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CONGESTION MANAGEMENT PROCESS (CMP) TECHNICAL REPORT

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July 10, 2012

National Capital Region Transportation Planning Board
Metropolitan Washington Council of Governments

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The Metropolitan Washington Council of Governments (COG) is the regional organization of the Washington area's major local governments and their governing officials. COG works toward solutions to such regional problems as growth, transportation, the environment, economic development, and public safety. The National Capital Region Transportation Planning Board (TPB) conducts the continuing, comprehensive transportation planning process for the National Capital Region under the authority of the Federal-Aid Highway Act of 1962, as amended, in cooperation with the states and local governments.

ABSTRACT:

This report provides technical details and documents the Congestion Management Process in the National Capital Region. It contains updated congestion information and congestion management strategies on the region's transportation systems, as well as the process integrating the Congestion Management Process into the region's Financially Constrained Long-Range Transportation Plan.

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EXECUTIVE SUMMARY

Background

A Congestion Management Process (CMP) is a requirement in metropolitan transportation planning from both the 2005 federal SAFETEA-LU transportation legislation and its supporting metropolitan planning regulations. These regulations were a basis for the CMP components that are wholly incorporated in the region's Constrained Long-Range Plan (CLRP) for transportation. The CMP component of the CLRP constitutes the region's official CMP, and serve to satisfy the SAFETEA-LU requirement of having a regional CMP.

This CMP Technical Report serves as a background document to the official CLRP/CMP, providing detailed information on data, strategies, and regional programs involved in congestion management. T his 2012 CMP Technical Report is an updated version of the previously published CMP Technical Reports (2010 and 2008, respectively).

Components of the CMP

The National Capital Region's Congestion Management Process has four components as described in the CLRP:

- Monitor and evaluate transportation system performance
- Define and analyze strategies
- Implement strategies and assess
- Compile project-specific congestion management information

This report documents and provides technical details of the four components of the CMP. It compiles information from a wide range of metropolitan transportation planning activities, as well as providing some additional CMP specific analyses, particularly travel time reliability and non-recurring congestion analyses.

Congestion on Freeways

FREEWAY MONITORING

The National Capital Region's freeway monitoring program has been traditionally based upon a comprehensive aerial photography survey of the region's freeway system conducted by Skycomp, Inc. AM and PM peak periods[1] congestion is monitored once every three years since 1993 and the most recent survey was conducted in Spring 2011[2].

[1] The AM peak was 6:00-9:00 AM outside the Capital Beltway and 6:30-9:30 AM inside the Capital Beltway. The PM peak was 4:00-7:00 PM inside the Capital Beltway and 4:30-7:30 PM outside the Capital Beltway.
[2] *Traffic Quality on the Metropolitan Washington Area Freeway System*: *Spring 20011 Report*. Prepared by: Skycomp, Inc. (Columbia, Maryland)

Since July 1, 2008, the majority of the region's freeways have also been monitored by the I-95 Corridor Coalition's Vehicle Probe Project[3] and its expansions made available by Virginia and Maryland (300+ centerline miles freeways, as shown in red in Figure 1). The two most significant advantages of this new innovative data source are that it provides continuous (24/7/365) monitoring, and that it reports segment-based speeds and travel times, which are more accurate than estimates from speeds measured by location-fixed detectors.

The third regional freeway monitoring activity is provided by the Federal Highway Administration's Transportation Technology Innovation and Demonstration (TTID) Program, which was enabled by SAFETEA-LU to advance the deployment of intelligent transportation infrastructure[4]. This TTID program provides valuable vehicle volume information.

Vehicle speeds collected by the Vehicle Probe Project and volumes offered by the TTID program are integrated in this report to provide critical performance measures such as person- or vehicle-delay, vehicle miles of travel (VMT), vehicle hours of travel (VHT), etc.

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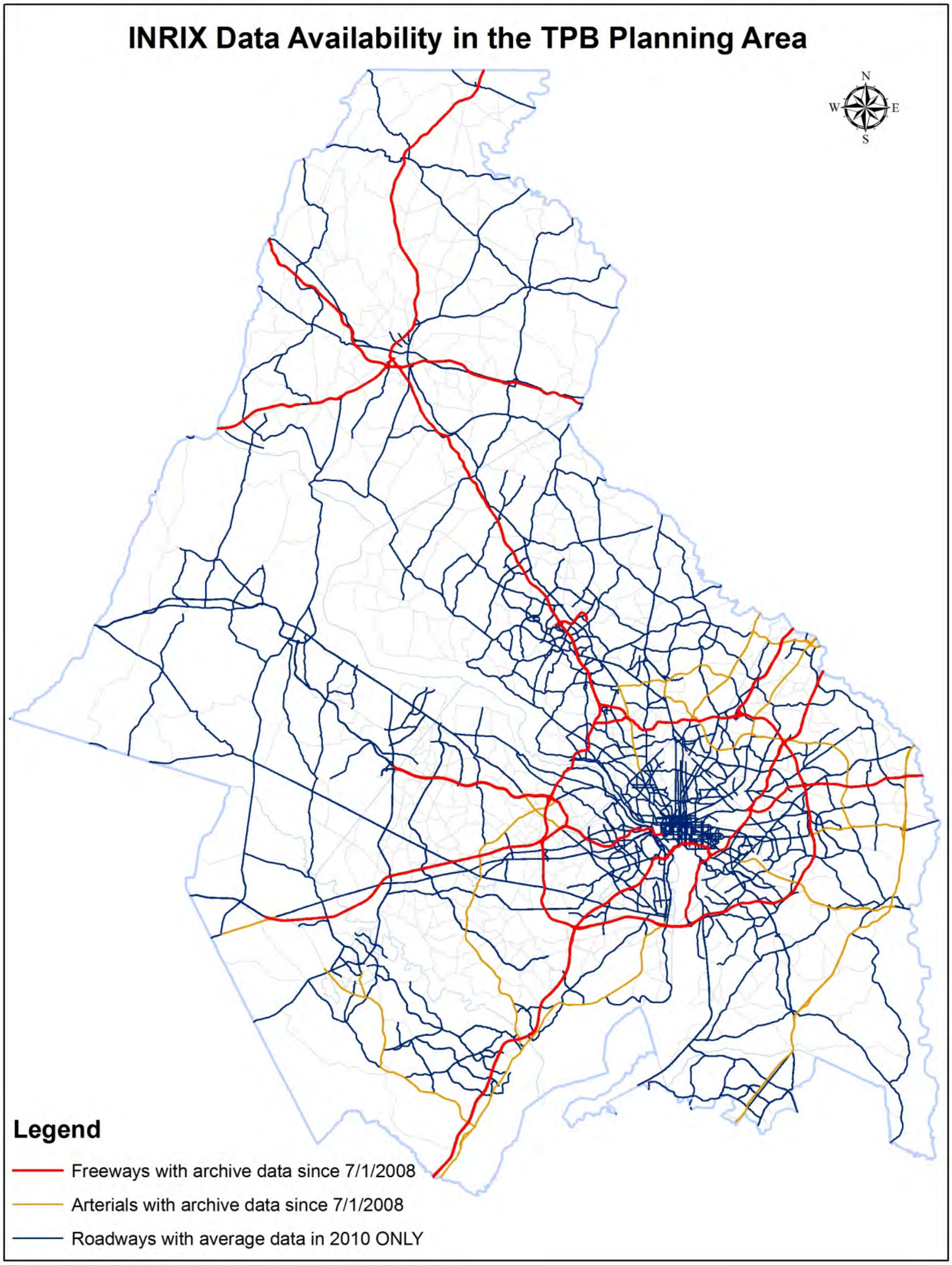
[3] The I-95 Corridor Coalition has contracted for data services from INRIX, Inc., and for the duration of its contract is making data available free of charge to Coalition members including TPB http://www.i95coalition.org/i95/VehicleProbe/tabid/219/Default.aspx

[4] FHWA, Transportation Technology Innovation and Demonstration (TTID) Program http://ops.fhwa.dot.gov/travelinfo/ttidprogram/ttidprogram.htm

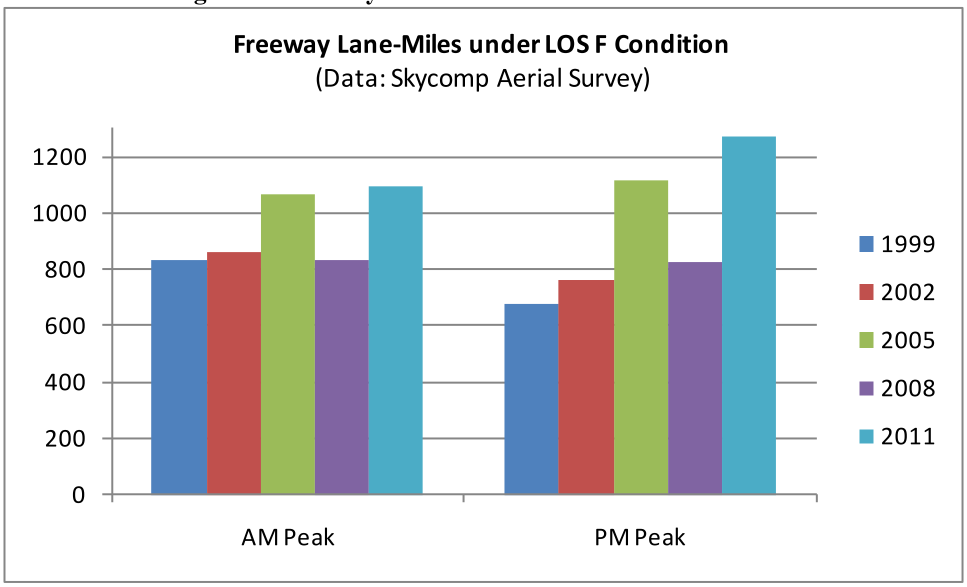
Figure 1: INRIX Data Coverage in the National Capital Region (as of 12/31/2011)



FREEWAY CONGESTION

From 2008 to 2011, lane-miles of congestion in the Washington region continues to grow according to the aerial photography surveys conducted by Skycomp, Inc. Regionally lane-miles[5] under congested conditions (LOS F), which experienced a dip in 2008 due to the downturn in economy, has increased by 50% over 2008 conditions but only 10% over the 2005 conditions (Figure 2). The Capital Beltway had a 260 lane-miles increase in congestion during the AM and PM peak periods compared to the 2008 survey.

Figure 2: Freeway Lane-Miles under LOS F Condition



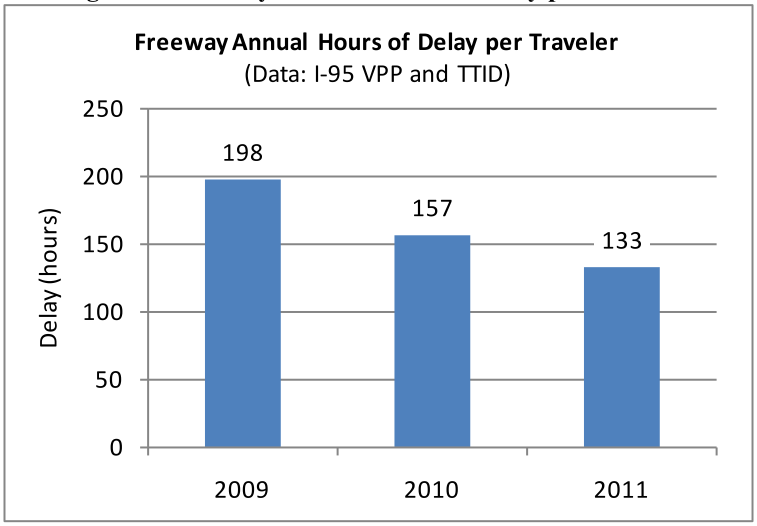
From 2009 to 2011, freeway travelers in the Washington region on average experienced decreasing delays[6] according to data provided by the Vehicle Probe Project and the TTID program (Figure 3). The 2011 total hours of delay of a typical traveler who commuted on freeways was 133 hours (or 5.5 days, or 32 minutes per workday per traveler), decreased by 15% and 33% compared to 2010 and 2009, respectively. If converted to a monetary value, the 2011 annual delay cost was $2,558 per traveler (or 7 dollars per day per traveler)[7].

[5] The lane-miles were calculated as the *total* of the three-hour peak period (i.e., total AM peak = sum of each hour's lane-miles under LOS F in the 3-hour AM peak period). Regionally, the TPB has about 2,000+ freeway lane-miles

[6] The differences between the Skycomp survey findings and the INRIX data analysis results could be: 1) Time periods of analysis are different. The Skycomp survey compares Spring 2008 and Spring 2011, while the INRIX data compare 2009 through 2011. Skycomp photo samples were collected during AM and PM peaks for four good-weather days, while INRIX gathers data 24/7/365. 2) Performance measures used are different. LOS F is a very broad spectrum for traffic conditions, with speed ranges from stop-and-go to about 40 mph. Delay is used in analyzing INRIX data, and it can capture any difference between free flow speed and actual speed.

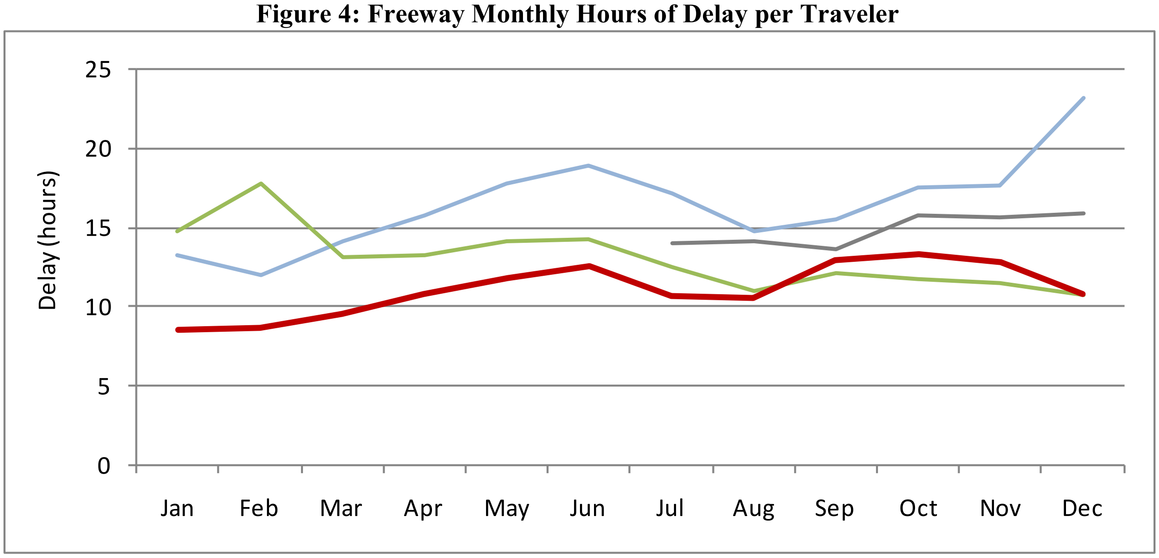
[7] 1 hour = $19.24, a value derived from the TPB travel demand model and the 2007/2008 Household Travel Survey.

Figure 3: Freeway Annual Hours of Delay per Traveler



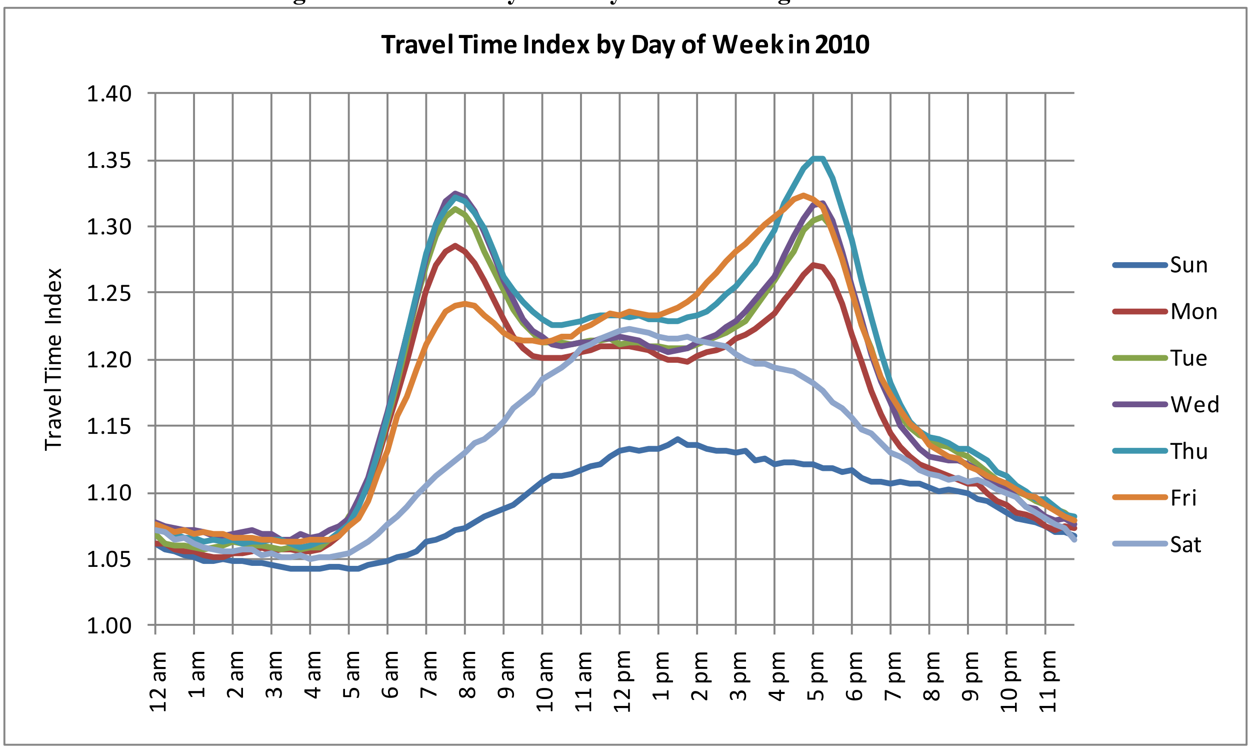
The delay had clearly seasonal variations over the course of a year (Figure 4). June usually experienced the longest delay, while the winter months and August had only moderate delays, except when adverse weather conditions were in presence, such as the winter storms occurred in December 2009 and February 2010. Compared with the same months from 2009 to 2011, the 2009 months, except for January and February, had the longest delays. Chronologically, the higher level delay existed from early summer 2009 to February 2010; then it started to decrease until early 2011; thereafter the delay started increasing and even exceeded the 2010 level in the second half of the year, but still lower than that of 2009 and 2008.

