8:00-9:00 AM) passenger volumes by travel direction. Red and Orange/Blue Lines carry the highest passenger volumes in the system morning peak hour, on segments from Dupont Circle to Farragut North (eastbound), Gallery Place to Metro Center (westbound), and Court House to Foggy Bottom (eastbound). Please note the 8:00-9:00 AM system graphic does not reflect true max-loads on the Green Line. Unlike the other lines, the Green Line actually reaches peak loads between 7:30 AM and 8:30 AM, ahead of the other lines, with hourly passenger loads exceeding 5,500 from Waterfront to L'Enfant Plaza.

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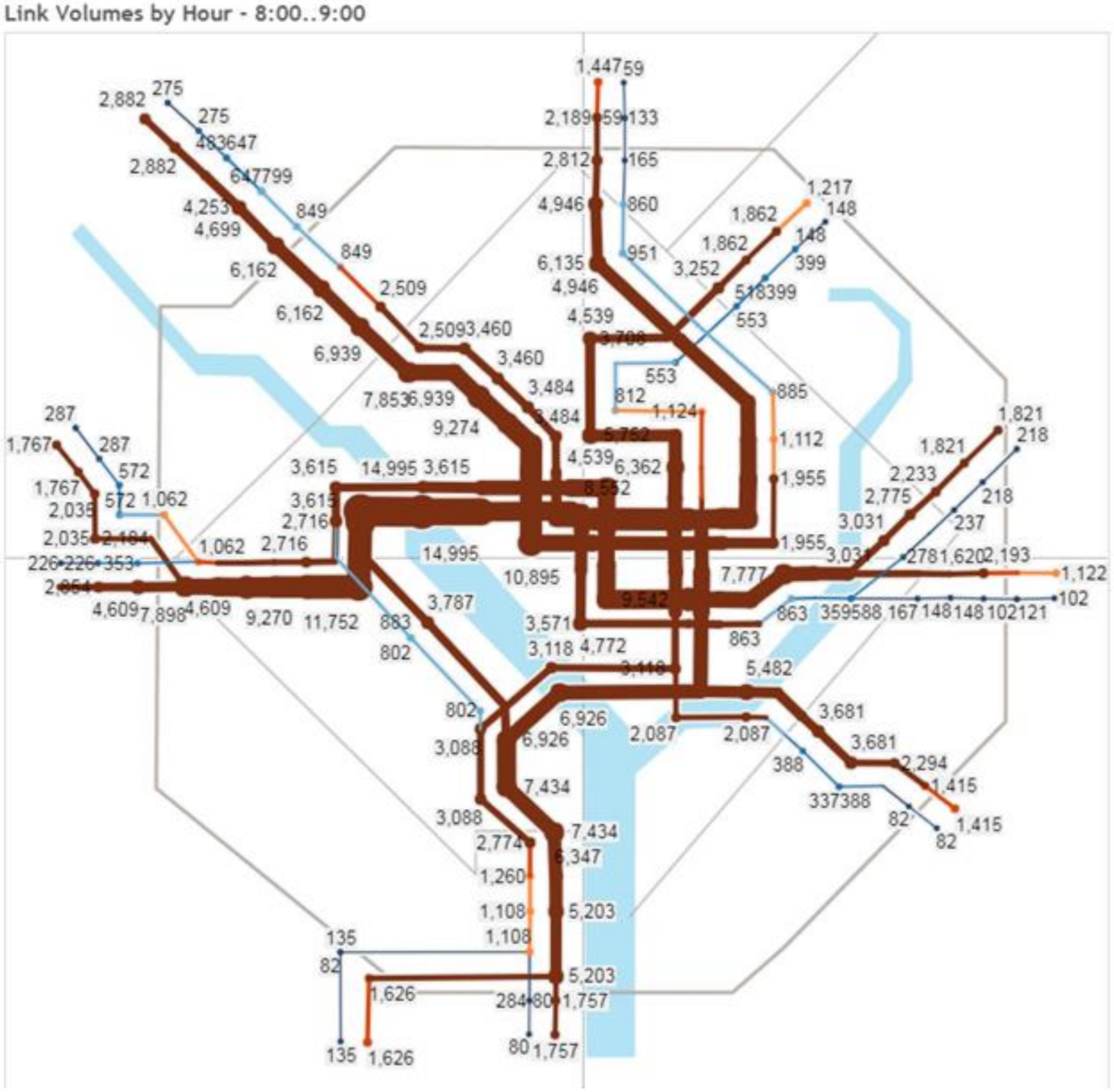
[52] https://www.wmata.com/initiatives/strategic-plans/

[53] https://www.wmata.com/initiatives/strategic-plans/upload/2Metro-2025-Core-Station-Improvements-Secure.pdf

[54] https://www.wmata.com/initiatives/strategic-plans/upload/momentum-full.pdf

[55] Washington Metropolitan Area Transit Authority, Data Visualization, Peak Hour Passenger Ridership on Metrorail. http://planitmetro.com/data

Figure 2-43 AM Peak Hour (8:00-9:00 AM) Metrorail Link Passenger Volumes



Source: WMATA; data based on an average weekday in May 2015, 8:00-9:00 AM [56].

WMATA also built an internal tool, called Line Load App, to monitor the passenger loads and crowdedness on Metrorail systems[57]. One example provided in Figure 2-44 shows the passenger per car (PPC) on each of the cars on eastbound Red Line at Dupont Circle station during weekday morning hour 8:00-9:00 AM in October 2014.

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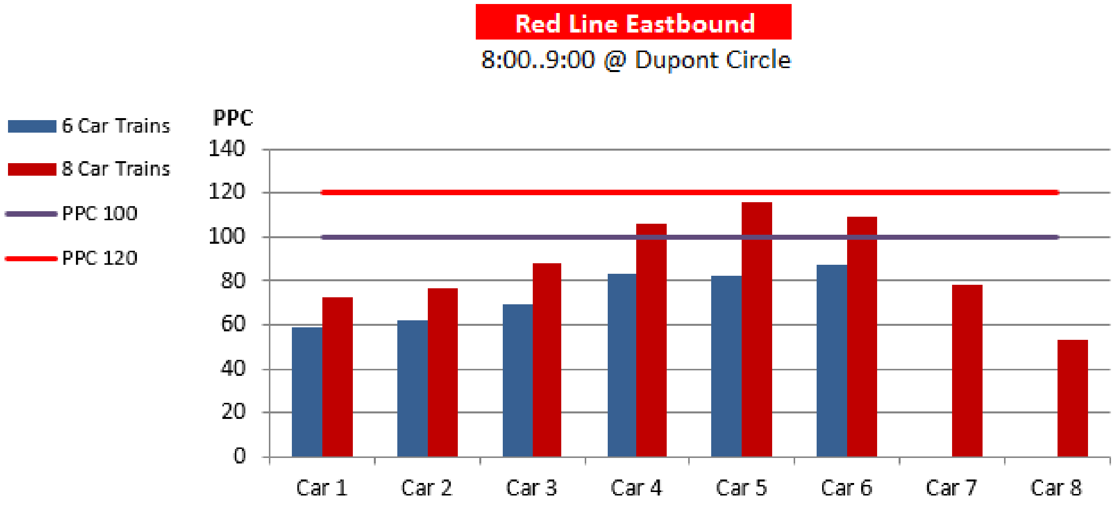
[56] https://public.tableau.com/profile/planitmetro#!/vizhome/MetrorailLinkVolumesbyHour/LinkVolumesbyHour

[57] Melissa, Monitoring Passengers Loads on Metrorail – Using New Tools to Examine the Data, January 5, 2016. http://planitmetro.com/2016/01/05/monitoring-passengers-loads-on-metrorail-using-new-tools-to-examine-the-data/

Figure 2-44 WMATA's Line Load Application Tool



Source: WMATA, Average Car Loads in the AM Peak Hour – October 2014 Weekdays – Modeled Distribution of Passengers at Dupont Circle. The estimated railcar crowding is based on the scheduled Red Line service.

Metrorail experiences congestion not only in stations, but also on-board trains. As Table 2-11 below from Momentum shows, many trains are crowded at peak periods today; without rail fleet expansion, most rail lines will be even more congested by 2025.[58] The plan lays out seven Metro 2025 initiatives, including running eight-car trains during peak periods and core station improvements. For riders, Momentum will mean more trains, reduced crowding, faster buses, brighter, safer, easier-to-navigate Metrorail stations, and information when and where you want it. For the region, Momentum will increase capacity throughout the system, enable future expansion, and remove vehicles from our already-crowded roadways. As of 2018, however, the region and funding agencies have not identified the funds needed to implement the Metro 2025 initiatives.