Figure 4: Freeway Monthly Hours of Delay per Traveler



Congestion also varies among different time of day and day of week, as illustrated by travel time index – the ratio of actual travel time over free flow travel time – in Figure 5 using procured INRIX 2010 data (including freeways and arterials, totaling 5,564 route miles). Wednesday mornings and Thursday afternoons were the busiest AM and PM peak periods. Thursday 5:00-6:00 PM remained the most congested hour of the week and Wednesday 7:00-8:00 AM remained the most congested morning rush hour. For the same workday, the morning peak hour could be more or less congested than the evening peak hour: on Mondays, Tuesdays and Wednesdays, the AM peak was more congested; on Thursdays and Fridays the PM peak was more congested. Finally, Saturdays had more traffic than Sundays, but both weekend days were generally less congested than workdays, especially during peak periods.

Figure 5: Time of Day and Day of Week Congestion Variation



TOP 10 BOTTLENECKS

Based on the number of vehicles per lane per mile (i.e., density of traffic flow), the Spring 2011 Skycomp survey identified the top 10 most congested locations in the region, as listed in Table 1. Based on travel time index (the ratio of actual travel time over free flow travel time) and the number of congested hours, the I-95 Corridor Coalition/INRIX data also identified the top 10 most congested bottlenecks for the monitored freeways in the region, as listed in Table 2. There are 5 locations identified by both lists and merit further investigation for improvements. Out of the 10 bottlenecks identified by INRIX data, there were 7 bottlenecks always in the top 10 list from 2009 to 2011, and they should be further examined in relevant studies.

Table 1: 2011 Top 10 Freeway Bottlenecks Identified by Skycomp Aerial Survey

Rank	Road/Direction	Segment/Interchange	Density	Speed Range (MPH)
1*	**I-395 NB**	**VA-27 to VA-110**	**145**	**5**
2A	I-495 IL	VA-193 to GW Pkwy	125	5-10
2B	I-395 SB/SW Fwy	4th St to 12th St	125	5-10
4	**I-66 EB**	**VA-7 to Dulles Access**	**115**	**7-12**
5A	**I-495 IL**	**MD-355/I-270 to MD-185**	**110**	**10-15**
5B*	I-495 OL	VA-267 to VA-123	110	10-15
7A	**I-495 OL**	**I-95 to MD-695**	**105**	**12-20**
7B*	**I-495 IL**	**Gallows Rd to US-50**	**105**	**12-20**
8A	I-66 EB	VA-234 Bypass to VA-234	95	15-25
8B*	11th St Bridge WB	I-295 to Southeast Fwy	95	15-25

* While impacted by construction, these links are historically congested.
Locations marked by bold text were identified as top 10 bottlenecks by both Skycomp survey and INRIX data.

Table 2: 2011 Top 10 Bottlenecks Identified by INRIX Data

Road/Direction	Segment/Interchange	Hours of Congestion in a Week*	Average Speed when Congested (mph)	Travel Time Index	Rank** 2009	Rank** 2010	Rank** 2011
I-95 SB	US-1/EXIT 161	40	29	2.83	1	8	1
I-395 NB	**11TH ST/EXIT 11**	**48**	**25**	**2.17**	**6**	**1**	**2**
MD-295 NB	POWDER MILL RD	43	32	2.30	5	5	3
I-66 EB	**VA-267/EXIT 67**	**43**	**32**	**2.26**	**10**	**4**	**4**
I-95 HOV SB	End of HOV	42	34	2.19	7	3	5
I-495 IL	**MD-355/EXIT 34**	**32**	**29**	**2.70**	**3**	**7**	**6**
I-495 OL	VA-193/EXIT 44	39	32	2.16	>10	>10	7
I-495 OL	**MD-650/EXIT 28**	**31**	**30**	**2.74**	**8**	**9**	**8**
I-495 IL	**US-50/EXIT 50**	**39**	**34**	**2.10**	**>10**	**>10**	**9**
I-66 WB	FAIRFAX DR/EXIT 71	42	35	1.92	>10	6	10

*This number is out of the 168 hours of a full week (24 hours a day and 7 days a week).
**Rank is based on the product of Hours of Congestion in a Week (duration of congestion) and Travel Time Index (intensity of congestion).
Locations marked by bold text were identified as top 10 bottlenecks by both Skycomp survey and INRIX data.

TOP 10 MOST UNRELIABLE SEGMENTS

Leveraged by the I-95 Corridor Coalition/INRIX data, travel time reliability has been examined in the CMP since 2009. Travel time reliability is a consistency or dependability in travel times, as measured from day to day or across different times of day[8]. It considers both recurring congestion and non-recurring congestion and provides travelers the amount of time needed to be budgeted to ensure on-time arrivals most of the time.

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

Based upon one of the most widely used reliability measures – Planning Time Index (the ratio of 95th percentile travel time to free flow travel time)[9] – the top 10 most unreliable segments in 2011 on monitored freeways in the Washington region were identified, as listed in Table 3. Over the three years from 2009 to 2011, there were 6 segments always in the top 10 list, and they should be further examined in relevant studies.

Table 3: 2011 Top 10 Most Unreliable Segments

Road/Direction	Segment/Interchange	Planning Time Index*	Also a Top 10 Bottleneck in 2011?	Rank 2009	Rank 2010	Rank 2011
I-495 IL	I-270/EXIT 35	5.33	Yes	1	1	1
I-95 SB	US-1/EXIT 161	5.02	Yes	>10	>10	2
I-95 SB	VA-234/EXIT 152	4.76	Yes	6	3	3
I-495 OL	MD-650/EXIT 28	4.67	Yes	3	2	4
I-395 NB	11TH ST/EXIT 11	4.31	Yes	10	5	5
I-495 IL	US-50/EXIT 50	4.09	Yes	9	7	6
I-95 NB	I-395/I-495	4.08	No	>10	>10	7
I-66 WB	VADEN DR/EXIT 62	4.02	No	>10	8	8
I-66 EB	VA-267/EXIT 67	4.01	Yes	7	6	9
I-495 OL	GW PKWY/EXIT 43	3.83	Yes	>10	>10	10

*Planning Time Index is the ratio of 95th travel time to free flow travel time. This measure is used for ranking.

TOP CONGESTED AND UNRELIABLE LOCATIONS

The most congested and unreliable locations in 2009-2011 can be obtained by selecting the top bottlenecks (Table 2) and the most unreliable segments (Table 3) that ranked within 1-10 from 2009 to 2011. There are 5 such locations identified, as listed in Table 4, and they merit further investigation for improvements.

Table 4: Top Congested and Unreliable Locations in 2009-2011 (based on INRIX data)

Road/ Direction	Segment/Interchange	Congestion: 2011 Hours of Congestion in A Week	Congestion: 2011 Travel Time Index	Congestion: 2009 Rank	Congestion: 2010 Rank	Congestion: 2011 Rank	Reliability: 2011 Planning Time Index	Reliability: 2009 Rank	Reliability: 2010 Rank	Reliability: 2011 Rank	2009 - 2011 Overall Rank
I-495 IL	I-270/MD-355	32	2.70	3	7	6	5.33	1	1	1	1
I-95 SB	End of HOV/Exit 152	42	2.19	7	3	5	4.76	6	3	3	2
I-395 NB	11TH ST/EXIT 11	48	2.17	6	1	2	4.31	10	5	5	3
I-495 OL	MD-650/EXIT 28	31	2.74	8	9	8	4.67	3	2	4	4
I-66 EB	VA-267/EXIT 67	43	2.26	10	4	4	4.01	7	6	9	5

MAJOR 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 22 major freeway commute routes are defined between major interchanges and/or major points of interest for each

[9] For example, a Planning Time Index of 2 for a 30-minute free flow trip means one has to budget as much as twice of the free flow time, 60 minutes, to arrive on time.

peak period. Three performance measures are calculated for the AM and PM peaks respectively from 2009 to 2011: the most congested 5 minutes, average travel time, and reliable (95th) travel time (with which the majority of trips can finish the trip on the specified route). Details of this analysis can be found in Chapter 2.

Congestion on Arterials

Arterial Monitoring

The TPB's arterial monitoring program had been historically carried out by staff using global positioning system-equipped floating vehicles. The last regional survey was conducted in FY[10] 2011, which will be summarized in the appendix of this report. In view of emerging data sources such as probe-based data and Bluetooth data, staff has been evaluating the feasibility and cost-effectiveness of applying such data in future arterial monitoring activities.

As part of the effort of the I-95 Corridor Coalition Vehicle Probe Project, about 400 route (not centerline) miles of arterials in the TPB Planning Area are monitored by the project since July 1, 2008. In order to capture more data on arterials, VDOT procured INRIX 2010 data for all the TMC-coded[11] roads for the entire state in early 2011. Following this procurement, the TPB acquired additional INRIX data for the rest of TMC-coded roads in the TPB Modeled Area, which includes a total of 8,300 route miles of all roadway types in the TPB Modeled Area, of which about 4,600 route miles of arterials are in the TPB Planning Area. This report utilized the procured data to draw a baseline of arterial congestion, which can be compared to if similar third-party datasets will be procured in the future[12].

Arterial Congestion

The procured INRIX 2010 data provided unprecedented spatial and temporal coverage for the Washington region. From a system perspective, this report developed three performance measures for the arterials: percentage of congested route miles, Travel Time Index, and speed. The following is a brief summary of the first measure.

A 24-hour percentage of congested arterial route miles in the region is shown in Figure 6. There were more than a quarter of all the monitored arterial route miles in congested conditions in all the daytime periods (AM peak, Midday and PM peak). This is different from freeways on which only a small percentage of congested lane miles found during the midday time period. The chart below also revealed a "lunch peak" on arterials around 12:00 PM. Consistent with the freeways, the most congested AM and PM peak hours were 8:00-9:00 AM and 5:00-6:00 PM respectively.

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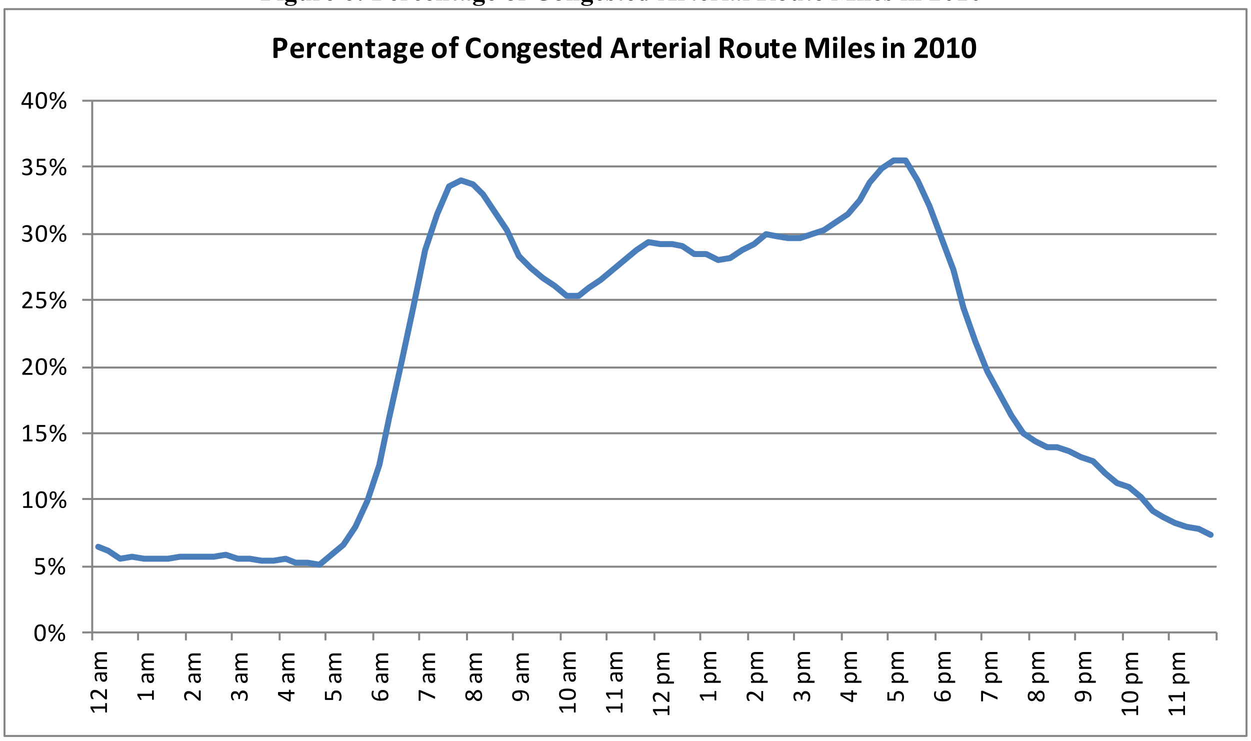
[10] A TPB Fiscal Year (FY) starts on July 1 and ends on June 30 of the next year, e.g., FY 2010 is from 7/1/2009 – 6/30/2010.

[11] TMC stands for Traffic Message Channel – the de facto industrial standard for roadway segmentation. More information about TMC is available at http://www.tisa.org/technologies/tmc/

[12] Virginia added INRIX real-time data on major arterials in early 2012; Maryland procured INRIX 2011 archived data for all TMC-coded roads in the state.

Each individual jurisdictions[13] experienced different levels of congestion during AM and PM peak periods[14] in 2010, a s shown in Figure 7. DC had the highest percentage of congested arterials in 2010: more than half in the AM peak and two thirds in the PM peak. Alexandria, Arlington and Fairfax had about 30% - 40% congested arterials. Montgomery, Prince George's and Prince William had about 20%-30% congested arterials. Charles, Frederick and Loudoun were the least congested counties and had only about 10% of congested arterials. Overall, this region had 24% congested arterials in the AM peak and 28% in the PM peak, which were relatively higher compared to congested freeway percentages in the same year (20% in the AM peak and 27% in the PM peak).

Figure 6: Percentage of Congested Arterial Route Miles in 2010



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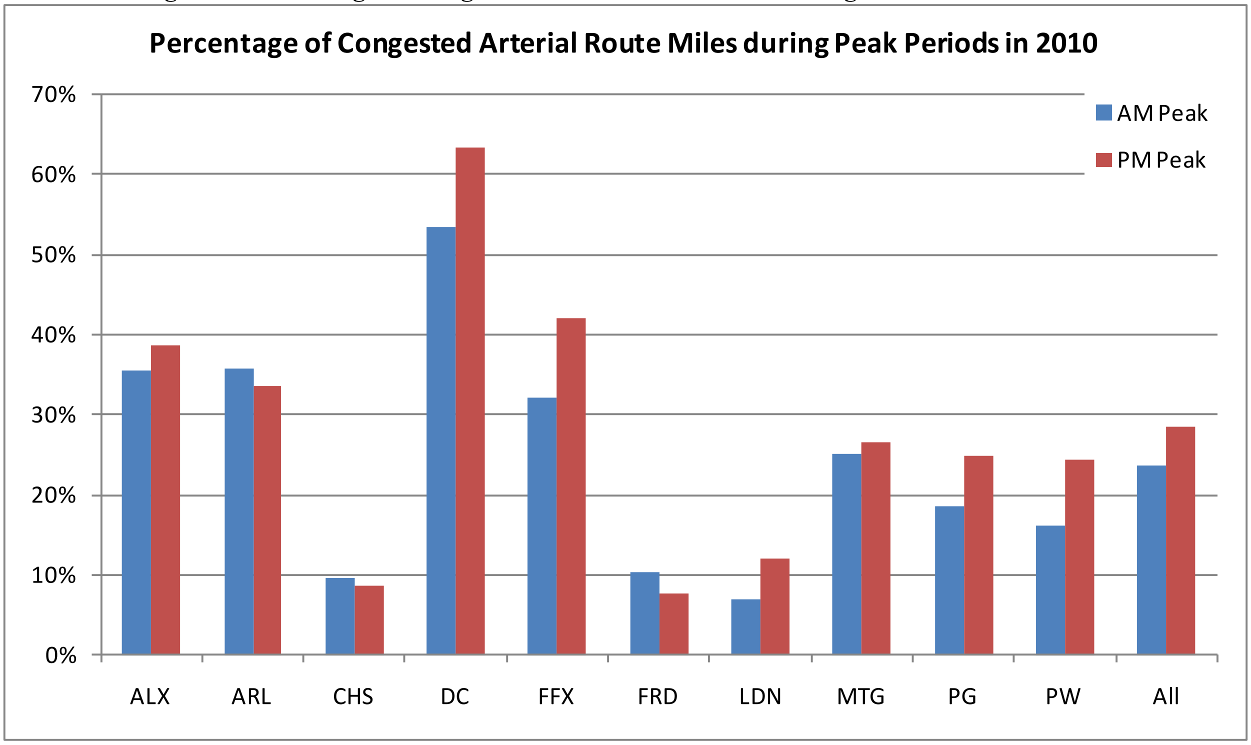
[13] Fall Church, Manassas, Manassas Park are excluded from the analysis as they have very limited number of road miles covered by the procured INRIX data.
[14] AM Peak is 6:00-10:00 am and PM Peak is 3:00-7:00 pm.

Figure 7: Percentage of Congested Arterial Route Miles during Peak Periods in 2010



TRAFFIC SIGNAL TIMING

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 two surveys of the status of signal optimization in 2005 and 2009. The 2009 survey found that of the total 5,400 signalized intersections in the region, 80 percent were computer optimized (56%) or checked or adjusted (24%). If a weighted average methodology was used to describe the results, giving half weights to non-computer methods, then 68 percent of signals were "optimized". This percentage is the same as what was found in 2005 but better than the 2002 result, 45 percent.

Even though the percentage of optimized signals kept unchanged from 2005 to 2009 , the region may have better results than that may indicate because: 1) the most critical signals in many cases were being checked and optimized even more frequently than once every three years; 2) all major agencies (with more than 50 s ignals) reported that they had optimized or checked significant numbers of their signals within the reporting period – no major agency reported not optimizing or checking; and 3) there were anecdotal reports of more resources annually being put into optimization in recent years than in previous years – this will be beneficial if continued.

In late 2011, i n response to a request made by the COG Incident Management and Response (IMR) Steering Committee, the Traffic Signal Subcommittee conducted a regional survey on traffic signals power back-up systems[15]. This survey found that about 20% of the region's 5,000+ signals are already equipped with a back-up system, of which 15% are battery-based systems and 5% are generator-ready systems. These back-up systems are critical in the event of an emergency, particularly if the event involves a lack of power.

Congestion on Transit and Other Systems

TRANSIT

The National Capital Region possesses a multimodal and diverse transit system, including Metrorail, commuter rail and a variety of bus operations. Congestion on the transit system is always one of the concerns of the CMP.

Congestion on the region's roadway network often has an impact on transit systems, such as rail and bus. The identified congested locations, especially those on the Washington Metropolitan Area Transit Authority's (WMATA) Priority Corridor Network, are usually also bottlenecks for bus transit. Relieving roadway congestion will directly have a positive impact on bus operations, such as reducing travelers' delay, reducing bus operations cost, improving bus reliability and increasing ridership.

Congestion can also be an issue within transit. If the demand for buses, rail and train is high and the capacity cannot keep up with that demand, then transit becomes overcrowded. Congestion also exists within certain transit stations, especially multimodal transit centers, e.g. Union Station. Station congestion is a congestion of different nature, mostly due to limitations in design and circulation as well as ridership growth. The 2008 Metrorail Station Access & Capacity Study found that 19 Metrorail stations need to expand their capacity in order to satisfy the demand imposed by existing large ridership and/or future ridership increases.

HOV FACILITIES

COG/TPB has conducted surveys on the high occupancy vehicle (HOV) freeway facilities in 1997, 1998, 1999, 2004, 2007 and 2010. The most recent survey found that: 1) during Spring 2010, all of the HOV lanes required fewer cars to carry more persons per lane during the HOV restricted periods than adjacent non-HOV lanes making the HOV lanes more efficient at moving people to their destinations; 2) most of the HOV lanes provide travel time savings when compared to non-HOV alternatives, especially the barrier separated HOV lanes in the I-95/I-395 corridor in Northern Virginia; and 3) average auto occupancy in 2010 was little-changed from 2004 and 2007, even though the HOV lanes in Northern Virginia continue to exempt vehicles with "Clean Special Fuel Vehicle" registration plates from the HOV requirement.

PARK-AND-RIDE FACILITIES

The National Capital Region has over 300 park-and-ride lots where commuters can conveniently join up with carpools, vanpools, or connect to public transit. According to the region's Commuter Connections program: about one third of Park & Ride Lots have commuter bus service available; approximately one third of the Park & Ride Lots have rail service

[15] http://www.mwcog.org/uploads/committee-documents/bV1eW1lb20120215174845.pdf (slides 8-13).

available, including Metro, MARC, VRE and Baltimore Light Rail; parking is free at 90% of the Park & Ride Lots; and about 25% of the Park & Ride Lots have bicycle parking facilities. According to Maryland's estimate, about 34% of the Maryland state-owned Park & Ride lots have bicycle parking facilities.

The 2008 Metrorail Station Access & Capacity Study found Metro presently owns and operates 58,186 parking spaces. On an average weekday, almost all of those spaces are occupied, especially stations at East Falls Church, Van Dorn Street, Naylor Road and Branch Ave. 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 daily unused available capacity.

In 2009, WMATA and VDOT completed the Feasibility Study of Real Time Parking Information at Metrorail Parking Facilities (Virginia Stations)[16], 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

AIRPORT ACCESS

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). According to the most recent TPB Air Passenger Survey[17], the majority (94%) of those traveling to the region's airports does so via the highway network (i.e. personal cars, rental cars, taxis, buses). Therefore, understanding ground airport access is important to congestion management.

The TPB regularly carries out Regional Airport Ground Access Travel Time Studies (1995, 2003 and 2011) and provides relevant information to congestion management. Comparing the 2011ground access travel time data to that of 2003, it was found travel time overall was increasing.

FREIGHT

The National Capital Region has a responsive freight system to support the vitality of economy and quality of life. This region features a consumer and service-based economy and approximately three quarters of freight traveling to, from, or within the region is transported by

[16] 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

[17] *2009 Washington-Baltimore Regional Air Passenger Survey,* September 2010.
http://www.mwcog.org/uploads/committee-documents/a15XXFle20101203144651.pdf

truck[18]. The interaction between freight movement and passenger travel is high. The following five worst truck bottlenecks[19] are also among the most congested locations for all traffic.

- I- 95 at VA-7100, Virginia
- I- 95 at VA-234, Virginia
- I-95 at I- 495, Maryland
- I- 495 at American Legion Bridge, Virginia
- I-495 at I-66, Virginia

Future Congestion

The 2010 CLRP Performance Analysis[20] forecasts 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 2011.

Over the next three decades, increasing population and job growth will lead to additional vehicles, trips, and congestion on the region's transportation system. While vehicle miles of travel (VMT) per capita, which is a measure of how much people drive, is actually forecast to decline slightly, overall VMT is increasing faster than new freeway and arterial lane-miles slated for construction in the plan.

Transit work trips are forecast to increase by 43% as an increasing number of people are expected to use transit to commute to work. This will inevitably create even more crowding on the Metrorail and bus system, since the ability of the system to expand its capacity is limited by funding constraints.

The road network will also experience a gap between forecast demand and additional capacity. Given funding constraints, lane-miles are only expected to increase 11%, while VMT is expected to rise 22%, resulting in a 38% increase in the number of lane-miles of congestion. Nearly all of this congestion will occur in the suburbs, with inner suburban jurisdictions experiencing the worst congestion. The outer suburban jurisdictions, however, will experience the most dramatic increase in congestion, with a 111% increase in lane-miles of congestion by 2040.

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[18] . *Enhancing Consideration of Freight in Regional Transportation Planning*, Cambridge Systematics, Inc., 2007. http://www.mwcog.org/uploads/committee-documents/bF5fW1pX20080222142629.pdf

[19] I-95 Corridor Coalition, *Mid-Atlantic Truck Operations study – Final Report*. Cambridge Systematics, Inc. October 2009. http://www.i95coalition.net/i95/Portals/0/Public_Files/pm/reports/DFR1_MATOps_Truck%20Operations%20V3.pdf

[20] The Financially Constrained Long-Range Transportation Plan (2010), November 2010. http://www.mwcog.org/store/item.asp?PUBLICATION_ID=412

Severe stop-and-go congestion is expected to be prevalent throughout the entire region in 2040, not just in isolated areas. In 2040, there are some areas of forecasted improvement, such as I-95 and I-495 in Virginia, which will benefit from HOT lane projects included in the 2010 CLRP.

Outer suburban jurisdictions in the region will experience the greatest increase in congestion, while the already congested inner suburban jurisdictions will experience the worst overall congestion. Making matters worse, congestion will increasingly not be limited to rush-hour periods, but will also affect off-peak weekday periods and weekends.

Due to a lack of funding for capacity enhancement projects to accommodate all of the projected transit ridership growth in the region, the Metrorail system will likely reach capacity on trips to and through the regional core. According to a WMATA study, without additional railcars beyond those currently funded, all lines entering the core will become congested by 2040, and the Orange/Dulles, Yellow and Green lines are forecast to be highly congested.

Another way to measure the performance of the plan is by residents' accessibility to jobs by transit and auto. The average accessibility to jobs by auto is expected to increase slightly between 2011 and 2040, and accessibility by transit is forecast to increase more significantly. However, overall accessibility by transit will still remain less than by auto.

National Comparison of the Washington Region's Congestion

The Washington region is among the several most congested metropolitan areas in the nation. Based on the ratio of actual travel time over free flow travel time (or travel time index), the region ranked 2nd in Texas Transportation Institute's 2011 Urban Mobility Report (for 2010 data), and 6th in INRIX's National Traffic Scorecard (for 2011 data). Different methodologies are the most likely reason for this discrepancy in ranking, such as the different spatial and temporal coverage of the data, and the different weight used to calculate the regional value. Based on annual hours of delay per traveler, this region ranked 1st in 2010 (74 hours) in the Mobility Report.

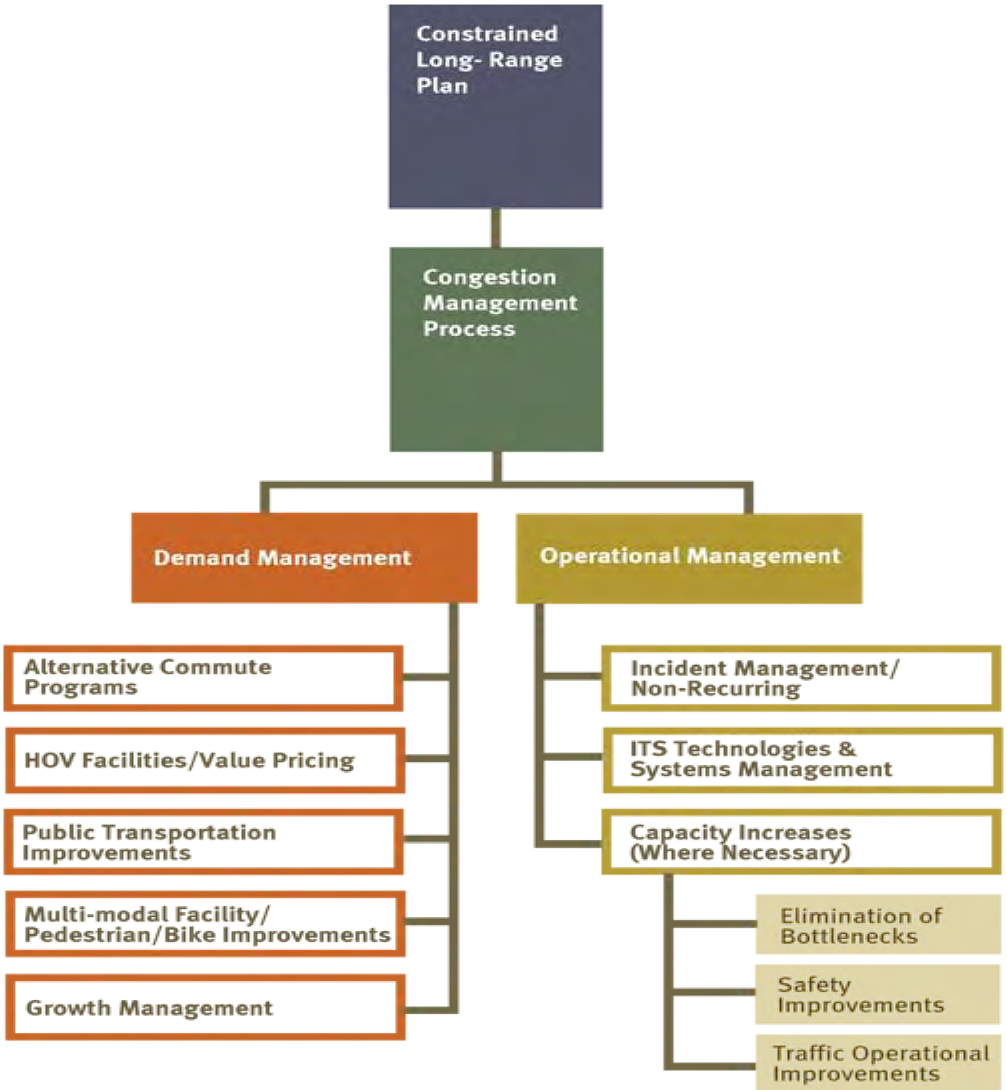
Congestion Management Strategies

The CMP has been playing an important role in developing strategies, including strategies in association with capacity-expanding projects, to combat congestion or mitigate the impact of congestion. The CLRP and TPB member agencies have pursued many alternatives to capacity increases, with considerations of these strategies informed by the CMP. Implemented or continuing strategies include demand management strategies and operational management strategies, as shown in Figure 8. It should be noted that although strategies are divided into two categories for reporting purposes in this document, demand management and operational management strategies should be designed and implemented to work in cooperation.

Demand Management Strategies

Demand Management aims at influencing travelers' behavior for the purpose of redistributing or reducing travel demand. Examples of TPB's demand management strategies include:

Figure 8: Major CMP Strategies



Note: There are synergies between demand management and operational management strategies, such real-time traveler information on ridesharing opportunities responsive to a real-time traffic incident or situation.

- Commuter Connections Program – Including strategies such as Telework, Employer Outreach, Guaranteed Ride Home, Liver Near Your Work, Carpooling, Vanpooling, Ridematching Services, Car Free Day, and Bike To Work Day.
- Promotion of local travel demand management – Local demand management strategies are documented in the main body of the CMP Technical Report.
- Public transportation improvements – The Washington region continues to support a robust transit system as a major alternative to driving alone.
- Pedestrian and bicycle transportation enhancements as promoted and tracked through the Bicycle and Pedestrian Planning program – The number of bicycle and pedestrian facilities in the region has increased in recent years; the District of Columbia bikesharing program was one of the first of its kind in North America; the Capital Bikeshare now

covers Washington, D.C. and Arlington, VA, and will expand to Alexandria, VA and possibly Montgomery County, MD.

- Car sharing - Location governments encourages private companies (e.g., Zipcar, Car2Go, and Hertz On Demand) to participate in the region's car sharing market. Zipcar estimates that each Zipcar takes 16 personally owned vehicles off the road.
- Land use strategies – Including those promoted by the Transportation-Land Use Connections (TLC) Program.

OPERATIONAL MANAGEMENT STRATEGIES

Operational management focuses on improvements made to the existing transportation system to keep it functioning effectively. Examples of TPB's operational management strategies include:

- High Occupancy Vehicle (HOV) facilities – Existing HOV facilities include I-66, I-95/I-395, I-270, US-50 and the Dulles Toll Road.
- Variably-Priced Lane Facilities – The 18-mile Intercounty Connector (ICC) in Maryland opened from I-270 to I-95 in November 2011; the 495 E xpress Lanes in Northern Virginia are under construction and to be completed in 2012; and the I-95 Express Lane project is under development in Northern Virginia with a completion date of 2015 listed in the CLRP.
- Incident Management – The region's state DOTs all pursue strategies for managing their transportation systems, including operation of 24/7 traffic management centers, roadway surveillance, service patrols, and communications interconnections among personnel and systems.
- Regional Transportation Operations Coordination – Notably the Metropolitan Transportation Operations Coordination (MATOC) program, whose development the TPB helped shepherd, uses real-time transportation systems monitoring and information sharing to help mitigate the impacts of non-recurring congestion. In addition, a Regional Incident Coordination (RIC) Program was recommended in the Major Regional Incident Response Action Plan developed by the Incident Management and Response (IMR) Steering Committee.
- Intelligent Transportation Systems are considered, particularly through the Management, Operations, and Intelligent Transportation Systems (MOITS) program and committees. Examples include traffic signal optimization, safety service patrols, and traveler information.