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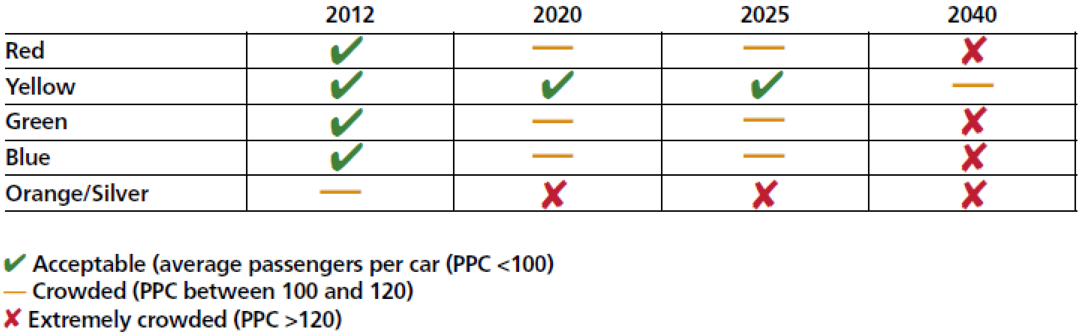
[58] WMATA, Momentum, http://www.wmata.com/Momentum/

Table 2-11 Metrorail System Peak Period Capacity by Line without Fleet Expansion



	2012	2020	2025	2040
Red	✓	—	—	✗
Yellow	✓	✓	✓	—
Green	✓	—	—	✗
Blue	✓	—	—	✗
Orange/Silver	—	✗	✗	✗

✓ Acceptable (average passengers per car (PPC <100)
— Crowded (PPC between 100 and 120)
✗ Extremely crowded (PPC >120)

Source: WMATA, 2013, Momentum, Strategic Plan 2013-2025.

The CMP recognizes the growing concern of congestion within our regional transit systems. As the region's population grows and "going green" trends advances, there will be more commuter and residents looking to transit options instead of driving. While increase in transit use is overall a positive trend, it is important that the concern of transit congestion throughout the region be examined further.

Congestion management will benefit from continuing to encourage transit in the Washington region and explore transit priority strategies. The transit system in the Washington region serves as a major alternative to driving alone, and it is an important means of getting more out of existing infrastructure. Additional work with appropriate committees and transit agencies to address related data and performance measure issues would help further support the CMP.

2.4. Other Congestion Monitoring and Data Consolidation Activities

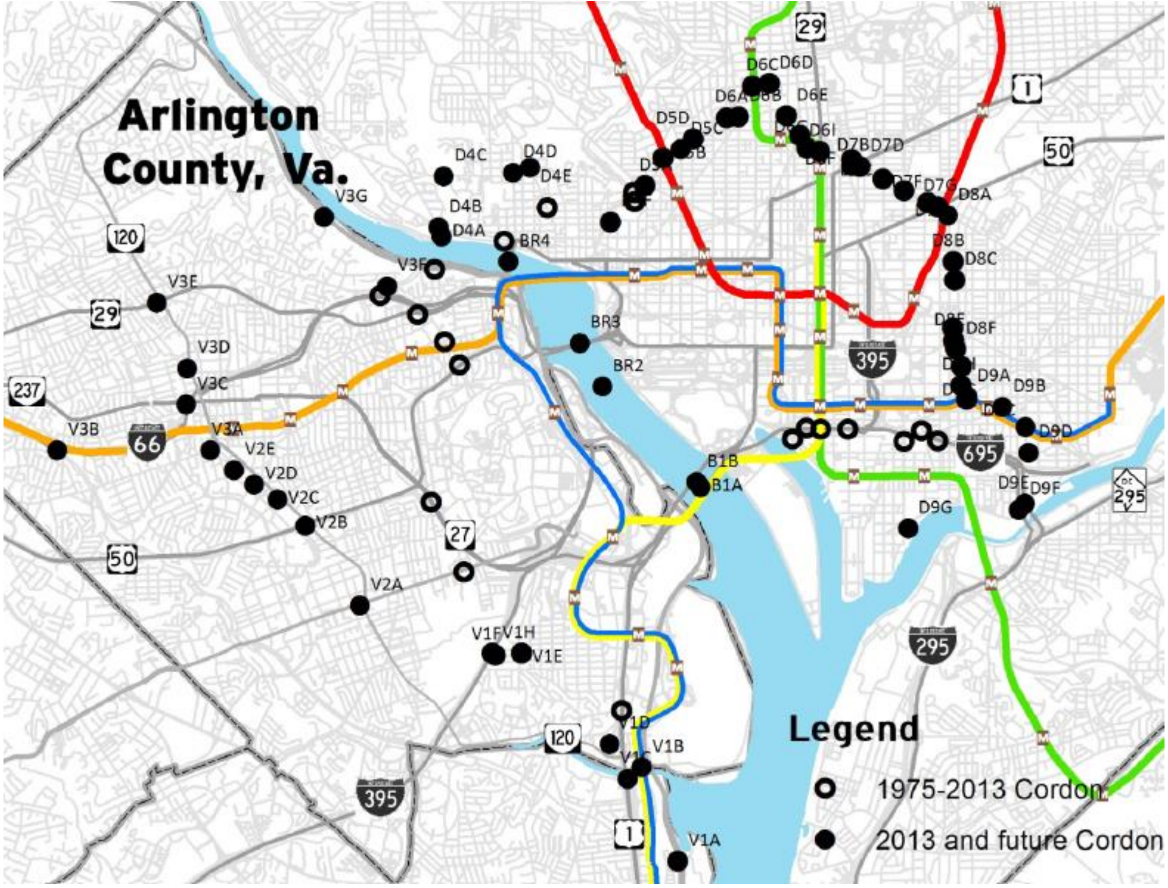
In addition to the congestion monitoring activities presented above in this chapter, the following monitoring and data consolidation activities have also been carried out in the Washington region.

2.4.1. CORDON COUNTS

The cordon count program originated from the desire to assess the impact of the construction of the region's Metrorail system stating in the late 1960's. Thus, a cordon line around the Central Business District (the "core") was determined by the inbound point at which there were more destinations (alighting from transit buses) than origins (loadings onto transit buses). The central business district includes the downtown area of the District of Columbia, Georgetown south of "Q" Street, N.W., the U.S. Capitol, and the nearby sections of Arlington County, Virginia, including Rosslyn, the Pentagon, Pentagon City, Crystal City and Reagan National Airport. In later years, additional cordon counts were added to the program, including:

- Vehicle counts, classification, and occupancy were taken on facilities that cross the region's center core cordon.
- Monitoring of freeway routes in the region with HOV lanes.
- Other data collection projects, including counts of commercial vehicles and roadside truck surveys.
- In 2013, a revised cordon line was used in the count and the expanded cordon include "new" employment that has and will happen between 1975 and 2020, as shown in Figure 2-45 below.

Figure 2-45 Cordon Count Stations



These projects help to inform the development of regional travel forecasting computer models and provide an opportunity for trend analysis.

The most recent cordon count study is the 2013 Central Employment Core Cordon Count of Vehicular and Passenger Volumes[59]. This study collected data for the Spring 2013 Central Employment Core Cordon Count of peak period person and vehicle volumes entering the downtown employment area of the District of Columbia and Arlington County, Virginia, designated the Central Employment Core (formerly Metro Employment Core), the largest activity center in the Washington metropolitan region. Data were collected from 5 A.M. to 10 A.M. inbound along two cordon lines, the "traditional" cordon line which dates to the opening of the initial segment of the Metrorail system in 1976, and an revised or expanded cordon.

Most comparisons are made with results obtained from the previous Central Employment Core Cordon Count conducted in Spring 2009, though some are with the Spring 2006 Cordon Count. Between the 2009 and 2013 counts, some demographic and transportation system changes have occurred that may have influenced the numbers of people and how they have commuted into the regional core. Data were not collected during the P.M. peak period for this effort.

Trends and changes in person and vehicle trips by mode are emphasized for the 6:30 - 9:30 A.M. peak period inbound. The following changes were observed:

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[59] *2013 Central Employment Core Cordon Count of Vehicular and Passenger Volumes*, Draft, December 30, 2013. http://www.mwcog.org/uploads/committee-documents/k11ZXV5e20140127094130.pdf

1) Total inbound travel decreased in the A.M. peak period from about 463,000 person trips in 2009 to 446,000 in 2013. Trips crossing the revised cordon in 2013 were about 435,000.
2) Inbound peak period transit trips were about 211,000, little changed from 2009. Transit trips crossing the revised cordon line were about 197,000.
3) Person trips by automobile in 2013 were about 236,000, a decrease of about 21,000 from 2009. Most of the decrease in person trips were in multiple occupant vehicles (2 or more persons per vehicles), which declined by about 21,000 trips.
4) The number of automobiles entering the Central Employment Core in the A.M. peak period has declined from 203,000 in 2009 to about 192,500 in 2013. For the five-hour monitoring period, the decline was similar in absolute terms, from about 273,000 in 2009 to 263,000 in 2013.
5) Traffic volumes crossing the revised cordon line were only slightly higher, but person trips were lower.
6) About 3,500 bicycles entered the Central Employment Core in the A.M. peak period. In the full five hour monitoring period, almost 5,000 trips by bike were observed.

Figure 2-46 and Figure 2-47 below contain charts that depict the trends in person trips from 1999 to 2013, in the inbound peak period.

Figure 2-46 2013 Cordon Count Trends in Person Trips: 1999-2013, Inbound 6:30-9:30 am

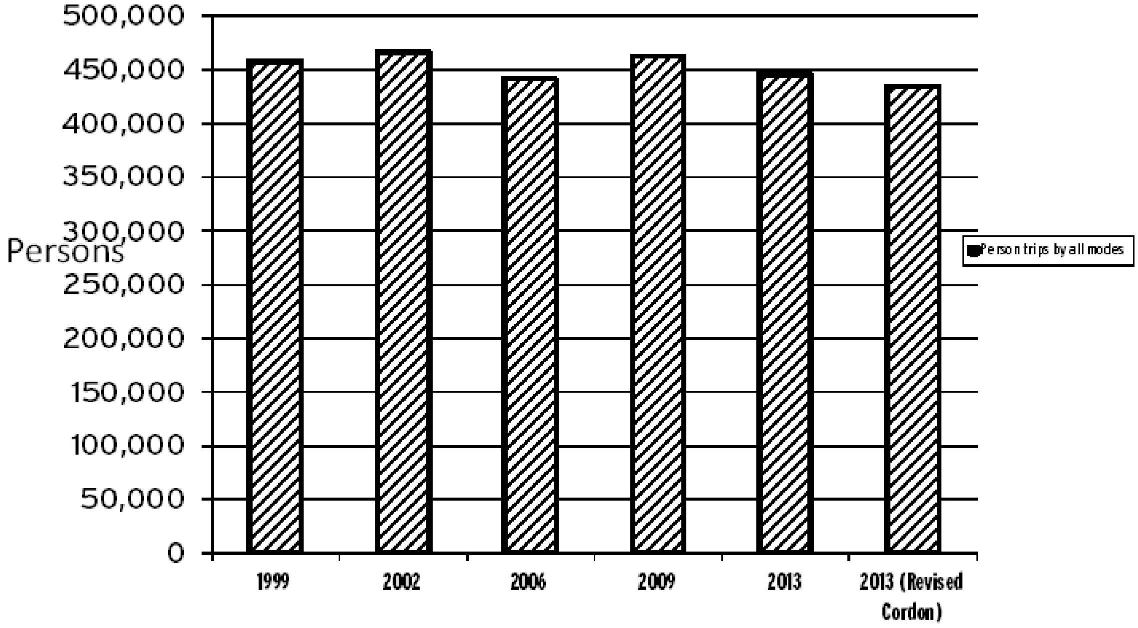
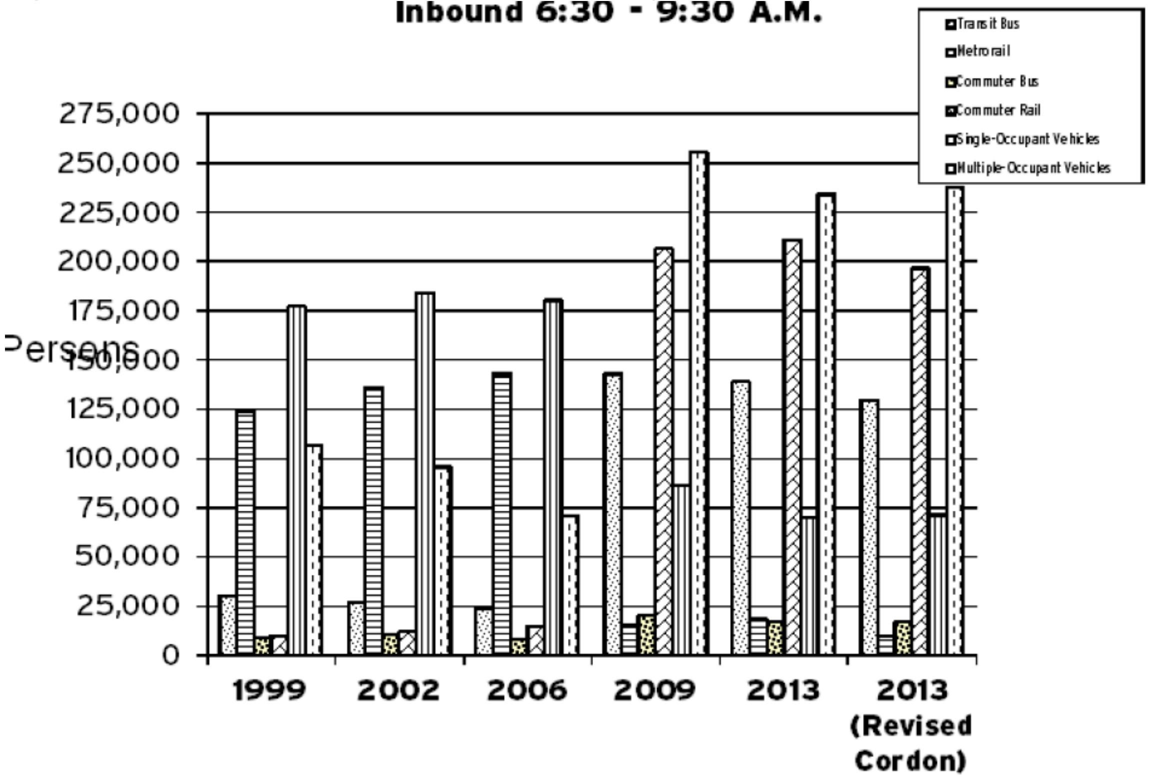


Figure 2-47 2013 Cordon Count Trends in Person Trips by Mode: 1999-2013, Inbound 6:30-9:30 am



2.4.2. PARK-AND-RIDE FACILITIES

There are over 160,000 parking spaces at nearly 400 Park & Ride lots throughout the Washington/Baltimore Metropolitan areas where commuters can conveniently bike, walk or drive to and join up with carpools/vanpools or gain access to public transit. The following statistics provide an idea of why park-and-ride lots play such a popular role in the region's transportation system[60]:

- Two thirds of Park & Ride Lots have bus or rail service available.
- Parking is free at 89% of the Park & Ride Lots.
- More than 25% of Park & Ride Lots have bicycle parking facilities.

In addition to the above statistics, Intelligent Transportation Systems (ITS) strategies such as traveler information systems and electronic payment systems can add to the convenience of park-and-ride lots. In 2009, WMATA and VDOT completed the Feasibility Study of Real Time Parking Information at Metrorail Parking Facilities (Virginia Stations)[61], evaluating the feasibility of a real-time parking application for the Metrorail system, with the purpose of improving operations efficiency, reducing operating costs by providing guidance to available parking spaces, encouraging more transit usage and reducing congestion.

Commuter Connections also displays a park-and-ride map on their website, which provides users with the location of lots, transit stations in the vicinity, and the location of Telework centers.

Due to the popularity of park-and-ride lots, some are experiencing overcrowding, where demand exceeds supply. This tends to happen at lots at or near Metrorail and commuter rail service. Over the past several years, Maryland State Highway Administration (MDSHA) has taken inventory of the SHA owned and maintained ridesharing facilities in the state[62]. Maryland has 103 park and ride lots located in 20 counties throughout the State providing a total of 12,572 spaces. In 2012, approximately 7,300 spaces were utilized on a given day which accounts for about 60% usage of the total spaces. It is estimated that providing the park and ride lot facilities resulted in 108 million fewer vehicle miles of travel in 2012.

The most recent TPB study on the usage of park-and-ride lots was conducted in 1996. As the region continues to grow and the demand for park-and-ride lots increases, this is an area that may need to be examined more closely. Remove this.

According to the 2008 WMATA Metrorail Station Access & Capacity Study, Metro presently owns and operates 58,186 parking spaces. On an average weekday, almost all of those spaces are occupied. Only a handful of stations—White Flint, Wheaton, College Park-U of MD, Prince George's Plaza, and Minnesota Ave—have a substantial amount of available capacity. Table 2-12 shows parking lot utilization as of October 2006.