ADDITIONAL SYSTEM CAPACITY

Federal law and regulations list capacity increases as another possible component of operational management strategies, for consideration in cases of elimination of bottlenecks, safety improvements and/or traffic operational improvements. These capacity increase projects are documented in CLRP or TIP.

There have been relatively few capacity increase projects in recent years, however. This region has an emphasis on demand and operational management strategies, such us transit improvements, the Commuter Connections program and the Management, Operations and Intelligent Transportation Systems (MOITS) program.

Assessment of Congestion Management Strategies

ASSESSMENT OF IMPLEMENTED STRATEGIES

The TPB assesses the implemented congestion management strategies in a variety of ways. Many strategies have specific assessments and the overall effectiveness of all strategies is repeatedly evaluated by congestion monitoring and analysis.

Specific assessments (of individual or several strategies):

- A variety of surveys within the Commuter Connections Program are regularly conducted to provide firsthand data inputs for the assessments, including the Guaranteed Ride Home Customer Satisfaction Survey, Commuter Connections Applicant Placement Rate Survey, State of the Commute Survey, Employee Commute Surveys, Carshare Survey, Vanpool Driver Survey, Employer Telework Assistance Follow-up Survey, and the Bike-to-Work Day Participant Survey.
- In conjunction with the regional air quality process, vehicle trips reduced, vehicle miles of travel (VMT) reduced and environmental benefits are assessed in the Transportation Emission Reduction Measure (TERM) Evaluations.
- Public transportation improvements, pedestrian and bicycle transportation improvements, and land use strategies are assessed in Regional Household Travel Surveys, Regional Bus Surveys, Regional Activity Centers and Regional Activity Clusters Studies, the Regional Travel Trends Report, and Cordon Counts.
- The region's HOV facilities are monitored by the TPB's HOV monitoring and surveys.
- Status of traffic signal timing is assessed by Management, Operations and Intelligent Transportation Systems (MOITS) program's traffic signal timing surveys. Traffic signal power backup system was surveyed by the Traffic Signal Subcommittee of the MOITS program.
- The Metropolitan Area Transportation Operations Coordination (MATOC) program is assessed by a benefit-cost study.

Overall assessments (of all implemented strategies):

- The TPB's aerial photography survey of the region's freeway system congestion conditions (every three years for AM and PM peak periods and every five years for weekend and off-peak period).
- The TPB's arterial floating car travel time and speed study (every year a sample of major arterials in DC, MD and VA is studied and the same sample was repeated every three years). This study was terminated in FY 2012 and an enhanced arterial monitoring program is under development. COG/TPB has procured a comprehensive historical dataset for calendar year 2010 from INRIX, Inc. to benchmark regional arterial performance.
- In addition to the TPB's monitoring activities, the TPB also utilize other regional and national monitoring activities to complement and enhance the congestion monitoring and analysis in the National Capital Region. These utilized "outside" monitoring activities include:
    a) I-95 Corridor Coalition/INRIX, Inc. probe-vehicle-based traffic monitoring data.

b) The FHWA Transportation Technology Innovation and Demonstration (TTID) Program/ Traffic.com traffic monitoring.
c) Maryland, Virginia and the District of Columbia's Highway Performance Monitoring Systems (HPMS).

Assessment of Potential Strategies Through Scenario Planning

The TPB has a long history of strategy analysis for air quality purposes which focuses on emissions reductions from individual strategies. In 2010 the results of two scenarios which studied were presented. These scenarios looked at groupings of strategies and how they could interact with each other. In May 2010, the TPB completed a scenario study examining the role of regional transportation in climate change mitigation in the Washington region, called the "What Would it Take?" scenario[21]. The scenario is a goal-oriented study that specifically asks and tries to answer the question of what it would take in the Washington region to meet aggressive greenhouse gas emissions reduction goals in transportation. The study includes the analysis of over 50 strategies from national level CAFE standards and alternative fuel mandates to regional and local level bicycle plans and congestion reduction strategies to determine their potential to reduce emissions and contribute to the environmental resilience of this region.

A second scenario, the "CLRP Aspirations" scenario, was developed and analysis was completed in September 2010. The CLRP Aspirations scenario seeks to create a land use and transportation vision that can serve as a de facto unconstrained plan for the region. The scenario includes an aggressive land use growth vision centered around reimagining the region's activity centers and transit station areas to be walkable, mixed use, and vibrant neighborhoods. These centers are envisioned to be connected via a bus rapid transit system running on a network of priced road lanes.

In an effort to assist municipalities in implementing strategies suggested by the Scenario Study, the TPB created the Transportation/Land Use Connections (TLC) Program. The TLC Program addresses the “how to” challenges related to improving transportation/land-use coordination and realizing an alternative future for the region, through providing both direct technical assistance and information about best practices and model projects. Through the program, the TPB provides communities with up to $60,000 worth of technical assistance to catalyze or enhance planning efforts. Any local jurisdiction that is a member of the TPB is eligible to apply. The second part of the TLC program is the Clearinghouse, a web-based source of information about transportation/land use coordination, including regional and national experience with transit-oriented development and other key strategies.

Some potential operational congestion management strategies are assessed in the Strategic Plan for the Management, Operations and Intelligent Transportation Systems (MOITS) Planning Program[22].

TPB also assesses special potential strategies on an as-needed basis, such as congestion pricing.

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[21] Scenario Planning, TPB Constrained Long-Range Plan (CLRP).
http://www.mwcog.org/clrp/elements/scenarios.asp

[22] *Strategic Plan for the Management, Operations and Intelligent Transportation Systems (MOITS) Planning Program*, June 16, 2010. http://www.mwcog.org/transportation/activities/operations/moits-strategic.asp

Compiling Project-Specific Congestion Management Information

Pursuant to Federal regulations, the TPB encourages consideration and inclusion of congestion management strategies in all Single Occupancy Vehicle (SOV) capacity-increasing projects. This involves compiling and analyzing information in the Call for Projects documentation forms, which are submitted from regional agencies when the CLRP is developed.

The Call for Projects documentation requests any project-specific information available on congestion that necessitates or impacts the proposed project. Agencies compile this information from various sources, including TPB-published congestion information (if available), internal or other directly measured information, or by conducting engineering estimates of the Level of Service (LOS). TPB compiles and analyzes this submitted information, along with information from other CMP sources.

Specifically for SOV capacity-increasing projects, the TPB requests documentation that the implementing agency considered all appropriate systems and demand management alternatives to the SOV capacity. In the Call for Projects documentation a special set of SOV questions is completed by implementing agencies and the TPB compiles this information.

Congestion Management as a Process in the CLRP

Components of the CMP Fully Integrated in the CLRP

The four major components of the CMP as described earlier are fully integrated in the CLRP. More specifically:

In monitoring and evaluating transportation system performance, the TPB uses Skycomp aerial photography freeway monitoring and a number of other travel monitoring activities to support both the CMP and travel demand forecast model calibration, complementing operating agencies' own information, and illustrating locations of existing congestion. CLRP travel demand modeling forecasts, in turn, provide information on future congestion locations. This provides an overall picture of current and future congestion in the region, and helps set the stage for agencies to consider and implement CMP strategies, including those integrated into capacity-increasing roadway projects.

The CMP component of the CLRP defines and analyzes a wide range of potential demand management and operations management strategies for consideration. T PB, through its Technical Committee, Travel Management Subcommittee, Travel Forecasting Subcommittee, and other committees, reviews and considers both the locations of congestion and the potential strategies when developing the CLRP.

For planned (CLRP) or programmed (TIP) projects, cross-referencing the locations of planned or programmed improvements with the locations of congestion helps guide decision makers to prioritize areas for current and future projects and associated CMP strategies. Maps in the 2009

CLRP showed a high correlation between the locations of planned or programmed projects and locations where congestion is being experienced or is expected to occur.

Thus CLRP and TIP project selection is informed by the CMP, and implementation of CMP strategies is encouraged. The region relies particularly on non-capital congestion strategies in the Commuter Connections program of demand management activities, and the Management, Operations, and Intelligent Transportation Systems (MOITS) program of operations management strategies. Assessments of these programs are analyzed, along with regular updates of travel monitoring to look at trends and impacts, to feed back to future CLRP cycles.

The TPB also compiles information pertinent to specific projects in its CMP documentation process (form) within the annual CLRP Call for Projects. This further assures and documents that the planning of federally-funded SOV projects has included considerations of CMP strategy alternatives and integrated components.

Regional Transportation Priorities Plan Facilitates CMP-CLRP Integration

The Regional Transportation Priorities Plan (RTPP)[23], which is a milestone of TPB's Performance-Based Planning approach, facilitates the integration of the CMP and the CLRP. The RTPP is expected to be completed in the first quarter of fiscal year 2014.

Building on previous regional transportation planning activities, the RTPP is to identify those transportation strategies that offer the greatest potential contributions to addressing continuing regional challenges, and to provide support for efforts to incorporate those strategies into future updates of the CLRP in the form of specific programs and projects. The plan will articulate regional priorities for enhancing the performance of the CLRP in advancing regional goals for economic opportunity, environmental stewardship, and quality of life. The RTPP will focus on identifying a limited number of regional priorities, perhaps 10 to 15 at any one time.

The development of the RTPP is taking place over a period of two years. An interim report on near-term regional priority strategies, programs and projects is expected to be complete by the summer of 2012, with a report on longer-term regional priorities due the following summer, in time to influence the projects and programs that will be a part of the next full CLRP update in 2014.

Key Findings of the 2012 CMP Technical Report

1. Freeway travelers in the Washington region on average experienced decreasing delays from 2009 to 2011. The total hours of delay of a typical traveler who commuted on freeways was 133 hours (at a cost of $2,558) in 2011, decreased by 15% and 33% compared to 2010 and 2009, respectively. Consistent with the decease of delay, the intensity, spatial extent of freeway congestion during AM and PM peak periods, and the vehicle miles traveled (VMT) on freeways also decreased in the same time period; travel time reliability on freeways improved.

[23] Regional Transportation Priorities Plan, http://www.mwcog.org/transportation/priorities/

2. Congestion varies seasonally on freeways in the region: June usually experienced the longest delay in a year, while the winter months and August had only moderate delays, except when adverse weather conditions were in presence, such as the winter storms occurred in December 2009 and February 2010.

3. About 4,600 directional route miles of arterials were scanned for the first time in the region, thanks to the procurement of INRIX 2010 historical traffic data. Initial analysis revealed that there were always more than a quarter of the 4,600 route miles of arterials congested from 7:00 AM to 6:30 PM on a workday in 2010 (not necessarily the same set of arterials always congested).

4. Arterial congestion unevenly distributed in the region, with more congestion in dense urban areas where there is an emphasis on streets as accessibility in addition to mobility.

5. The TPB's Regional Transportation Priorities Plan (RTPP) has taken a performance-based transportation planning approach to identify those transportation strategies that offer the greatest potential contributions to addressing continuing regional challenges, and to provide support for efforts to incorporate those strategies into future updates of the CLRP in the form of specific programs and projects. The CMP supports the RTPP by monitoring congestion and providing strategies that could improve the mobility of the transportation systems.

6. The Commuter Connections program remains the centerpiece to assist and encourage people in the Washington region to use alternatives to the single-occupant automobile. The transit system in the Washington region serves as a major alternative to driving alone – transit mode share is among the highest several metropolitan areas in the country.

7. This region has enhanced efforts in regional transportation operations coordination. The Metropolitan Area Transportation Operations Coordination (MATOC) program was recently enhanced with more staff covering longer time period, and a dedicated MATOC public website (www.matoc.org) providing real-time traffic and incidents information. A Regional Incident Coordination (RIC) program was newly created to facilitate regional coordination upon a variety of emergent incidents. A dedicated website (www.capitalregionaupdates.gov) was also launched to provide the general public one-stop shop for emergency alerts, weather, traffic, and utilities information.

8. Variably Priced Lanes (VPLs) provide options to travelers. Maryland Route 200 (Intercounty Connector (ICC)) was fully opened in November 2011 for the section between I-270 and I-95; some positive effects in reducing congestion and providing more options have already been observed. The 495 Express Lanes will be open on the Virginia side of the Capital Beltway in 2013.

9. Bike Sharing and Car Sharing programs are growing. The number of bicycle and pedestrian facilities in the region has increased in recent years. The Capital Bikeshare now covers Washington, D.C. and Arlington, VA, and will be expanded to Alexandria, VA and possibly Montgomery County, MD. Car sharing has taken off in the Washington

region, with over 800 shared Zipcar® cars in the District of Columbia alone with plans for that number to continue growing. In addition to Zipcar®, Car2Go and Hertz On Demand have moved into the Washington region car sharing market.

10. Congestion management strategies of Management, Operations, and Intelligent Transportation Systems (MOITS) provide essential ways to make most of the existing transportation facilities.

Recommendations for the Congestion Management Process

The 2012 CMP Technical Report documents the updates of the Congestion Management Process in the Washington region from mid 2010 to mid 2012. Looking forward, the report leads to several important recommendations for future improvements.

1. **Continue to enhance the Congestion Management Process to help support the** Regional Transportation Priorities Plan (RTPP), and other performance-based planning and programming processes.

2. **Continue the Commuter Connections program.** The Commuter Connections program is a primary key strategy for demand management in the National Capital Region and it is beneficial to have a regional approach. Meanwhile, this program reduces transportation emissions and improves air quality, as identified by the TERMs evaluations.

3. **Continue and enhance the MATOC program and support agency/jurisdictional transportation management activities including the Regional Incident Coordination (RIC) Program.** The MATOC program/activities are key strategies of operational management in the National Capital Region. Future enhancements of the MATOC program should be considered when appropriate to expand the function and participation of the program.

4. **Capacity increasing projects should consider variable pricing and other management strategies.** Variably priced lanes (VPLs) provide a new option to avoid congestion for travelers and an effective way to manage congestion for agencies.

5. **Encourage implementation of congestion management for major construction projects.** The construction project-related congestion management has been very successful in the past such as the Woodrow Wilson Bridge and Springfield Interchange projects.

6. **Continue 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. Local jurisdictions are encouraged to work closely with transit agencies to explore appropriate transit priority strategies that could have positive impacts on travelers by all modes.

7. **Continue to encourage access to non-auto travel modes**. The success of the Capital Bikeshare program and the decrease in automobile registrations in the District of Columbia indicate that there is a shift, at least in the urban areas, to non-automobile transportation.

8. **Continue to explore Integrated Corridor Management (ICM) systems and Active Traffic Management (ATM) strategies.** State DOTs are encouraged to explore ATM strategies along congested freeways and actively manage arterials along freeways. Transportation agencies (including transit agencies) and stakeholders are encouraged to work collaboratively along a congested corridor to explore the feasibility of an ICM system.

9. **Continue and enhance providing real-time, historical, and multimodal traveler information.** Providing travelers with information before and during their trips can help them to make decisions to avoid congestion and delays and better utilize the existing road and transit infrastructure. Website such as MATOC's www.trafficview.org, www.CapitalRegionUpdates.gov, state DOTs' 511 systems, and real-time transit information allow travelers to make more informed decisions for their trips. The value of real-time traveler information can be largely enriched by integrating historical travel information which can provide valuable travel time reliability measures. Agencies are encouraged to coordinate on providing multimodal information along a corridor (e.g., the outcome envisioned in the I-95/I-395 Integrated Corridor Management Initiative).

10. **Continue and enhance the arterial congestion monitoring program.** The TPB's traditional arterial floating car travel time studies ended in FY 2011 in view of that emergent private sector probe-based monitoring can provide unprecedented spatial and temporal coverage on arterials. There are needs to study the cost effectiveness and further verify the quality of data provided by different sources, and to formalize the arterial monitoring program for the future.

11. **Continue and enhance frequently updated congestion reporting with a standardized procedure in calculating performance measures and more trip-based assessments.** This CMP report and the National Capital Region Congestion Report established a hierarchical performance measurement structure for highway mobility/congestion assessments. T here are needs to standardize the performance measures calculation procedure since different variations in the calculation could yield to different results, and to provide more customized information with trip-based travel time analysis.

12. **Continue to conduct Geographically-focused Household Travel Surveys to collect mode choice information.** These studies can collect data to allow planners to see local level travel patterns and behaviors impacting mode shifts. In areas with major transportation improvements planned, these studies can provide a baseline for a before and after analysis.

MAIN REPORT

1. INTRODUCTION

1.1 Need for a CMP Technical Report

This report presents a technical review of the Congestion Management Process (CMP), as addressed by the Transportation Planning Board (TPB) of the Metropolitan Washington Council of Governments (COG).

The Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users (SAFETEA-LU) requires that metropolitan transportation planning processes include a Congestion Management Process (CMP). The CMP is similar to the previous requirements for a Congestion Management System (CMS), except that the change in name and acronym of CMS to CMP is intended to place a greater emphasis on the planning process and environmental review process, while maintaining and developing effective management and operation strategies. Federal regulations state that Metropolitan transportation planning areas with a population of 200,000 or more, designated as a Transportation Management Area (TMA), are required to have a CMP, and that long-range transportation plans developed after July 1, 2007 must contain a CMP component. Also, in metropolitan planning areas classified as non-attainment for ozone and Carbon Monoxide (CO) under the Clean Air Act, no single occupant vehicle (SOV) capacity expanding project can receive federal funds unless it shows that the CMP has been considered.