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[60] Source: Commuter Connections http://76.227.210.32/commuters/transit/park-ride-locations/

[61] Wilbur Smith Associates and Michael Baker Jr., Inc., Feasibility Study of Real Time Parking Information at Metrorail Parking Facilities (Virginia Stations), June 2009. http://www.wmata.com/pdfs/planning/Real_Time_Parking_Study.pdf

[62] Maryland State Highway Administration, 2013 Maryland State Highway Mobility Report, Sep. 2013. Available: http://sha.maryland.gov/OPPEN/2013_Maryland__Mobility.pdf

Table 2-12 Metro Parking Lot Utilization, October 2006

Station and Region	Lot Capacity	Average Utilization[12]	Average Utilization
		Mon-Thurs	Fri
MONTGOMERY COUNTY			
Grosvenor	1,894	103%	92%
White Flint	1,158	41%	31%
Twinbrook	1,097	84%	70%
Rockville	524	104%	101%
Shady Grove	5,467	83%	78%
Glenmont	1,781	103%	102%
Wheaton	977	63%	40%
Forest Glen	596	101%	96%
PRINCE GEORGE'S COUNTY			
New Carrollton	3,519	98%	88%
Landover	1,866	76%	49%
Cheverly	530	97%	84%
Addison Road-Seat Pleasant	1,268	91%	71%
Capitol Heights	372	88%	82%
Greenbelt	3,399	99%	85%
College Park-U of MD	1,870	68%	64%
Prince George's Plaza	1,068	67%	60%
West Hyattsville	453	101%	102%
Southern Ave	1,980	98%	89%
Naylor Road	368	110%	107%
Suitland	1,890	100%	91%
Branch Ave	3,072	108%	106%
Morgan Boulevard	635	95%	87%
Largo Town Center	2,200	97%	87%
DISTRICT OF COLUMBIA			
Deanwood	194	95%	82%
Minnesota Ave.	333	52%	44%
Rhode Island Ave.	340	95%	94%
Fort Totten	408	88%	86%
Anacostia	808	89%	71%
NORTHERN VIRGINIA			
Huntington	3,090	99%	93%
West Falls Church-VT/UVA	2,009	103%	89%
Dunn Loring-Merrifield	1,319	107%	105%
Vienna/Fairfax-GMU	5,849	100%	91%
Franconia-Springfield	5,069	96%	88%
Van Dorn Street	361	110%	118%
East Falls Church	422	117%	129%
System Total	**58,186**	**94%**	**85%**

Source: WMATA

2.4.3. HOUSEHOLD TRAVEL SURVEYS

The TPB conducts Household Travel Surveys of households in the Washington region and adjacent areas about every ten years to gather updated information on area wide travel patterns. These surveys provide information on such important determinants of travel as household demographics, income, employment destinations, and number of vehicles available. This data helps guide future transportation planning as the area continues to grow.

The last comprehensive regional Household Travel Survey was conducted by TPB staff in 2007-2008, which surveyed 11,472 households in the TPB modeled area. The survey was conducted in two stages: household recruitment by mail and reporting of household travel by telephone. Some key results of survey data analysis include:

- The significant increase in the proportion of single person households in the region had a dramatic impact on the average number of daily trips per household.
- Per person daily trip rates decreased moderately for persons from 5 to 34.
- Per person daily trip rates increased significantly for persons 65+.
- The share of daily trips by auto driver vehicle trips decreased 2.2 percentage points, the walk share increased by 1.6 percentage points, and the transit share increased by 0.7 percentage points.
- The biggest modal shifts between auto driver vehicle trips and the transit and walk modes were seen in the 16 to 34 and the 55 to 64 age groups.
- Persons 25 to 34 more likely to live in Regional Activity Centers.

Following the 2007-2008 TPB Regional Household Travel Survey that was primarily conducted for the development of the new travel demand model, geographically-focused household travel surveys have been conducted from 2010 to 2013. The objective of the surveys are threefold: (1) analyzing daily travel behavior in communities with different densities, physical characteristics and transportation options, (2) assisting local planners with current local land use and transportation planning efforts, and (3) building a household travel survey database that can measure changes in local community travel behavior over a period of time (Before and After comparisons).

The TPB's first phase of Geographically-Focused Household Travel Surveys was conducted in spring 2010, fall 2011 and spring 2012. Surveys were conducted at five high-density developments (14th St NW/Logan Circle, Crystal City, Friendship Heights, and Shirlington), two planned high-density development areas (White Flint and National Harbor), three areas experiencing growth (New York Avenue Corridor area, St, Charles Urbanized Area, and the Dulles North Area) three areas with emerging transportation options (Woodbridge, VA, Beauregard Avenue Corridor, and Frederick, MD), and five study areas with recent or planned rail transit options (Columbia Pike Corridor; Reston, VA; the University Boulevard corridor in Maryland; and the area around the Largo Metrorail Station, and the Falls Church Area[63]. Results for the first ten locations were presented to the TPB at its May 2012 meeting[64]. Results of the additional seven locations were reported in March 2013[65].

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[63] TPB Weekly Report (5/29/12): In-Depth Surveys Provide New Understanding of Neighborhood-Level Travel Patterns in Region, http://www.mwcog.org/transportation/weeklyreport/2012/05-29.asp

[64] Robert Griffiths, 2011 TPB Geographically-Focused Household Travel Surveys Initial Results, a presentation to the TPB Board Meeting on May 16, 2012. http://www.mwcog.org/uploads/committee-documents/k11dXIIe20120517145044.pdf

[65] Robert Griffiths, 2012 TPB Geographically-Focused Household Travel Surveys Initial Results, a presentation to the TPB Travel Forecasting Subcommittee on March 22, 2013. http://www.mwcog.org/uploads/committee-documents/bF1bXVdd20130322143328.pdf

A new, large-scale household travel survey (the TPB 2017/2018 Regional Travel Survey) is currently being conducted in the region that will target 15,000 households in the TPB modeled area. Survey strata consist of Census Public Use Microdata Areas (PUMAs) and COG-defined Regional Activity Centers.[66] The survey launched on October 3, 2017 and data collection for this survey will continue through October 2018. The survey asks households to share information about their usual travel patterns as well as to complete a detailed travel diary for one randomly assigned weekday. Households are being recruited through mailed invitations and will complete the survey using a web-based app or by telephone. Data from the survey will provide insights on whether and how technological and other advances over the last decade have impacted regional travel patterns, particularly the widespread use of smartphones and location-based apps that enable ride-hailing, navigation, and real-time arrival and trip-planning for transit, bicycle, and other travel modes.[67] The preliminary findings from the survey are expected in 2019.

2.4.4. SPECIAL SURVEYS AND STUDIES

The TPB and its member agencies undertake special studies or data collection efforts, on both one-time and recurring bases. Examples include compiling data to form a regional travel trends report, as well as monitoring transit usage, and cordon counts of traffic on specified areas of the region.

2.4.4.1. Regional Bus Survey

A major regional bus survey was conducted in Spring 2008 on behalf of the TPB[68]. The purposes of this survey were to: 1) collect the jurisdiction of residence data of Washington Metropolitan Transit Authority's (WMATA) weekday bus passengers in support of WMATA's bus subsidy allocation formula; 2) collect origin and destination trip patterns of the local jurisdiction bus systems for local bus route planning and regional travel demand model validation; and 3) collect other travel-related and demographic data to update the regional profile of WMATA and local bus system riders and their related bus trips.

Transit systems surveyed were ART (Arlington Transit), The Bus (Prince George's County), CUE (Fairfax, VA), DASH (Alexandria Transit Co.), TransIT (Frederick County Transit), OmniRide/OmniLink (PRTC), Ride On (Montgomery Co.) and Metro Bus (D.C, Virginia, Maryland). Some key findings of this survey include:

- Except for Metrobus, most systems primarily served residents of a particular geographic subarea of the region.
- Except for PTRC and TheBus, more than half the riders access their bus by walking to it.
- The PRTC and TheBus systems have large percentages of riders who park-and-ride, at 22% and 15% respectively.
- Commuting to work accounts for one-half to two-thirds of the trips on each bus system.
- SmarTrip was the predominant payment method used by PRTC (57%) and Metrobus (42%).
- Overall 24% of the surveyed bus riders reported receiving a transit benefit from their employer.
- Choice riders are riders who had a vehicle available to them to make the trip they were making, but "chose" to make the trip by bus instead. The PRTC ART and DASH systems had the greatest percentages of "choice" riders.

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[66] Kenneth Joh, 2017-2018 Regional Household Travel Survey Status Report #8, a presentation to the TPB Travel Forecasting Subcommittee on September 22, 2017. https://www.mwcog.org/file.aspx?&A=ikZMncsfgEIBnHbqVOnibWiE2L1E%2buXFS3%2bUHfdNI4U%3d

[67] TPB News (10/10/17): Once-In-A-Decade Regional Travel Survey Kicks Off, https://www.mwcog.org/newsroom/2017/10/10/once-in-a-decade-regional-travel-survey-kicks-off/

[68] NuStats, *2008 Regional Bus Survey Technical Report*, June 2009.

An updated survey, the 2014 Metrobus Survey[69] was initiated in late 2013 and completed in 2015[70]. This survey aimed to update ridership by jurisdiction of residence for use in Metrobus's operating subsidy allocation, and collect demographic, travel, and access data for Title VI compliance, system planning, and operation analyses. This was not a customer opinion survey; it focused on ridership and travel characteristics,

Some initial results were posted on the Metro's Planning Blog, PlanItMetro[71], and reported to the TPB's Regional Public Transportation Subcommittee[72]. The survey data and survey instrument can be downloaded from PlanItMetro.

2.4.4.2. Regional Travel Trends Report

The TPB receives updates regarding regional travel trends from time to time, and the latest report was made to the TPB on April 20, 2016[73]. The rate and spatial pattern of population growth are key to the underlying changes in travel trends. The metropolitan Washington region has seen a fast increase in growth over the last several decades, and with that come major changes in how and why people travel. This is important to congestion management, in that it is important in understanding why congestion may be occurring in particular areas. In addition, travel trends can help predict, and prepare for, future congestion.

General findings of the 2000-2015 regional travel trends include:

- Population and employment in the region increased by 9% between 2000 and 2007. Weekday VMT increased by 18% and Metrorail ridership increased by 25% in this period.
- Between 2007 and 2014 population increased by 13% and employment increased by 2%. Weekday VMT declined by 1% and total transit ridership increased by 2%. Metrorail ridership decreased by 2% in this period. Total bus ridership increased by about 5% and commuter rail ridership increased by 25%.
- VMT per capita increased by 8.5% between 2000 and 2007 and decreased by 10.5% from 2007 to 2014. Peak period congestion decreased by 6.5% between 2010 and 2013.
- The share of commuters teleworking, at least occasionally, increased from 11% in 2001 to 27% in 2013. Commuter Rail and Metrorail commuters are more than Drive Alone and Bus commute to telework, at least occasionally.

2.4.4.3. Local Studies

Sometimes member state and local jurisdictions will conduct studies to analyze and evaluate their own programs, and these studies can be important to congestion management.

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[69] Robert E. Griffiths, 2014 Metrobus Survey, Presentation to Regional Bus Subcommittee, March 25, 2014. http://www.mwcog.org/uploads/committee-documents/a11ZWFtf20140325100202.pdf

[70] Melissa, 2014 "Metrobus Survey" Complete, a blog on PlanItMetro: http://planitmetro.com/2015/08/05/2014-metrobus-survey-complete/

[71] Justin, Three Tidbits: What the Metrobus 2014 Survey Can Tell Us, a blog on PlanItMetro, http://planitmetro.com/2015/10/26/three-tidbits-what-the-metrobus-2014-survey-can-tell-us/

[72] WMATA Office of Planning, 2014 Metrobus Survey, Presentation to Regional Public Transportation Subcommittee, October 2015. http://www.mwcog.org/uploads/committee-documents/lVxfWF9f20151027132346.pdf

[73] Robert Griffiths, Regional Travel Trends, a presentation to the TPB Board Meeting on April 20, 2016. https://www.mwcog.org/uploads/committee-documents/aFxeVlhd20160421091747.pdf

An example of one such effort is the Montgomery County Mobility Assessment Report (MAR) produced by the Maryland – National Capital Park and Planning Commission (MNCPPC)[74]. The report is updated annually (with exceptions) with the latest information regarding the status of congestion in Montgomery County, Maryland.

Intersections and arterials are two main focuses of the report. For intersections, observed Critical Lane Volumes (CLVs) is the performance measure and the ratio of CLVs over Local Area Transportation Review (LATR) standard is used to quantify intersection congestion. The report also ranks the most congested intersections in the county for more detailed analysis. For arterials, the VPP/INRIX data and the VPP Suite were used to analyze traffic congestion. Travel Time Index was the main performance measure and a color scheme of congestion severity was developed.

2.4.5. THE REGIONAL TRANSPORTATION DATA CLEARINGHOUSE[75]

Over the years, staff at the National Capital Region Transportation Planning Board (TPB) has collected transportation data from various sources, primarily member jurisdictions, state agencies, and transit authorities. These data are packaged into a web-based application, called the Regional Transportation Data Clearinghouse (RTDC). The RTDC was developed to improve access and data sharing between TPB member, jurisdictional partners, as well as other interested parties.

Datasets in the RTDC represent various transportation modes (highway, transit, bicycle, aviation). Current 'core' RTDC datasets such as traffic and transit counts are routinely updated as new data become available. Additionally, new content is added periodically, based on data availability, user requests and/or other means of discovery.

The RTDC contains two web-based components—a project page (data portal) and data viewer. Both of these components are built upon the ArcGIS Online platform, which includes the ArcGIS Open Data model. This flexible platform allows TPB easily share its spatial data resources and allows integration of data, maps and applications.

The RTDC Project Page can be accessed at http://rtdc-mwcog.opendata.arcgis.com/. Users can search for data by keyword or category and can also choose to show all available datasets. Each RTDC dataset has its own content page with metadata, a link to download data, and a summary of dataset attributes. The RTDC project page also contains sections for TPB web maps and applications shared through the Clearinghouse as well as the RTDC data viewer.

AVAILABLE DATA IN THE RTDC

- Annualized Traffic Volumes
    - Traffic Counts - Annual Average 2008-2015 (by Count Station)
    - Traffic Counts - Annual Average 2008-2015 (by network link)
    - Traffic Counts - Annual Average 2008-2015 (External Stations)
- Hourly Traffic Volumes 2008-2014
    - Permanent Count Stations
    - Short Term Count Stations

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[74] Maryland – National Capital Park and Planning Commission (MNCPPC), Mobility Assessment Report (MAR), Draft, April, 2014.
http://www.montgomeryplanning.org/transportation/documents/Mobility%20Assessment%20Report%202014%20-%20(6-3-2014).pdf

[75] Based on information provided by Charlene Howard to the TPB's Travel Forecasting Subcommittee meeting on May 20, 2016. http://www.mwcog.org/uploads/committee-documents/mFxdXV9f20160520135726.pdf

  - Hourly Traffic tables, 2008-2014
- 2014 Vehicle Classification - Weekday
  - AM (6:00 AM- 8:59 AM) (8)
  - Mid Day (9:00 AM - 2:59 PM) (9)
  - PM (3:00 PM - 6:59 PM) (10)
  - Night (After 7:00 PM) (11)
- Central Employment Core Cordon count, 1993-2013
  - Core Cordon Count - Vehicles by Mode
  - Core Cordon Count - Vehicles by Occupancy
  - Core Cordon Count - Passengers by Mode
- Road Networks
  - Regional Freight-Significant Network
  - Managed Lanes
  - Truck Restrictions
  - Highway Performance Monitoring System (HPMS)
  - National Highway System (NHS)
  - Vehicle Miles Traveled (VMT) tabular data
  - Electric Vehicle Charging station locations (point data)
  - Modeling-related datasets
    - External Stations
    - Screen lines
    - Central Core
- Transit Data
  - Average weekday transit ridership (bus routes, VRE, MARC)
  - WMATA Metrorail stations & lines
  - 2012 Metrorail Passenger Survey
  - Average weekday Metrorail ridership by month, 2010-2017
  - Historical Metrorail ridership by year, by station, 1977-2017
- Aviation
  - Washington-Baltimore Regional Air Passenger Survey Air Passenger Originations by Airport, 2011-2015
  - Enplanement 2000-2016 by Year, Month by Airport
- Land Use
  - Cooperative Forecast 9.0 by TAZ – population, households and employment 2015-2045
  - Cooperative Forecast tabular data for previous rounds (from 8.0a)
  - COG Regional Activity Centers
  - TPB TAZ by Activity Center
  - COG TAZ by Activity Center
- Performance-Based Planning and Programming (PBPP)
  - Bridge condition (2016 NBI)
  - Pavement Condition (2015 HPMS)
- Long Range Plan (CLRP, LRP, Environmental Justice)
  - 2015 CLRP Amendment
  - 2016 CLRP Amendment
  - Equity Emphasis Areas (based on Census block groups)
- Bicycle and Pedestrian
  - DC Bicycle Counts
  - VDOT Bicycle Counts
  - Regional automated bike/ped counter data

  - Capital Bikeshare stations (content from DC's Open Data)
  - Bike to Work Day, map of current pit stops
- Regional Boundaries
  - TPB Members
  - COG Members
  - TPB Modeled Area
  - COG Members with Adjunct Members
  - Air Quality Conformity Boundaries
  - TPB Urbanized Area
- Census Transportation Planning Products
  - Total Vehicles Available in TAZ
  - Total Vehicles Available per Worker Household at Place of Work TAZ
  - Percentage of workers with a Household income below $30,000 or above $150,000 at Workplace TAZ
  - Percentage of Households with a household income below $30,000 or above $150,000 at place of residence TAZ
  - Mode of Transportation of workers at workplace TAZ of Worker's Commute
  - Mode of Transportation, from place of residence TAZ
  - Mean Travel Time by means of Transportation – Place of Work (TAZ in minutes)
  - Mean Travel Time by Means of Transportation – Place of Residence TAZ (in minutes)
  - Household size by TAZ

THE RTDC DATA VIEWER

The RTDC Data Viewer (http://gis.mwcog.org/rtdc/map) provides users with a quick and simple way to explore many of the datasets in the RTDC. This data viewer is intended to provide a high-level glimpse into RTDC datasets and does not provide robust query and analytical capabilities.