Federal regulations state that:

"The transportation planning process shall address congestion management…
…through a process that provides for <u>safe and effective integrated management and operation</u> of the multimodal transportation system…
…based on a cooperatively developed and implemented <u>metropolitan-wide</u> strategy…
…of <u>new and existing</u> transportation facilities…
…through the use of <u>travel demand reduction and operational management</u> strategies."[24]

Additionally, the federal certification of the TPB planning process, dated March 2006, addressed CMS/CMP with the following recommendation:

> *The TPB should develop a comprehensive description of a regional Congestion Management System to demonstrate its application at critical stages of the metropolitan planning process, including the development of the CLRP, TIP, and the development of major projects and policies. The description should be part of the next update to the CLRP or a stand-alone document that is completed in one year from the issuance of this report. The description can build on key elements in place, including monitoring and*

[24] "Statewide Transportation Planning; Metropolitan Transportation Planning; Final Rule," *Federal Register*, Vol. 72, No. 30, February 14, 2007, § 450.320 (a) page 7274 – emphasis added.

> *evaluating alternatives to new capacity (such as for the Mixing Bowl Springfield Exchange and the Woodrow Wilson Bridge) and the range of congestion related strategies (such as the Commuter Connections Program).*[25]

The Congestion Management Process is intended to operate within or in conjunction with the planning process, which is the focal point for consideration of other factors, such as Clean Air Act requirements, transit, funding, land use scenarios, and non-motorized alternatives. The planning process also leads to decisions on which projects are programmed and implemented. The CMP will provide better information to decision-makers, such as the TPB, who consider transportation planning in our region.

This report is a step in the CMP, which is an ongoing activity. Just as there are many causes of congestion, there are also many solutions. While this report documents the region's recent CMP activities, the concept of addressing congestion and meeting regional goals will continue to be an integral part of the metropolitan planning process.

1.2 The Institutional Context of the CMP in the Washington Region

The federally designated Metropolitan Planning Organization (MPO) for the region is the National Capital Region Transportation Planning Board (TPB) at the Metropolitan Washington Council of Governments (MWCOG). The TPB is charged with producing long-range transportation plans and transportation improvement programs (TIPs) for the region, which includes the District of Columbia as well as portions of the States of Maryland and Virginia. The members of the TPB include representatives from state, county, local government agencies, as well as the Washington Metropolitan Area Transit Authority (WMATA), non-voting members of the Metropolitan Washington Airports Authority, and federal agencies.

The TPB is advised by a standing Technical Committee for transportation. The TPB Technical Committee oversees details of transportation planning and engineering studies and efforts required to support the region's transportation decision-making process. The Technical Committee has a number of standing subcommittees that focus on particular aspects of the transportation planning process, such as aviation, bicycle and pedestrian planning, regional bus planning, travel forecasting, transportation safety, transportation scenarios, and travel management.

The TPB Technical Committee is the oversight committee for the CMP, as the committee that guides long-range plan activity and oversees interaction of the various subcommittees. The Technical Committee is also advised by a number of the standing subcommittees who have knowledge about particular aspects of the CMP (for example, MOITS, Commuter Connections, and Travel Management).

Previous CMS/CMP activities of the region were steered by a CMS Task Force, developed in the mid-1990s. Congestion Management System reports were developed in FY 1995 and FY 1996.

[25] *Transportation Planning Certification Summary Report* (March 16, 2006). Prepared by Federal Highway Administration and Federal Transit Administration. Page 10.

However, a decision was then made to fully incorporate congestion management information into the CLRP rather than having a stand-alone document, in order to achieve continuity between the CMS and the CLRP. As such, over the years the CMS/CMP process had included data collection and analysis through compilation of information from implementing agencies associated with projects submitted to the CLRP and TIP, and through consideration of management and operations strategies under the Management, Operations, and Intelligent Transportation Systems (MOITS) Policy Task Force and MOITS Technical Subcommittee. The previously published 2008 CMP Technical Report represented a return to the practice of developing a separate Congestion Management document.

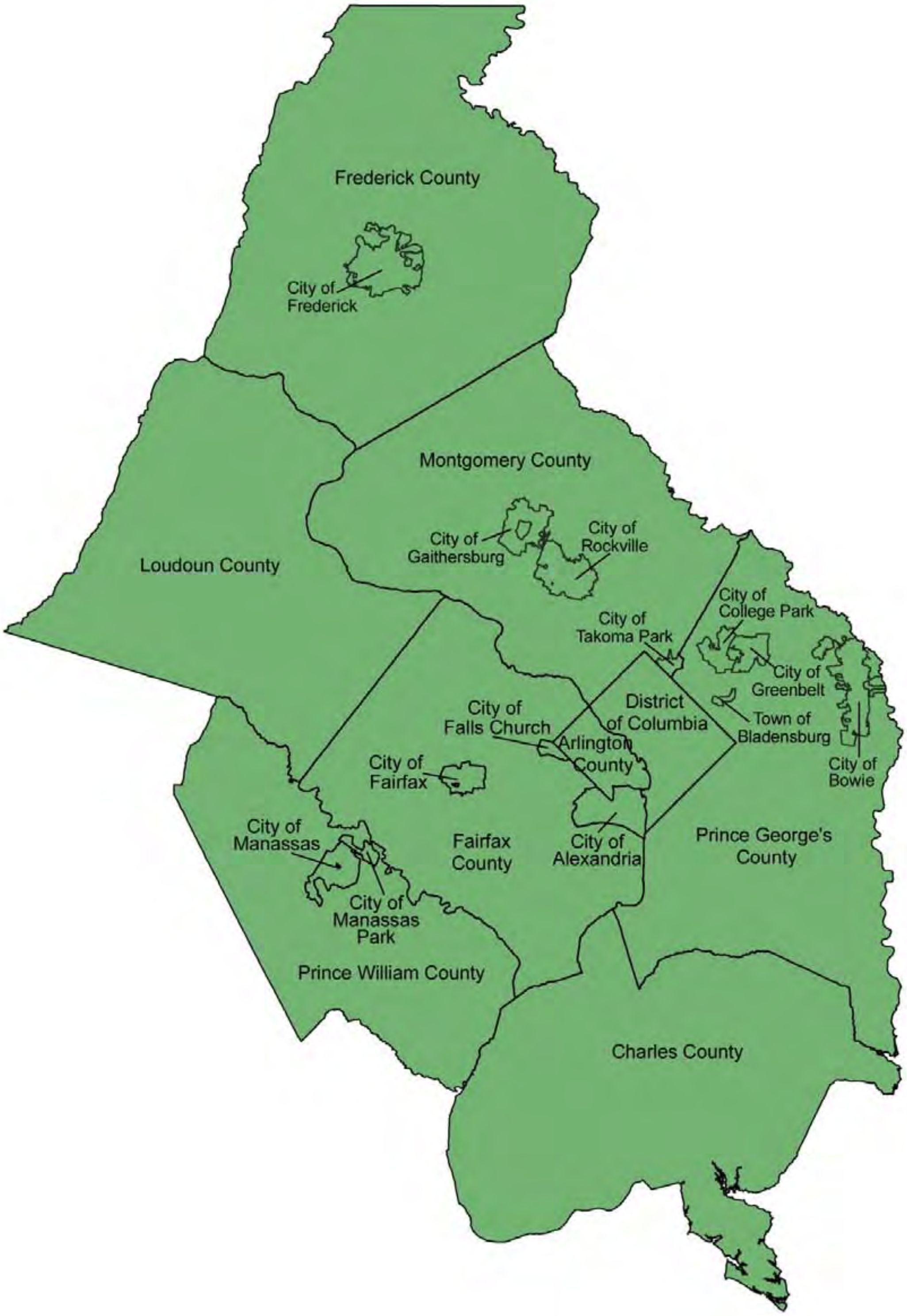
The 2010 report was the first report incorporated the I-95 Corridor Coalition Vehicle Probe Project/INRIX data and developed new performance measures. The current 2012 report utilizes even more third-party data than the previous one, including expanded Vehicle Probe Project coverage on freeways in Maryland and Virginia, procured INRIX 2010 historical data for the region's arterials, and traffic volume information from the Transportation Technology Innovation and Demonstration (TTID) Program of the Federal Highway Administration (FHWA)[26]. Section 1.5 summarizes the highlights of the 2012 CMP Technical Report.

1.3 Coverage Area of the CMP

The Washington region CMP covers the TPB planning area (Figure 9). The TPB's planning area covers the District of Columbia and surrounding jurisdictions. In Maryland these jurisdictions include Charles County, Frederick County, Montgomery County, and Prince George's County, plus the cities of Bowie, College Park, Frederick, Gaithersburg, Greenbelt, Rockville, and Takoma Park. In Virginia, the planning area includes Alexandria, Arlington County, the City of Fairfax, Fairfax County, Falls Church, Loudoun County, The Cities of Manassas and Manassas Park, and Prince William County.

[26] Transportation Technology Innovation and Demonstration (TTID) Program, FHWA, http://ops.fhwa.dot.gov/travelinfo/ttidprogram/ttidprogram.htm

Figure 9: TPB Planning Area



1.4 Components of the CMP

The Congestion Management Process in the National Capital Region consists of the following four components, all of which are wholly integrated into the CLRP:

1. **Monitoring and Evaluating Transportation System Performance.** This TPB effort includes Skycomp freeway aerial photography survey, arterial monitoring program, regional transportation data clearinghouse, special studies, data collections, as well as congestion analyses leveraged by emerging data sources (e.g. I-95 Corridor Coalition/INRIX data).

2. **Defining and Analyzing Strategies.** This component involves identifying existing and potential strategies by the TPB Technical Committee, subcommittees, and staff. The TPB considers a number of demand management and operational management strategies.

3. **Implementing Strategies.** This TPB effort is to focus on compiling information on strategies that have been implemented, particularly on a region-level basis. Also, the TPB is exploring how to assess previously implemented strategies. Feedback from the process is beneficial when it comes to updating the CMP and considering additional strategies and technical methods.

4. **Compiling Project-Specific Congestion Management Information.** Pursuant to Federal regulations, the TPB encourages consideration and inclusion of congestion management strategies in all SOV capacity-increasing projects. This involves compiling and analyzing information in the Call for Projects documentation forms, which are submitted from regional agencies when the CLRP is developed.

1.5 Highlights of the 2012 Update of the CMP Technical Report

The 2012 CMP Technical Report presented more congestion facts and analyses than the previous report while still maintaining a comprehensive and updated documentation of the congestion management strategies that are considered and implemented in the National Capital Region. The highlights of the 2012 update include:

- **Expanded Freeway Coverage.** The original I-95 Corridor Coalition Vehicle Probe Project/INRIX data used in the 2010 report covered only about 165 centerline miles of freeways, while the expanded coverage monitors more than 300+ centerline miles, accounting more than 90% of the region's freeway system, largely thanks to the expansion enabled by Maryland Department of Transportation. I-270, I-70, US-340 and US-15 in Maryland are now covered by this data source and the historical data can be traced back to July 1, 2008.

- **First Time Comprehensive Arterial Scan.** To obtain a comprehensive data coverage of the arterials and a few key freeways not monitored by the Vehicle Probe Project (e.g., George Washington Memorial Parkway), the TPB followed Virginia Department of Transportation's procurements and purchased complementary INRIX datasets for calendar year 2010. The procured data cover an approximate total of 4,600 route miles of arterials in the TPB Planning Area (cover a total of 8,300 route miles of all roadway types in the TPB), an unprecedented spatial and temporal coverage of arterials in the region. This report includes some initial analysis results of this rich dataset. In addition, this dataset has also supported other local/national studies, including the Intercounty Connector (ICC) Before and After study, Montgomery County's Mobility Assessment Report, the I-66 corridor bus operations analysis, and the NCHRP 8-36 (104) project – Integrating Performance Measures into a Performance-Based Planning and Programming (PBPP) Process.

- **New Performance Measures Enabled by Speed-Volume Data Integration.** The I-95 Corridor Coalition/INRIX speed data and the Transportation Technology Innovation and Demonstration (TTID) Program vehicle volume data are integrated in this report to develop personal or vehicular mobility/congestion performance measures such as delay, vehicle miles of travel (VMT) and vehicle hours of travel (VHT), based on which a three-layer hierarchical congestion/mobility performance measurement system is also established.

- **Enhanced Regional Transportation Operations Coordination.** The Metropolitan Area Transportation Operations Coordination (MATOC) program was officially established on July 1, 2009, and was recently enhanced with one facilitator and two operators covering 5 weekdays and 15.5 hours a day (4:30 am – 8:00 pm). A dedicated MATOC public website (www.matoc.org) was officially lunched that also provides real-time traffic and incidents information. A Regional Incident Coordination (RIC) program was newly created to facilitate regional coordination upon a variety of emergent incidents. A dedicated website (www.capitalregionaupdated.gov) was also lunched to provide the general public one-stop shop for emergency alerts, weather, traffic, and utilities information.

- **Variably Priced Lanes (VPLs) Provide Options to Travelers.** The Maryland Route 200 or Intercounty Connector (ICC) was fully opened in November 2011 for the section between I-270 and I-95; some positive effects in reducing congestion and providing more options have already been observed. The 495 Express Lanes will be open on the Virginia side of the Capital Beltway by the end of 2012.

- **Growing Bike Sharing and Car Sharing Programs.** The number of bicycle and pedestrian facilities in the region has increased in recent years. The Capital Bikeshare now covers Washington, D.C. and Arlington, VA, and will be expanded to Alexandria, VA and possibly Montgomery County, MD. Car sharing has taken off in the Washington region, with over 800 shared Zipcar® cars in the District of Columbia alone with plans for that number to continue growing. In addition to Zipcar®, Car2Go and Hertz On Demand have moved into the Washington region car sharing market.

- **Periodic updates.** Since the release of the 2010 CMP Technical Report, a variety of planning and program periodic updates and outside data sources have been released. This current report uses these updates to provide the most up-to-date information for the CMP. Some critical updates include, but are not limited to:

- 2011 CLRP and FY 2011-2016 TIP
- Freeway spring 2011 aerial survey results
- Arterial FY 2010 and FY 2011 floating car surveys results
- Round 8.0 Cooperative Forecasts of the region's demographics
- 2009 Washington-Baltimore Regional Air Passenger Survey
- 2009 Central Employment Core Cordon Count
- 2010 High-Occupancy Vehicle (HOV) facilities survey
- 2011 Washington-Baltimore Regional Airport Ground Access Travel Time Study
- Transportation Emission Reduction Measure (TERM) Analysis Report FY 2009-2011

2. STATE OF CONGESTION

2.1 Congestion on Freeways

Freeways comprise the critical backbone of the region's roadway system, and provide the most important indicator of our overall system. Generally they are used for longer distance travel and/or people opting for the most direct route between two points. They are different from arterials in that they have fewer access points, no at-grade intersections, more lanes, and generally can accommodate higher speeds. Because of their nature and their limited number, regional freeway congestion can be analyzed comprehensively for almost all freeway miles.

The TPB's regional freeway monitoring program consists of two major components:

- Aerial photography survey
- Use of third-party data, including
    - I-95 Corridor Coalition Vehicle Probe Project/INRIX speed and travel time data
    - FHWA TTID[27] Program vehicle volume data
    - Maryland Traffic Monitoring System (TMS) vehicle volume data

The TPB has contracted with Skycomp, Inc. to conduct a systematic aerial study of regional freeway congestion since 1993. The latest survey was completed in Spring 2011 and the final report, *Traffic Quality on the Metropolitan Washington Area Freeway System*: *Spring 2011 Report,* can be downloaded from www.mwcog.org[28].

Since July 1, 2008, most of the freeways[29] in the Metropolitan Washington area have been monitored by the I-95 Corridor Coalition Vehicle Probe Project. This project is a groundbreaking initiative and collaborative effort among the Coalition, University of Maryland and INRIX, Inc. providing comprehensive and continuous real-time and historical traffic information to members. As an affiliated 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.* Since then, there have been two major enhancements of this effort: (1) expanded freeway monitoring coverage enabled by Maryland Department of Transportation, and (2) integration of the Vehicle Probe Project/INRIX speed data, the FHWA TTID Program vehicle volume data, and the Maryland Traffic Monitoring System (TMS) volume data. As a result, a quarterly updated *National Capital Region Congestion Report* (or "Dashboard") has been developed to inform CLRP/TIP and the general public with more timely congestion information.

The following two sections will summarize each components of the TPB freeway monitoring program separately.

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[27] The Transportation Technology Innovation and Demonstration (TTID) Program of Federal Highway Administration (FHWA) is a public-private partnership among FHWA, state Departments of Transportation, and Traffic.com. For more information, visit http://ops.fhwa.dot.gov/travelinfo/ttidprogram/ttidprogram.htm.

[28] *Traffic Quality on the Metropolitan Washington Area Freeway System*: *Spring 20011 Report*. Prepared by: Skycomp, Inc. (Columbia, Maryland). http://www.mwcog.org/store/item.asp?PUBLICATION_ID=436

[29] Notable exceptions are George Washington Memorial Parkway and Dulles Greenway.

2.1.1 Freeway Aerial Photography Survey

Methodology

The TPB has contracted with Skycomp, Inc. to conduct a systematic aerial study of regional freeway congestion since 1993. Peak period congestion is monitored on a once-every-three-years cycle during the AM and PM peak periods, off-peak and weekend congestion is monitored once every five years, and there are periodic incident-related monitoring efforts. It provides 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.

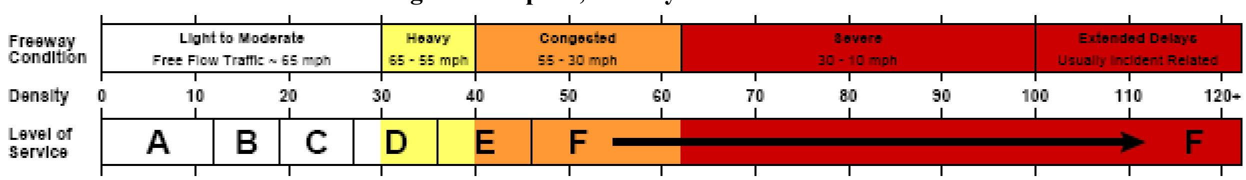
During a survey period, fixed-wing aircrafts follow designated flight patterns along the region's approximately 300 centerline miles of limited-access highways. Survey flights were conducted on weekdays, excluding Monday mornings, Friday evenings, and mornings after holidays, during the following time 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 four morning and four evening commuter periods (this means that, altogether, there were 12 morning and 12 evening observations of each highway segment).

Data was 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) using methods presented in the *Highway Capacity Manual 2000*. LOS "A" reflects generally free-flow conditions, and levels "E" and "F" reflects the most severe congestion with extended delays, as illustrated in the following diagram (Figure 10).

Figure 10: Speed, Density and LOS Chart



The most recent peak period survey was conducted in Spring 2011 and the following summarizes the highlights of the survey results.

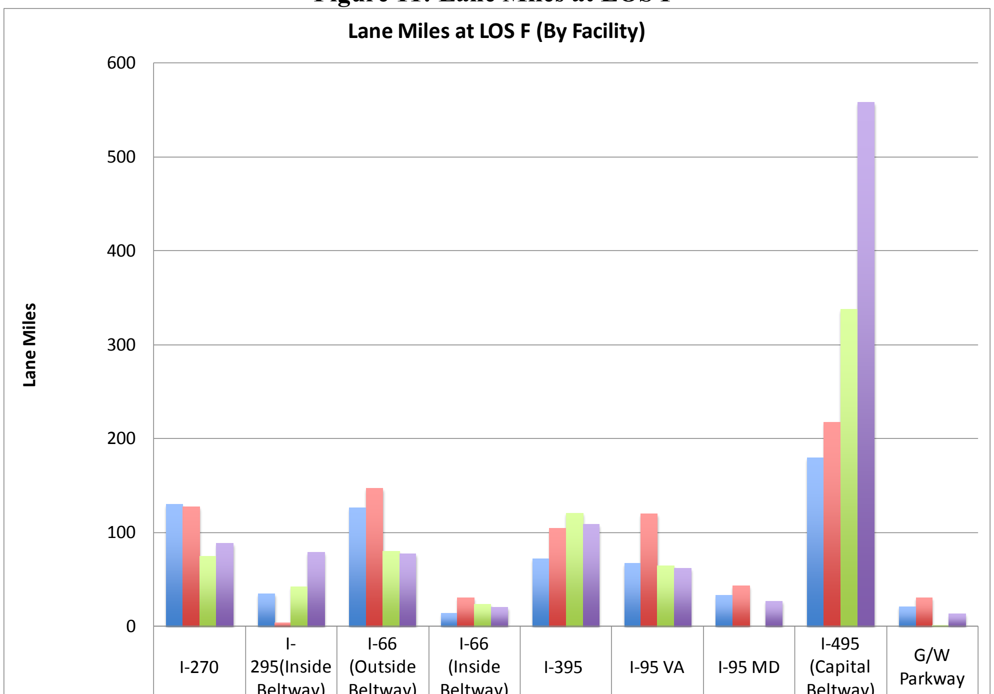
Highlighted Findings of the Spring 2011 Survey

Lane miles of congestion continue to grow in the region. Regionally lane miles under congested conditions (LOS F) which experienced a dip in 2008 due to the downturn in economy has increased by 50% over 2008 conditions but only 10% over the 2005 conditions. Note that the lane miles were calculated as the *total* of the three-hour peak period (i.e., total = sum of each hour's lane miles at LOS F).

Reviewing the 3-hour AM and PM peak period conditions, Skycomp also observed the peak spreading occurring in the region.

The lane miles at LOS F by facility is given in Figure 11. I-495 had the highest number of lane miles at LOS F in all time, and it also had the largest increase from 2008 to 2011 in the peak period (260 lane miles).

Figure 11: Lane Miles at LOS F



	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)	G/W Parkway
2008 (6-9AM)	130	35	126	14	72	67	33	180	21
2011 (6-9AM)	127	4	147	30	105	120	43	218	30
2008 (4-7PM)	75	42	79	23	121	64	0	337	1
2011 (4-7PM)	88	79	77	20	108	62	27	558	14

Improvements Observed in the Spring 2011 Survey

Figure 12 and Figure 13 provide overview maps of significant changes in traffic congestion from 2008 to 2011.

The biggest positive impact on congestion in the region was caused by the opening of the Wilson Bridge on May 30th, 2008. What used to be routine 3 hours of AM peak period congestion on the inner loop of the Capital Beltway (I-95) extending from St Barnabas Road in Prince George's County to Telegraph Road in Virginia has been completely eliminated. Additionally far away from the bridge AM peak period congestion on SB I-395 from the 11th street Bridge to the 14th Street Bridge and congestion on NB I-395 at the 14th Street Bridge in the District has been substantially reduced.

Another route with performance improvements was southbound Baltimore Washington Parkway due to geometric improvements, and bridge repair work. Congestion that existed since 2005 on SB B/W Parkway from I-495 to Pennsylvania has been substantially reduced.

Another route with improvement was eastbound VA 267 during the am peak between Fairfax County Parkway and International Drive. Skycomp could not identify any specific improvement that contributed to this change in congestion.

Degradation Observed in the Spring 2011 Survey

The following routes experienced more congestion as compared to 2008 and 2005 surveys. The cause appears to be increase in volume of traffic.

Eastbound I-66 during the AM peak period has deteriorated on both the general purpose lanes and HOV lanes between VA 234 bypass and VA 28.

Eastbound I-66 inside the beltway during the am peak period between VA 267 and Fairfax Drive even though this part of I-66 is limited to HOV 2+.

Northbound I-395 (general purpose lanes) during the AM peak period extending from the construction zone at the 14th Street Bridge to the Capital Beltway. The ramp from the HOV 3+ facility to the Pentagon also experienced congestion. The cause appears to be narrowing of lanes and short merge lanes due to the construction.

The right lane of southbound I-295 in Maryland during the pm peak period between Suitland Parkway and westbound Capital Beltway towards the Wilson Bridge. This bottleneck location could potentially be fixed by studying possible alternatives similar to the fix at the Beltway exit ramp to the Dulles Toll Road.

Figure 12: Significant Changes (2008-2011) – Morning Peak Period

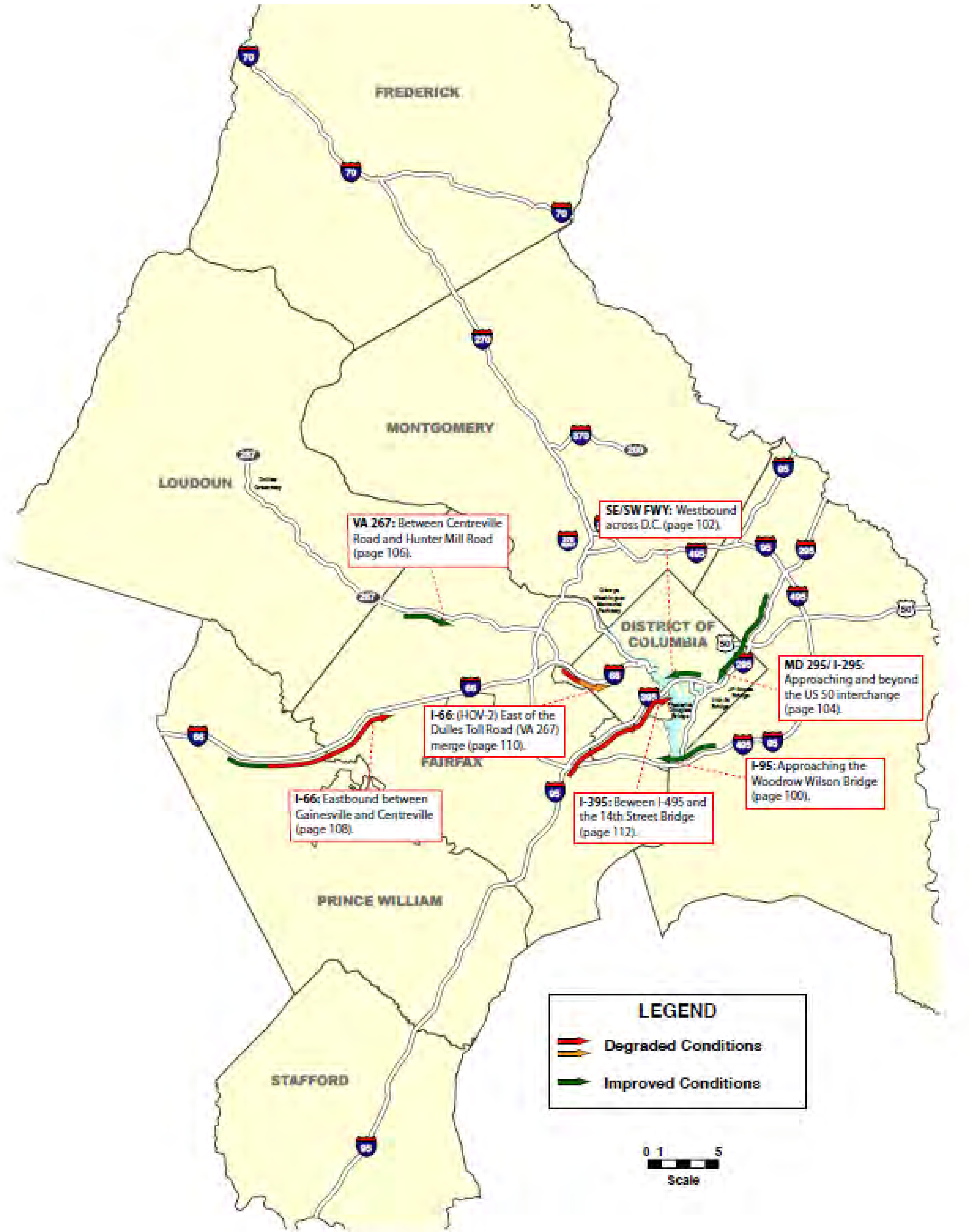
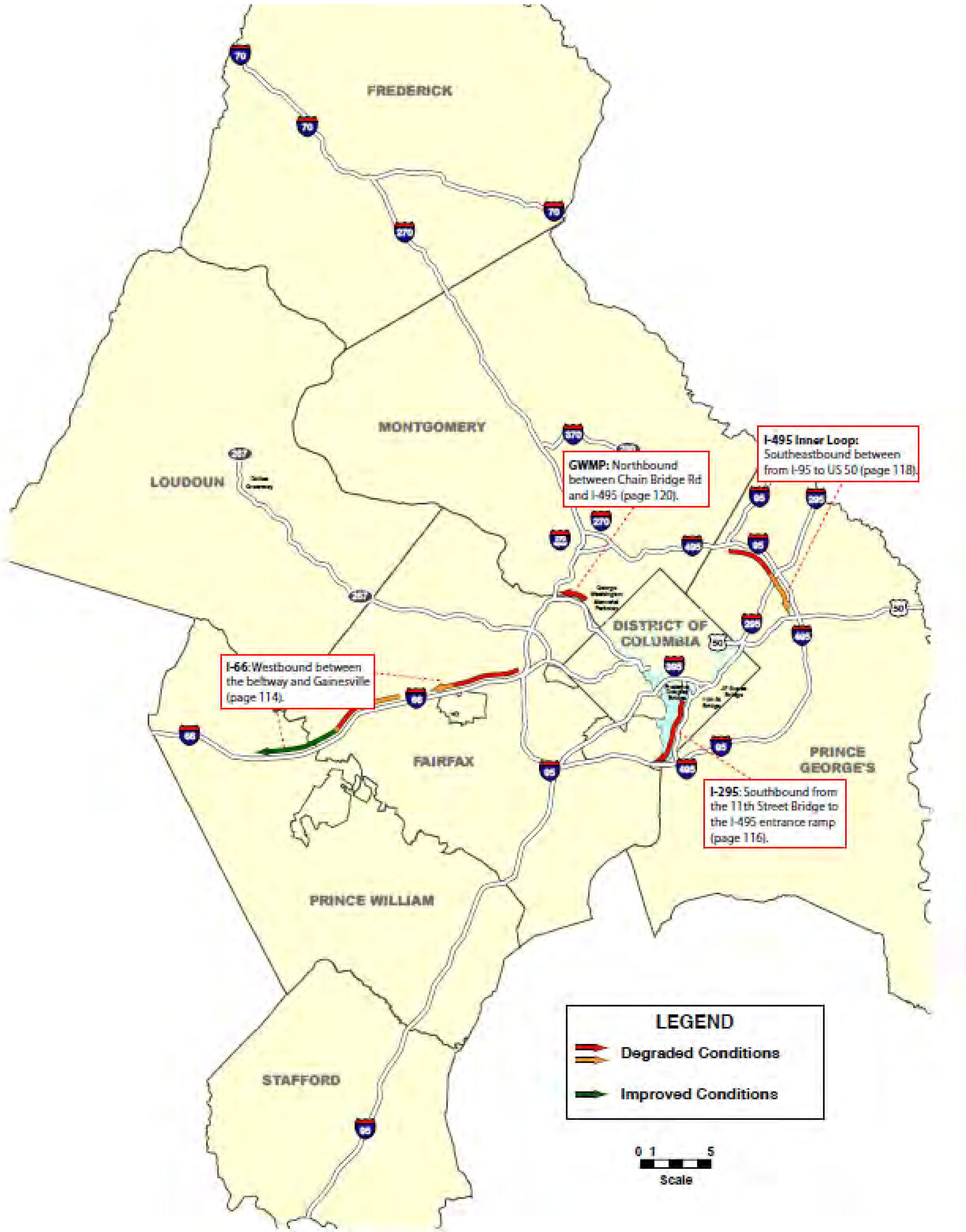


Figure 13: Significant Changes (2008-2011) – Evening Peak Period

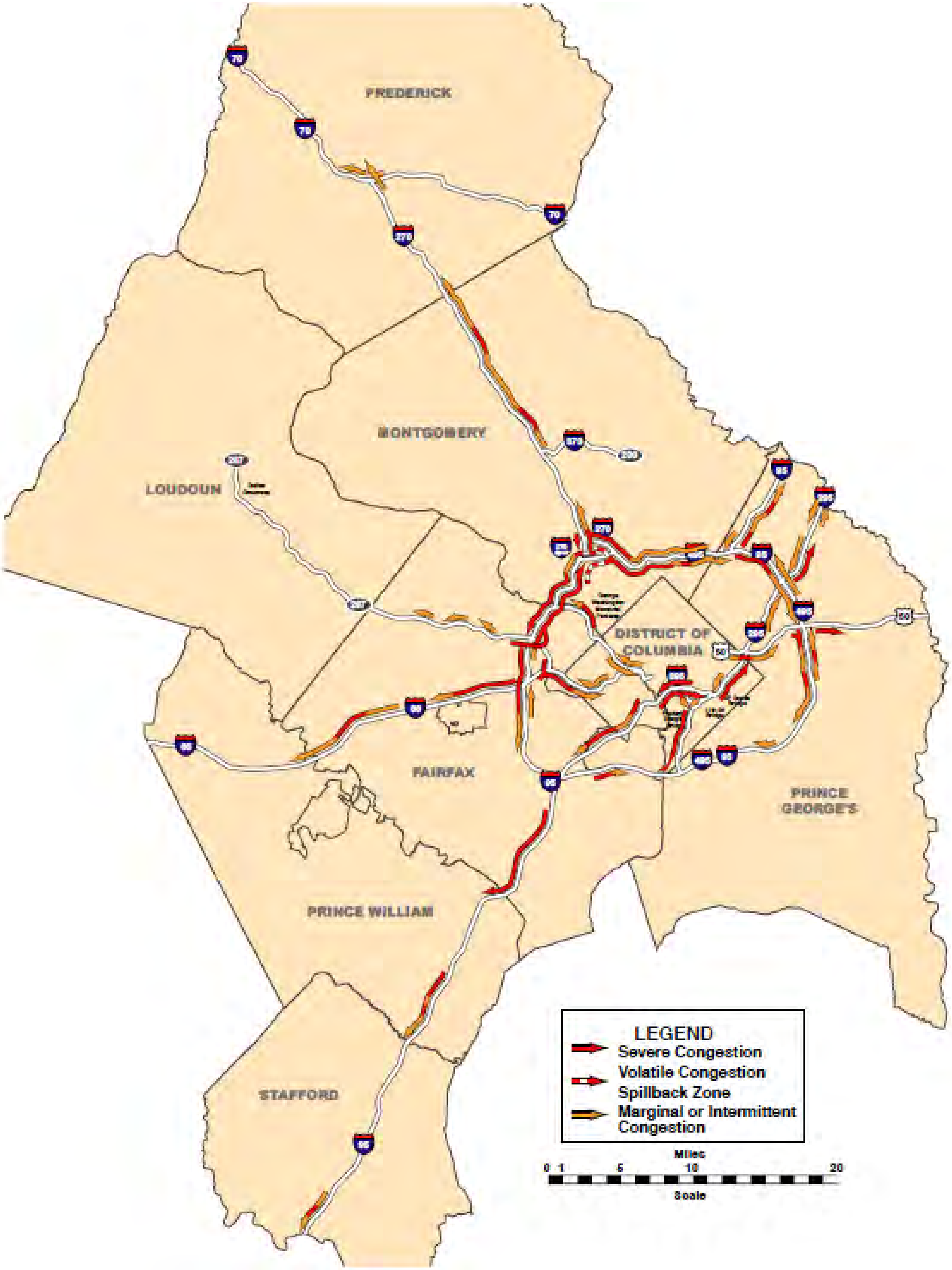


Summary Congestion Maps of the Spring 2011 Survey

The summary maps of the AM and PM congestion of the Spring 2011 Survey are provided in Figure 14 and Figure 15.