Users can turn layers on/off and click on features to open the popup window that display attribute data. The widgets on the toolbar allow users to interact with specific datasets. Each widget is described below. The widget toolbar is located on the bottom center of the application window. (Differences in position and appearance when viewed on mobile and tablet devices may be due the responsive design of the application).

- Add Data – enables users to add data to the map from ArcGIS Online, service URLs, or uploading local files in a variety of formats
- Query- Search traffic and transit datasets by various means (route name, transit operator, location); results returned on-screen and list format.
- Hourly Traffic Volumes by Station / Year – show hourly traffic volumes for a selected station per year. (hint: turn on hourly count layer to display stations before clicking on the map) Alternately, use the search tool to find a particular geographic area.
- Transit: Summary Charts – show summary-level data for transit datasets in the RTDC (average weekday ridership, Metrorail)
- TAZ Summary Tool – allows users to define an area on the map (click or defining an area freehand) and a buffer distance (optional) and return the number of TAZ in the area of interest as well as sum of TAZ Values for 2015 and 2045 population, households, and employment.
- VMT Regional Total (2005-2016) & Cumulative Growth, by Jurisdiction (2007-2016) – displays a graph of for the requested geography
- Charts: Pavement Conditions 2015 – displays the percentage of each rating value by Jurisdiction; based on 2015 Highway Performance Monitoring System (HPMS) data

- Charts: Bridge Conditions (2016) – displays the percentage of each rating value by Jurisdiction; based on 2016 National Bridge Inventory (NBI)
- Pavement Bridge and Pavement – retrieves bridge and pavement condition using a jurisdiction query
- Pedestrian & Bicycle Counts – allows users to select counts based on type of count
- Detailed Bicycle and Pedestrian – allows users to select counts by type of count
- Metrorail Average Weekday Ridership – use this tool to select year, month, and time of day to display the selected values for each Metrorail station. Data can be downloaded.
- Airport Stats by Year – displays data by airport and year
- Airport Stats by Month – provides airport enplanement/deplanement stats by year and airport

2.5. National Comparison of the Washington Region's Congestion

Regularly since 1982, the Texas A&M Transportation Institute releases an *Urban Mobility Report*[76], which outlines and compares urban congestion and mobility in all urban areas across the United States. The most recent report was released in August 2015 and was based on 2014 data from the National Highway Performance Monitoring System (HPMS) and INRIX, Inc. As of March 31, 2018, the "2015 Urban Mobility Scorecard" was the latest version published on the website. Since 2007, INRIX, Inc., an independent live traffic information provider based on GPS units equipped on smartphones, in-vehicle devices and commercial fleets, releases a *INRIX Traffic Scorecard*[77] for the largest 100 metropolitan areas in the U.S. TomTom also releases online TomTom Traffic Index[78] in recent years.

The above three national or international reports use different performance measures, which greatly impacts the rankings of cities (Table 2-13). The Washington region ranked No. 1, No. 2, and No. 8 in the latest rankings published by the Texas A&M Transportation Institute, INRIX, and TomTom, respectively. Although both the Texas A&M Transportation Institute and INRIX use annual hours of delay per person, the former was based on speed provided by INRIX and traffic volume estimated from AADT provided in the Highway Performance Monitoring System (HPMS), and the latter was calculated from Travel Time Index, typical commute trip length, and the number of trips the typical commuter takes in a month/year, resulting in different numbers of hours of delay and ranking. If based only on extra time compared to free-flow conditions, as used by TomTom, the Washington is only the 8th in the nation.

Table 2-13 National Comparison of the Washington Region's Congestion

Texas A&M Transportation Institute (2014 data)			INRIX Traffic Scorecard (2016 data)			TomTom Traffic Index (2016 data)		
Annual Hours of Delay per Auto Commuter			Average Hours Wasted in Traffic			Extra Travel Time compared to Free Flow Conditions		
Metro Area	Value	Rank	Metro Area	Value	Rank	Metro Area	Value	Rank
Washington	82	1	Los Angeles	102	1	Los Angeles	45%	1
Los Angeles	80	2	New York	91	2	San Francisco	39%	2
San Francisco	78	3	San Francisco	79	3	New York	35%	3
New York	74	4	Atlanta	70	4	Seattle	34%	4
San Jose	67	5	Miami	64	5	San Jose	32%	5
Boston	64	6	Washington	63	6	Miami	30%	6
Seattle	63	7	Boston	60	7	Portland	29%	7
Chicago	61	8	Chicago	57	8	Honolulu	29%	8

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[76] David Schrank, Bill Eisele, Tim Lomax, Jim Bak of the Texas A&M Transportation Institute and INRIX, Inc. *2015 Urban Mobility Scorecard*. August 2015. http://mobility.tamu.edu/ums/

[77] INRIX, Inc., Traffic Scorecard, http://inrix.com/scorecard/

[78] TomTom, Traffic Index, https://www.tomtom.com/en_gb/trafficindex/list

Houston	61	8	Seattle	55	9	Washington	29%	9
Riverside	59	10	Dallas	54	10	Boston	28%	10

2.6. Performance and Forecasting Analysis of the 2016 Financially Constrained Long-Range Transportation Plan (CLRP)

The CLRP includes all regionally significant transportation projects and programs planned in the Metropolitan Washington region over the next 25-30 years. Each year the CLRP is updated to include new projects and programs. TPB produces a performance analysis of every CLRP, which examines trends and assesses future levels of congestion and other performance measures. The 2016 CLRP Performance Analysis[79] provides both an overall assessment of the anticipated impacts of the CLRP, as well as an indication of future levels of congestion relevant to the CMP.

A new kind of long-range transportation plan, i.e. Visualize 2045, was introduced for the National Capital Region after the 2016 CLRP. The plan, which is being developed by the TPB, will show the more than 1,000 projects and improvements the region's transportation agencies are planning through 2045—both what they can afford now (previously included in the Constrained Long-Range Transportation Plan) and what they would build if they had more funding. Visualize 2045 is expected to be finalized in late 2018.

Plan performance analyzes the outlook for growth in the region. One of the cornerstones of plan performance is the forecasting of future congestion. The plan performance looks at where in the region congestion will occur in the future and compares current congestion to future congestion. It looks at criteria that may affect congestion, such as changes in population, employment, transit work trips, vehicle work trips, lane miles, and lane miles of congestion. The analysis also breaks down lane miles of congestion into core, inner suburbs, and outer suburbs, providing information on where, generally, the most lane miles of congestion can be found in 2040 compared to 2016.

From 2016 to 2040, the region is forecast to be home to 23% more residents and 29% more jobs in 2040 (Figure 2-48). Towards accommodating that growth, 7% more lane miles of roadway and 26% more transit rail miles are planned to be constructed. The total number of trips taken is expected to increase by 23%, while transit, walk, and bike trips together are expected to increase at a faster rate than single driver trips. The overall amount of driving (VMT) is expected to grow by 21%. This is slightly less than forecast population growth, which means that VMT per capita is expected to drop by 2%. The increase in demand on the roadways is forecast to out-pace the increase in supply, leading to a significant increase in congestion.