Figure 14: Morning Peak Period Regional Congestion - Spring 2011

Figure 15: Evening Peak Period Regional Congestion – Spring 2011



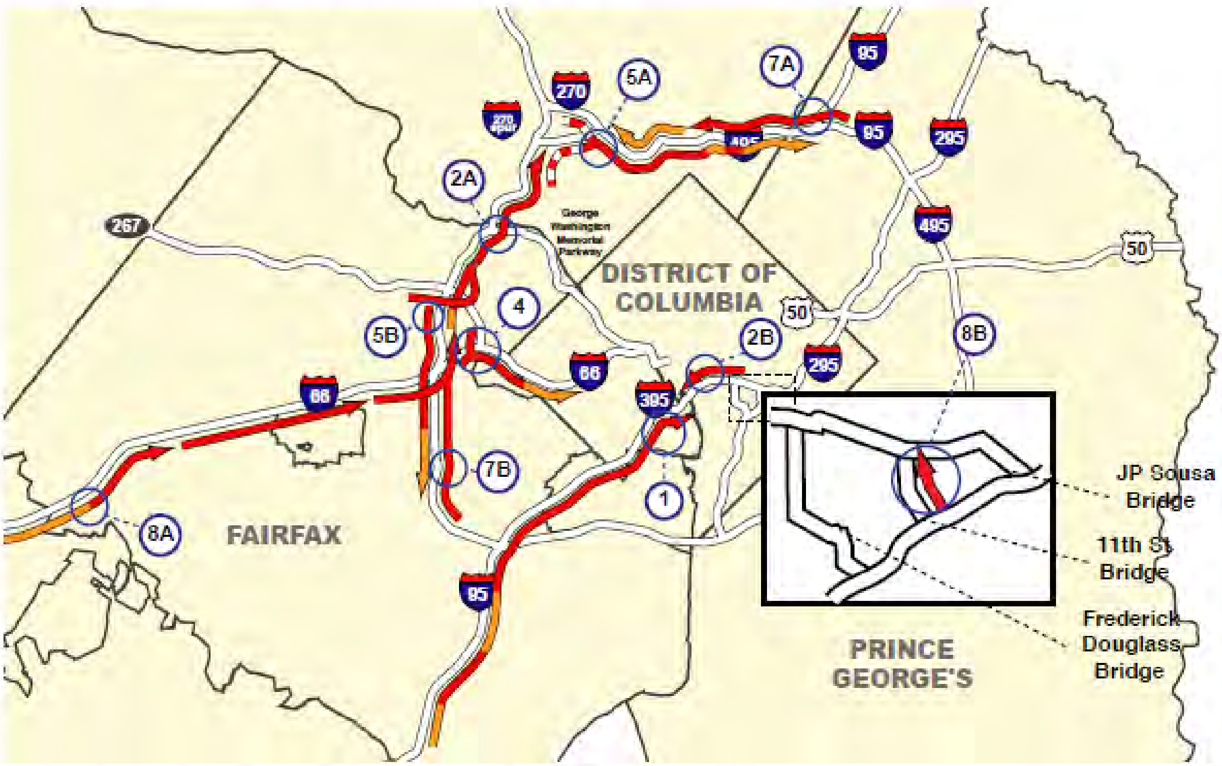
Top Ten Congested Locations in the Spring 2011 Survey

Figure 16 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 16: Top Ten Congested Locations – Spring 2011

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 (2011)

Rank	Route	From	To	Density	Speed Range
1*	NB I-395 (8:30 to 9:30 AM)	VA 27 (Washington Blvd)	VA 110 (Jefferson Davis Hwy)	145	5 MPH
2A	IL I-495 (5:30 to 6:30 PM)	VA 193 (Georgetown Pike)	George Washington Mem Pkwy	125	5 to 10 MPH
2B	SB I-395/SW Fwy (6:00 to 7:00 PM)	4th St	12th St	125	5 to 10 MPH
4	EB I-66 (6:00 to 7:00 PM)	VA 7 (Leesburg Pike)	Dulles Access	115	7 to 12 MPH
5A	IL I-495 (4:30 to 5:30 PM)	MD 355 / I-270	MD 185 (Connecticut Ave)	110	10 to 15 MPH
5B*	OL I-495 (5:30 to 6:30 PM)	VA 267 (Dulles Toll Rd)	VA 123 (Chain Bridge Rd)	110	10 to 15 MPH
7A	OL I-495 (8:00 to 9:00 AM)	I-95	MD 650 (New Hampshire Ave)	105	12 to 20 MPH
7B*	IL I-495 (8:00 to 9:00 AM)	Gallows Rd	US 50 (Arlington Blvd)	105	12 to 20 MPH
8A	EB I-66 (7:00 to 8:00 AM)	VA 234 Bypass	VA 234 (Sudley Rd)	95	15 to 25 MPH
8B*	WB 11th St Bridge (7:30 to 8:30 AM)	I-295	Southeast Fwy	95	15 to 25 MPH

* While impacted by construction, these links are historically congested

Longest Delay Corridors in the Spring 2011 Survey

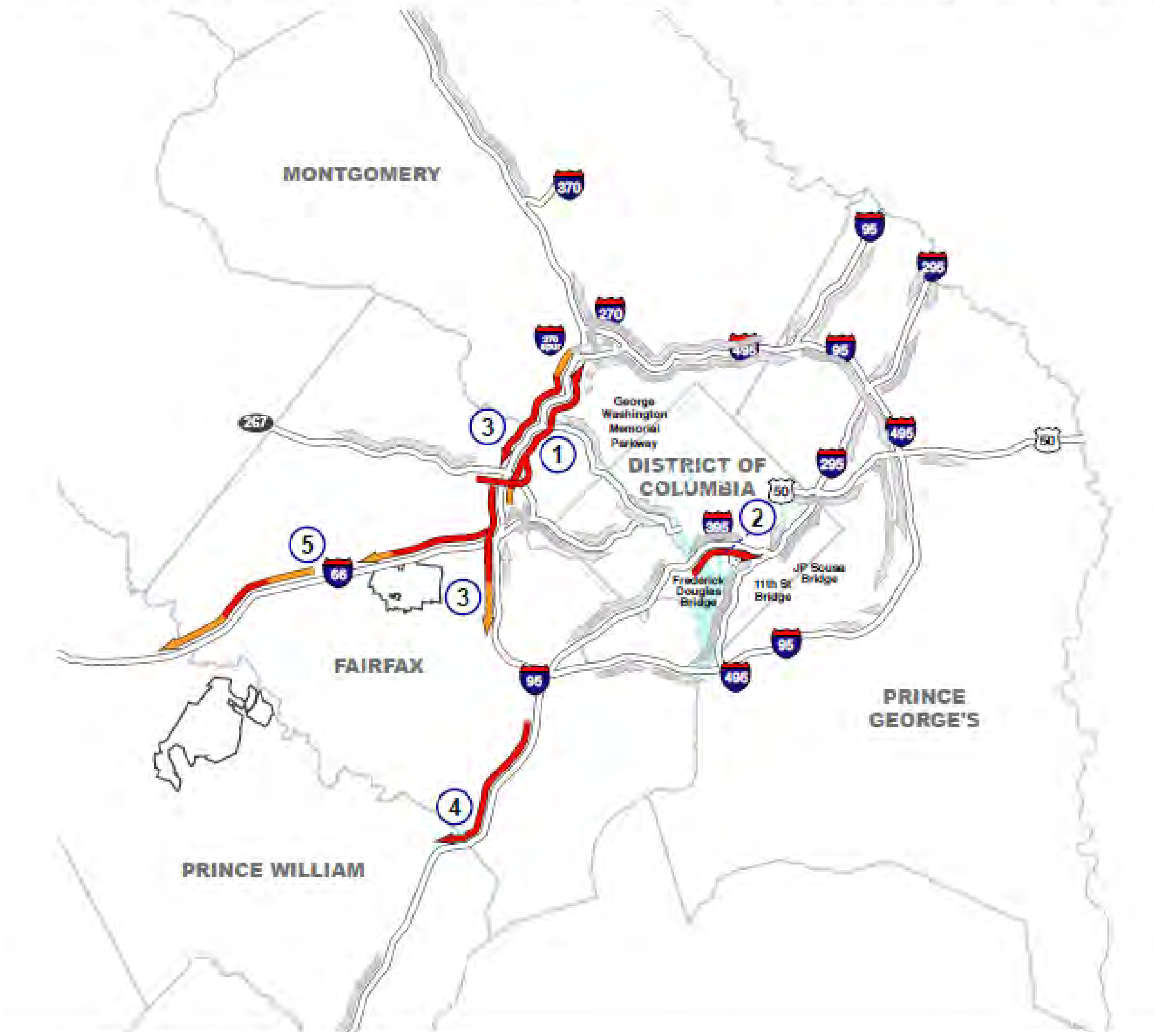
Beginning in 2008, the freeway aerial survey introduced a new metric – Longest Delay Corridors. The purpose of this metric was to identify corridors which might not have bottlenecks in the "Top Ten Congested Locations" but were long congested corridors. Delay was calculated by estimating the additional travel time during congested conditions over the free flow travel time. Free flow speed was assumed to be 60 mph. Figure 17 and Figure 18 present the top five congested corridors in the AM and PM peak period.

Figure 17: Longest Delay Corridors - Morning Peak Period (Spring 2011)

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/I-395	7:30 – 8:30	Northbound	US 1	GWMP	18.3	62.8	18	44.4
Site #2	I-66	7:00 – 8:00	Eastbound	VA 234 Bypass	I-495	19.4	48.0	24	28.6
Site #3	I-495	7:00 – 8:00	Outerloop	US 1	I-270	10.0	28.7	21	18.7
Site #4	I-495	8:00 – 9:00	Innerloop	I-95	I-66	8.0	24.9	19	16.9
Site #5	GWMP	7:30 – 8:30	Eastbound	Chain Bridge Rd	I-66	5.3	16.5	19	11.2

Figure 18: Longest Delay Corridors - Evening Peak Period (Spring 2011)

Site Name	Road Name	Time	Direction	From	To	Queue Length (miles)	Estimated Travel Time (minutes)	Estimated Speed (mph)	Estimated Delay (minutes)
Site #1	I-495	5:30 – 6:30	Innerloop	VA 7(Leesburg Pike)	I-270 Spur	10.3	41.8	15	31.5
Site #2	I-395	5:00 – 6:00	Northbound	VA 110 (Jeff. Davis Hwy)	Pennsylvania Ave	4.3	19.2	13	14.9
Site #3	I-495	4:30 – 5:30	Outerloop	MD 187 (Old Georgetonwn Rd)	VA 236 (Little River Turnpike)	8.8	22.6	23	13.8
Site #4	I-95	4:30 – 5:30	Southbound	I-495	VA 123 (Gordon Blvd)	9.7	22.4	26	12.8
Site #5	I-66	4:30 – 5:30	Westbound	I-495	VA 234 (Sudley Rd)	16.8	28.3	36	11.5



2.1.2 Use of Third-Party Data for Freeway Monitoring

Third-Party Data

The term "third-party data" in this report refers to the data collected by public agencies and/or private companies other than the efforts made by the Metropolitan Washington Council of Governments/National Capital Region Transportation Planning Board.

(1) The I-95 Corridor Coalition Vehicle Probe Project/INRIX Data: Speed & Travel Time

Since July 1, 2008, a portion of freeways and major arterials in the Metropolitan Washington Area have been monitored by the I-95 Corridor Coalition Vehicle Probe Project[30]. This project is a groundbreaking initiative and collaborative effort among the Coalition, University of Maryland and INRIX, Inc. providing comprehensive and continuous real-time and historical travel information to members. 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 flow.

As an affiliate member of the Coalition, the National Capital Region Transportation Planning Board has been granted the access to the data collected in the Vehicle Probe Project. The initial applications of this source data in the Congestion Management Process can be found in the 2010 CMP Technical Report[31].

The initial "core coverage" of this project included only two thirds of the freeways in the TPB Planning Area. The supplementary expansions enabled by Virginia Department of Transportation and Maryland Department of Transportation have extended the coverage to more than 90% of the freeways, with notable exceptions of George Washington Memorial Parkway, Dulles Access Road (no toll) and Dulles Greenway. The freeways monitored by this Vehicle Probe Project/INRIX and its expansions to date are shown in red in Figure 19.

The Vehicle Probe Project/INRIX data provide only speed and travel time information for a directional roadway segment, called TMC (Traffic Message Channel) – the de facto industry standard for roadway segmentation. The data lack another important variable to depict a full picture of traffic flow – volume. For this reason, two other third-party data sources have been investigated and utilized, as described in the following sections.

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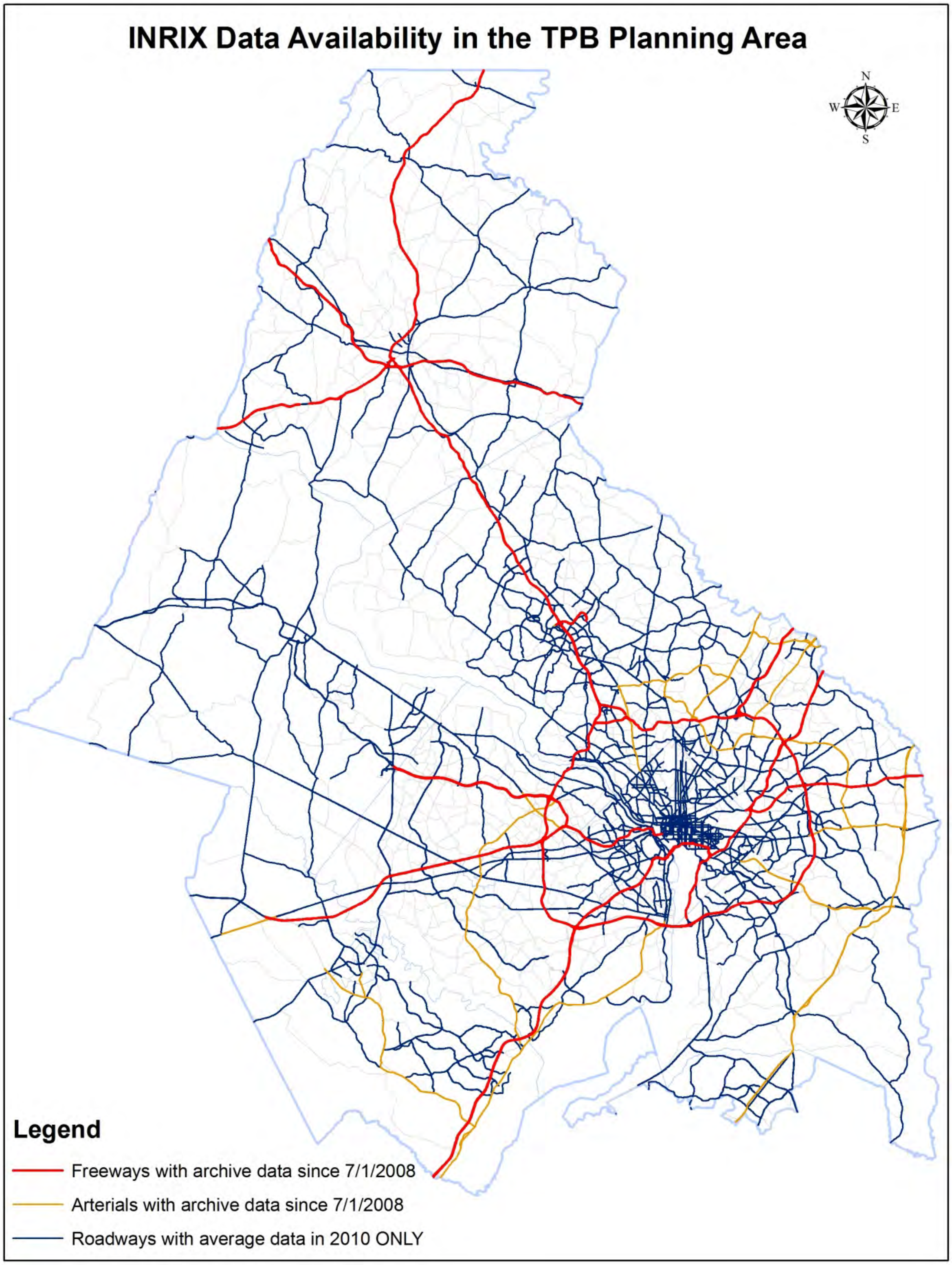
[30] Project Database, The I-95 Corridor Coalition: http://www.i95coalition.org/i95/Projects/ProjectDatabase/tabid/120/agentType/View/PropertyID/107/Default.aspx

[31] 2010 Congestion Management Process (CMP) Technical Report, Metropolitan Washington Council of Governments. www.mwcog.org/cmp.