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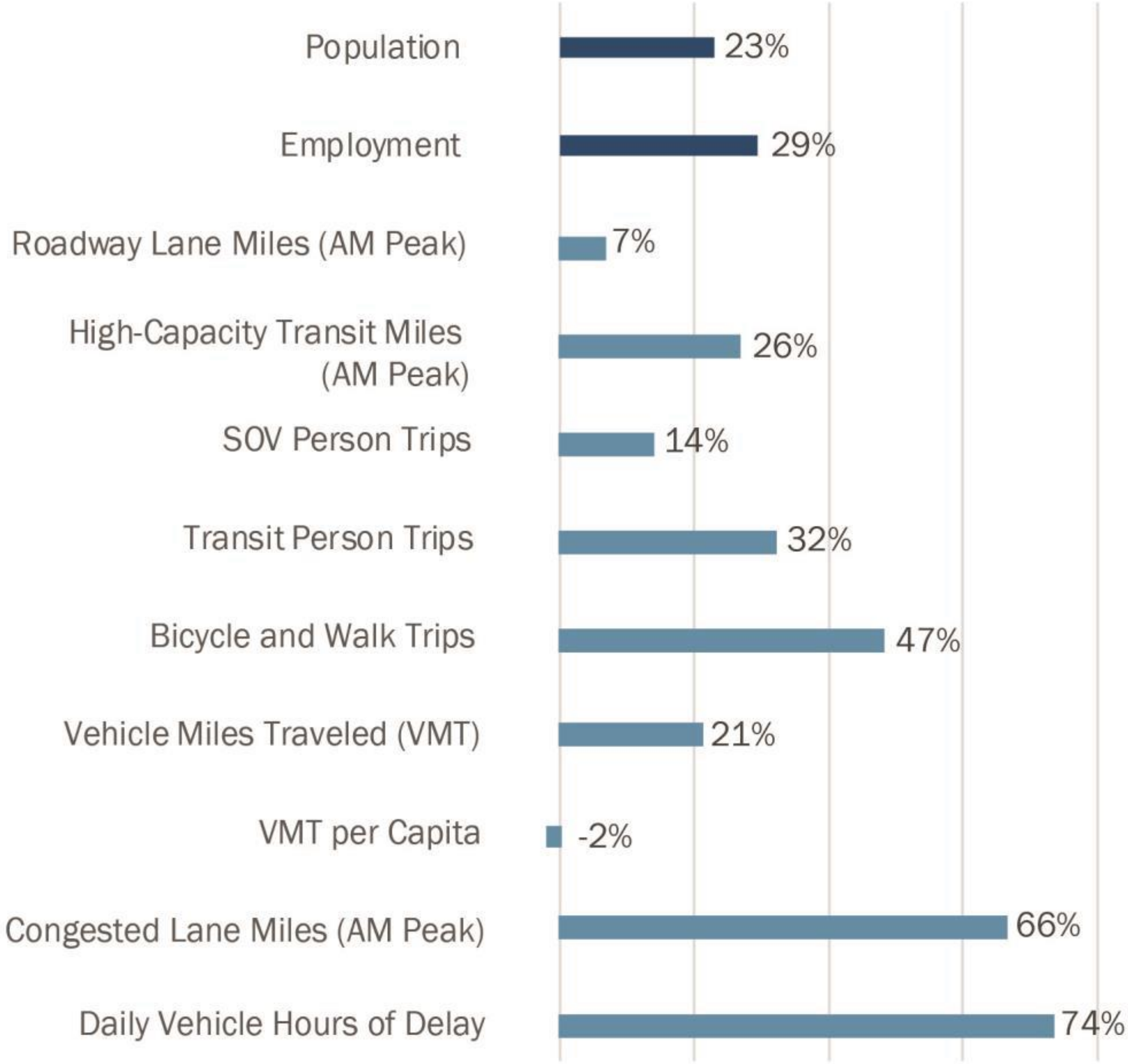
[79] TPB, FINANCIALLY CONSTRAINED LONG-RANGE TRANSPORTATION PLAN (CLRP) FOR THE NATIONAL CAPITAL REGION - 2016 CLRP Amendment Documentation, November 16, 2016. http://www1.mwcog.org/clrp/resources/2016/2016AmendmentReport.pdf

Figure 2-48 2016 Performance Analysis Summary



Congested lane miles in the AM peak hour are projected to increase by 66% in 2040 compared to 2016, meaning that 1,111 lane miles of roadway which were not congested in 2016 will be congested in 2040 (in the AM peak hour). In Figure 2-49, looking at the share of lane miles congested in comparison to all the lane miles of roadway in our region helps tell another part of the story: in 2016 during the AM peak hour 10% of lane miles in the region were congested and in 2040 during the AM peak hour 15% of lane miles are projected to be congested. This demonstrates that while roadway capacity is expanding, the region's travel demand due to growth in population and employment will further congest a small set of the most popular roadways

The amount of driving in the region, measured as vehicle miles traveled or VMT, is expected to grow over the next 25 years, but at a slightly lower rate than population growth (Figure 2-50). This means that the average amount of driving per person will be less in 2040 than it is today. Though the drop in VMT per capita is slight, it is noteworthy because it signals the reversal of a decades-long trend of ever-increasing driving in the region. As recently as the mid-2000s, the region's travel demand model was forecasting significant increases in VMT per capita well into the future. Changes in projected land-use and travel patterns are the primary drivers of the reversal of this trend.

Though congestion on many segments of the region's major highway system is expected to get worse over this period of time, some segments of highway will see slight relief in congestion thanks to capacity expansions or changes in travel behavior (Figure 2-51). Major highways seeing improvements in congestion include portions of I-66 East, I-70 East, and VA-267 East.

Figure 2-49 Share of AM Peak Hour Lane Miles that Are Congested

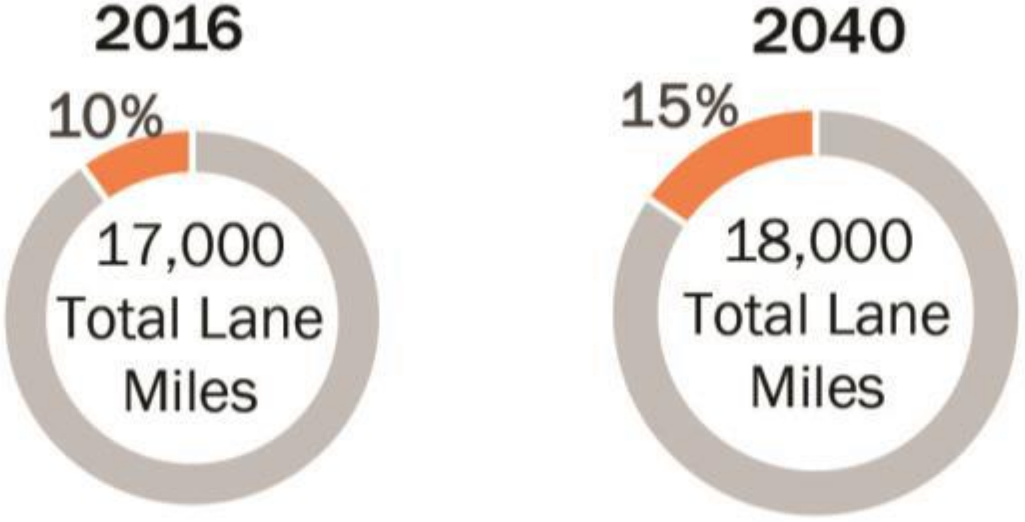


Figure 2-50 Vehicle Miles of Travel: Total and Per Capita

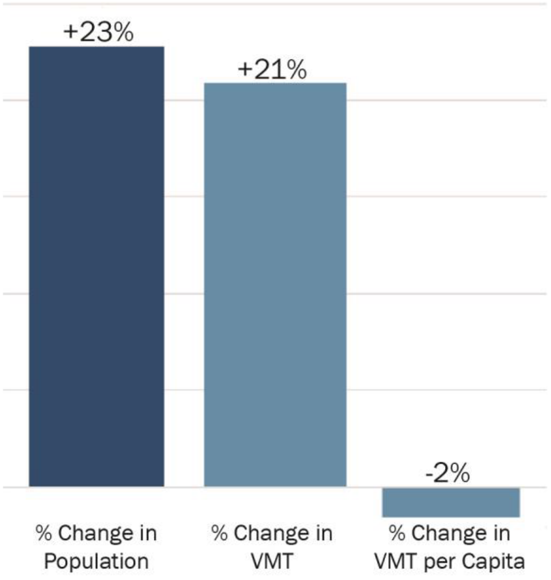
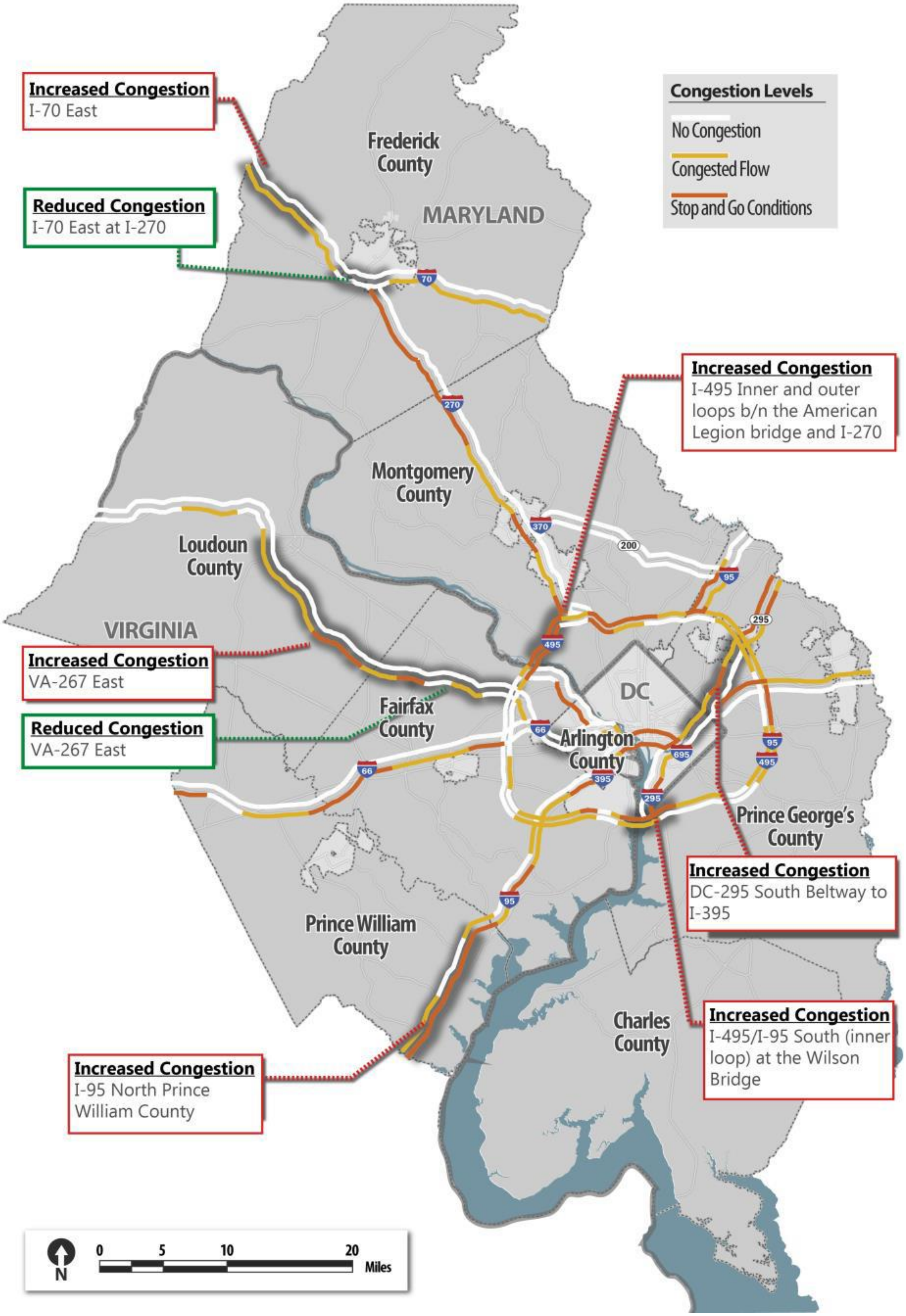
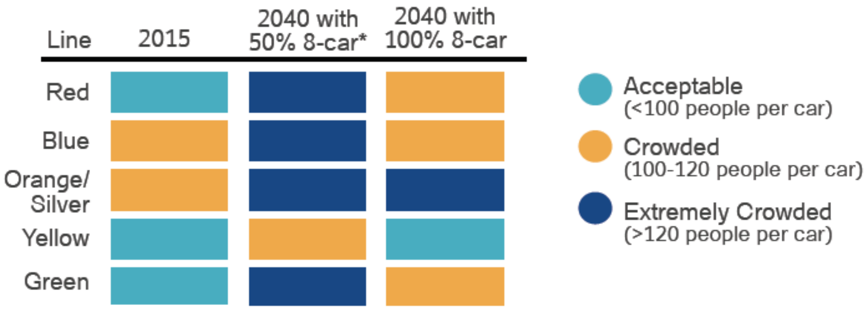


Figure 2-51 2040 Major Highway Congestion in AM Peak



With regard to transit congestion, analysis completed by WMATA shows that four out of five lines entering the downtown core are expected to become congested or highly congested by 2040 (Figure 2-52). Without additional capacity, WMATA estimates that the Metrorail system will reach capacity by 2040 on trips to and through the core.

Figure 2-52 Metrorail Crowding



Line	2015	2040 with 50% 8-car*	2040 with 100% 8-car
Red	🟦	■	🟧
Blue	🟧	■	🟧
Orange/ Silver	🟧	■	■
Yellow	🟦	🟧	🟦
Green	🟦	■	🟧

🟦 Acceptable (<100 people per car)
🟧 Crowded (100-120 people per car)
■ Extremely Crowded (>120 people per car)

The 2015 CLRP assumes 50% 8-car trains in 2040

The average number of jobs that are accessible within a 45-minute commute by automobile is expected to decrease slightly between now and 2040. Figure 2-53 shows the geographic distribution of the change in number of jobs accessible from 2016 to 2040. Significant declines in job accessibility by automobile are expected on the eastern side of the region and in the inner suburbs. These declines are the result of two important factors: one, anticipated increases in roadway congestion, which make it more difficult to reach other parts of the region by car within 45 minutes, and, two, the fact that more of the new jobs anticipated between now and 2040 are forecast to be located on the western side of the region, out of reach of those living in the east.

In 2040 there will be more jobs located near existing transit stations and stops, and expansions of the transit system across the region will also bring higher quality service to more areas. When looking at the geographic distribution of the change in access to jobs from 2016 to 2040 (Figure 2-54), most places that currently have access to transit will experience increases in the number of jobs that are accessible within a 45-minute commute. However, in 2040 transit may still not be a viable commute option for many people in the region due to lack of access to transit facilities and potentially long travel times.

Figure 2-53 Change in Access to Jobs by Automobile, 2016-2040

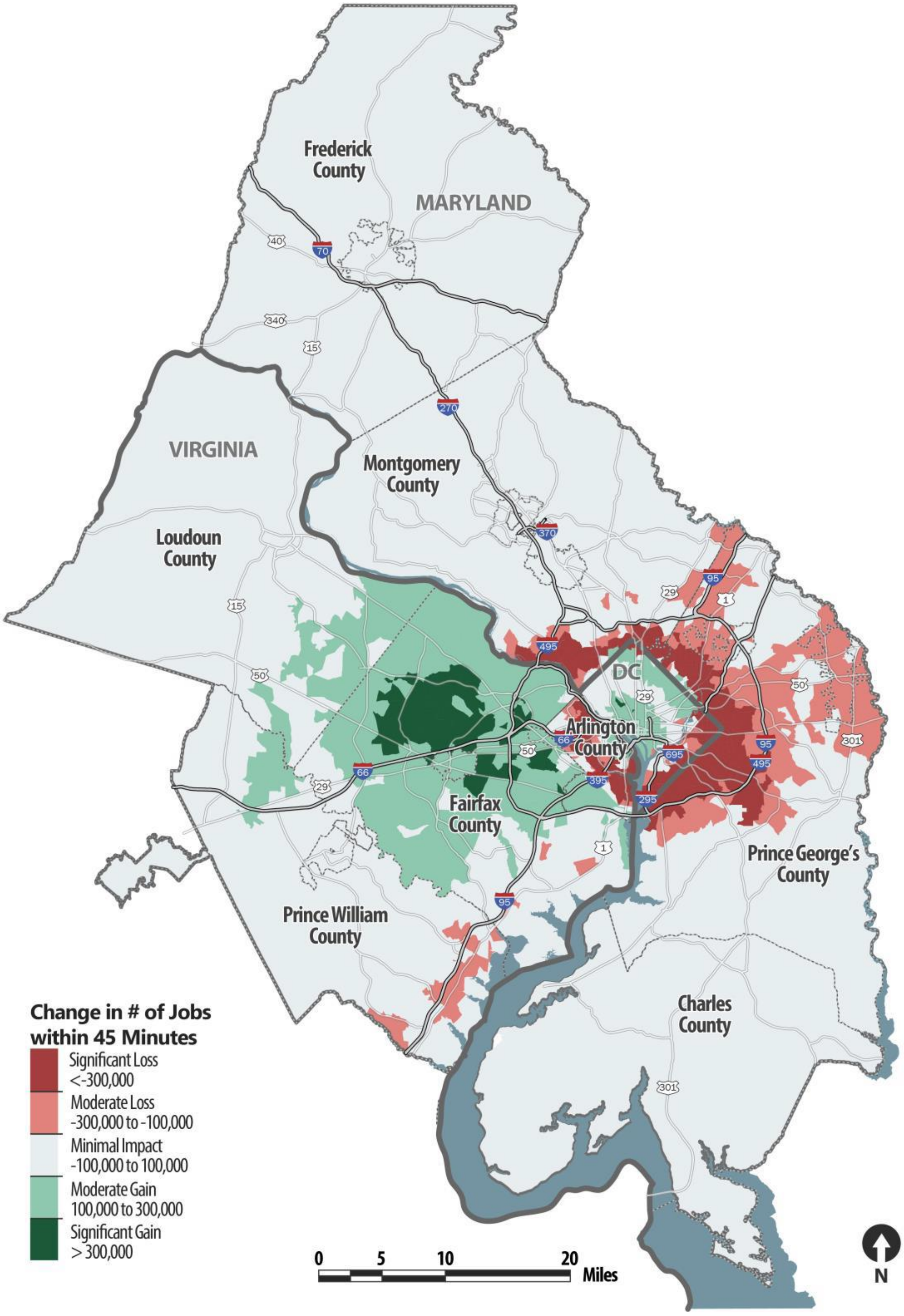


Figure 2-54 Change in Access to Jobs by Transit, 2016-2040