Figure 19: INRIX Data Availability in the TPB Planning Area



(2) FHWA TTID Program Data: Volume

The Federal Highway Administration's Transportation Technology Innovation and Demonstration (TTID) Program is enabled by SAFETEA-LU to advance the deployment of intelligent transportation infrastructure[32]. The purpose of this program is to address national, local, and commercial data needs through enhanced surveillance and data management in major metropolitan areas. This involves integration of data from existing surveillance infrastructure and strategic deployment of supplemental surveillance infrastructure to provide real-time and archived roadway system performance data. At the national level, the goal is to measure the operating performance of the roadway system across the nation. Made available locally, such roadway system performance data can be used to assist in local system planning, evaluation, and management activities. The same data that is useful to the public transportation agencies also has value for commercial traveler information purposes.

To date, the TTID program has completed the systems in 25 metropolitan areas, including the National Capital Region. Location-fixed detectors are the primary data collection devices and about 190 centerline miles of freeways in the region are covered by this program. The uncovered roads in the Washington region include MD-295, I-70, US-15 and US-340. The advantage of this data source lies in the continuous traffic volume information (besides speed) obtained from the detectors. Its disadvantages include typical detector-based data uncertainties (assumptions of vehicle length and segment length, mechanical failure, etc.) and uneven density of coverage.

(3) Maryland Traffic Monitoring System (TMS) Data: Volume

Given that several major freeways in the TPB Planning Area are not monitored by the TTID program (including MD-295, I-70, US-15 and US-340), the Maryland State Highway Administration (SHA) Traffic Monitoring System[33], which provides complementary volume information, is also investigated and utilized.

Unlike the TTID program, the Maryland TMS volume information is presented as annual average daily traffic (AADT) and annual average weekday traffic (AAWDT). For permanent, continuous counting Automatic Traffic Recording (ATR) stations, the TMS also provides monthly, daily and hourly fluctuation factors. COG also received hourly directional volume data for certain count stations from SHA. The above information together enables a common ground for TTID and TMS data combination: aggregate (TTID) or disaggregate (TMS) data to provide monthly average volume by hour of the day and day of the week. The combined volume data cover all the freeways monitored by the Vehicle Probe Project/INRIX.

(4) Data Compilation

The main task of third-party data compilation is to integrate the speed/travel time data provided by the Vehicle Probe Project/INRIX and the volume data provided by the TTID program and the

[32] Real-Time Traveler Information Program, Federal Highway Administration: http://ops.fhwa.dot.gov/travelinfo/ttidprogram/ttidprogram.htm
[33] Traffic Monitoring System, Maryland State Highway Administration: http://www.marylandroads.com/index.aspx?PageId=251

Maryland TMS. To archive this, the spatial and temporal relationships among the different data sources should be established respectively.

The first step is to establish the spatial relationship between the location references used by the different data sources. The Vehicle Probe Project/INRIX data are reported at the TMC level (TMC stands for Traffic Message Channel – the de facto industry standard for roadway segmentation), while the TTID and TMS volumes are recorded at location-fixed stations. Given the facts that the volume detectors are not evenly distributed on the road network and sometimes (not uncommon) certain detectors do not function to report data. The following rules of thumb are used to match the TMCs with the stations:

- Combine several successive TMCs to form a "segment" that includes at least one station;
- Segment should be at least 1-mile long;
- Segment ends/begins if
  - The number of lanes changes, or
  - At a major interchange or a point of interest;
- If a segment has multiple stations, use average volume as the whole segment volume.

The second step is to establish the temporal relationship between the source data reported in different lengths of time period. The Vehicle Probe Project/INRIX archives historical data in 5- or 1-minute increments[34]; The TTID program provides 5-minute average volumes; and the Maryland TMS can only provide monthly average volumes by hour of the day and day of the week. It is obvious that the temporal resolution of the Maryland TMS data is the common resolution at which all source data can be combined and further analyzed. Thus the Vehicle Probe Project/INRIX speed data and TTID volume data are respectively aggregated to monthly averages by hour of the day and day of the week.

Overview of Performance Measures

Currently, there is a significant national momentum towards performance-based transportation planning and programming processes. The use of appropriate and effective performance measures is one of the critical components towards the success of such a process. The TPB has adopted a set of performance measures in the 1994 Congestion Management System (CMS) Work Plan (please refer to Chapter 4 for more details). Since then, there has been an evolution towards more traveler-oriented metrics in conveying congestion and related information to the general public. Some of the measures are leveraged by emerging highway performance monitoring activities such as the I-95 Corridor Coalition Vehicle Probe Project that provides probe-based continuous monitoring. Currently, the TPB is developing a Regional Transportation Priorities Plan and a set of performance measures have been identified according to the regional goals and objectives set by the *TPB Vision* and COG's *Region Forward*.

The ongoing development of the Regional Transportation Priorities Plan has identified two performance measures to evaluate the effectiveness of the highway transportation system:

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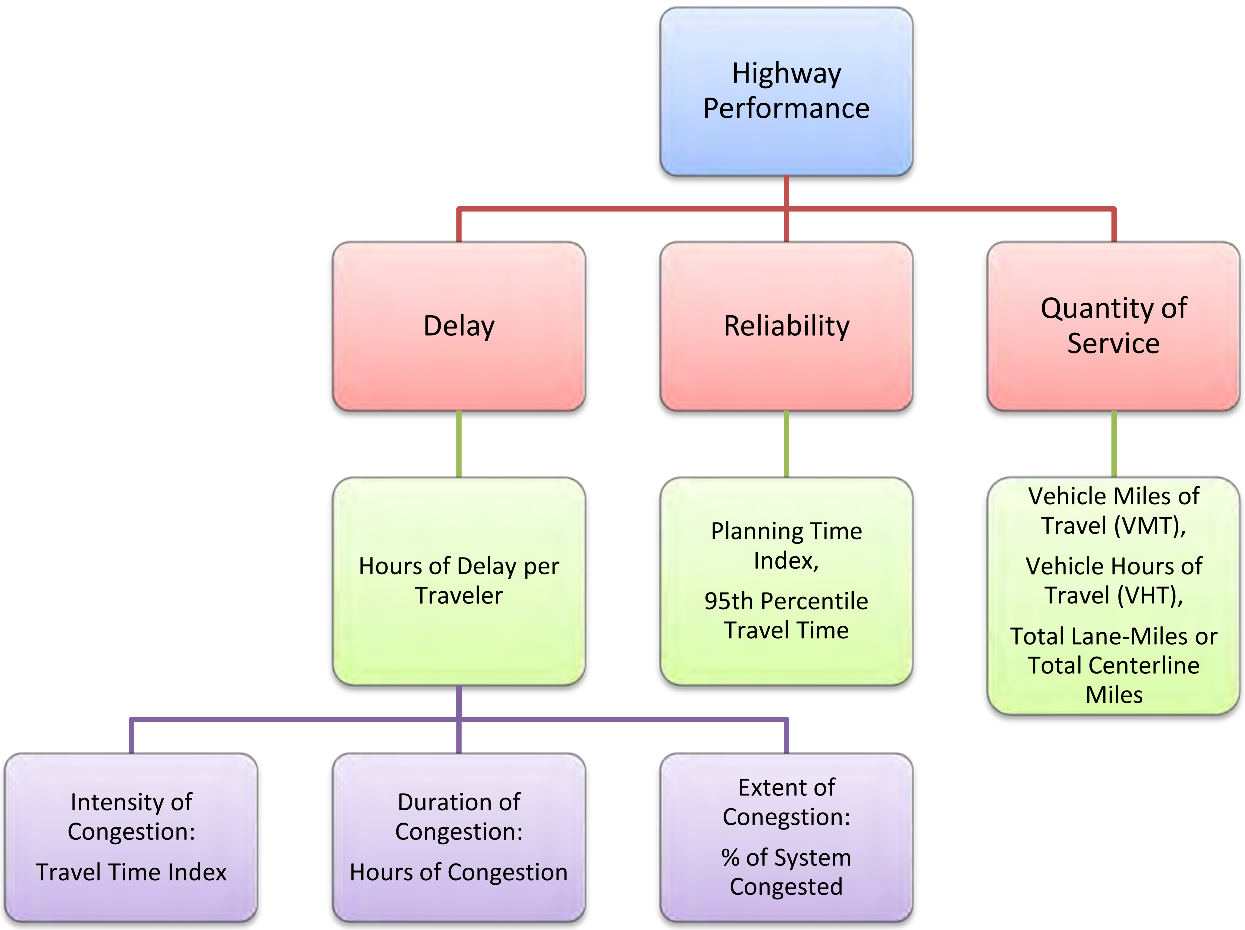
[34] The archived data retrieved from the I-95 Traffic Monitoring website (http://i95.inrix.com) is provided in 5-minute increments, i.e., one snapshot every 5 minutes. The data retrieved from the Vehicle Probe Project Suite (http://vpp.ritis.org/suite/) is provided in 1-minute increments.

Annual Hours of Delay per Traveler, and Planning Time Index (Extra Time for On-Time Arrival). These two measures, along with others, have already been used in the sister publication of the CMP Technical Report – National Capital Region Congestion Report. The hierarchical relationship between the adopted performance measures is illustrated in Figure 20.

Figure 20: Hierarchical Highway Performance Measures



Delay is the most important overarching measure for highway performance measurement. The three dimensions of congestion – intensity, duration, and extent (or location), and the two commonly referred congestion types – recurring and non-recurring, all lead to delay eventually. It is also easy to understand, and can be used by other modes such as transit. But there is an important characteristic of highway operations that delay cannot entirely capture: travel time reliability. For example, the same amount of delay, either in total or average forms, can have totally different travel time distributions with different travel experiences (e.g., moderate delay across all travelers versus severe delay to only a portion of the travelers). Therefore reliability stands out as an individual measure for highway performance. The quantity of service of a highway system, such as vehicle miles of travel (VMT), provides background information to help to understand the highway system as well as changes observed in delay and reliability.

As a summary, the highway performance measures developed from the third-party data are:

1) Annual Hours of Delay per Traveler
2) Travel Time Index
3) Percentages of Freeway Lane-Miles (or arterial centerline miles) by Congestion Level
4) Planning Time Index
5) Vehicle Miles of Travel (VMT)
6) Vehicle Hours of Travel (VHT)
7) Hours of Congestion (for bottlenecks only)
8) 95th Percentile Travel Time (for corridors only)

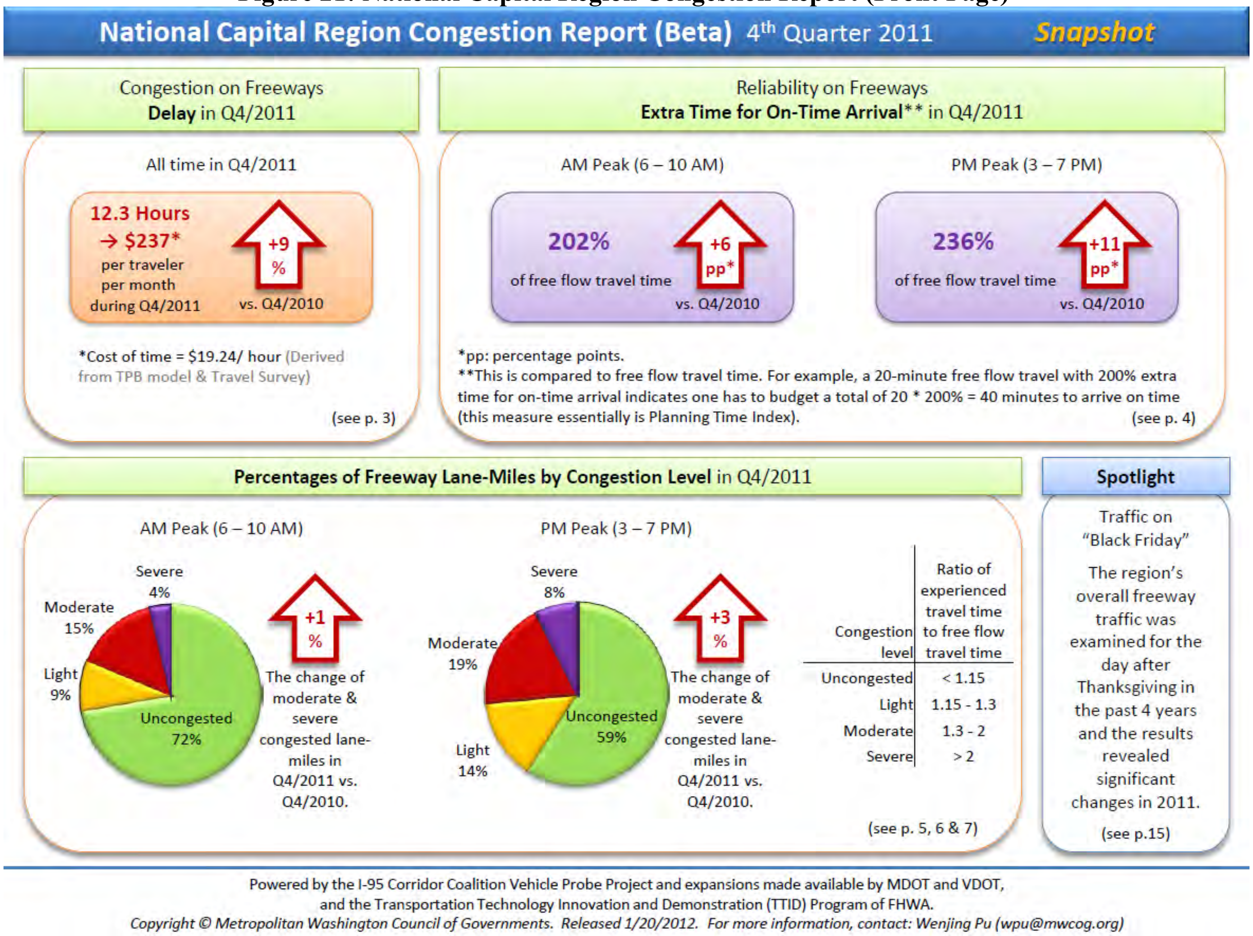
Performance measures 1), 5) and 6) are calculated from integrated speed/travel time and volume data; others are solely derived from speed/travel time data.

National Capital Region Congestion Report (Congestion Dashboard)

Inspired by various agency and jurisdictional dashboard efforts around the country (e.g., Virginia Department of Transportation Dashboard), driven by the emergent probe-based traffic speed data from the I-95 Corridor Coalition Vehicle Probe Project, this dashboard-style *National Capital Region Congestion Report* tries to take advantage of and integrate several existing data sources to produce customized, easy-to-communicate, and quarterly updated congestion and transportation operations performance measures for the Transportation Planning Board (TPB) Planning Area. The goal of this effort is to make the Congestion Management Process "alive" on the TPB website that timely summarizes the region's congestion and the programs of the TPB and its member jurisdictions that would have an impact on congestion. The higher goal of this report is to help to facilitate performance-based transportation planning and programming process in the National Capital Region.

This report can be accessed via http://www.mwcog.org/congestion. A screenshot of the first page of the dashboard report (which is for the 4th quarter of 2011) is provided below (Figure 21).

Figure 21: National Capital Region Congestion Report (Front Page)



National Capital Region Congestion Report (Beta) 4th Quarter 2011 *Snapshot*

Congestion on Freeways
Delay in Q4/2011

All time in Q4/2011

12.3 Hours
→ $237*
per traveler
per month
during Q4/2011

+9 %
vs. Q4/2010

*Cost of time = $19.24/ hour (Derived from TPB model & Travel Survey)

(see p. 3)

Reliability on Freeways
Extra Time for On-Time Arrival** in Q4/2011

AM Peak (6 – 10 AM)

202%
of free flow travel time
+6 pp*
vs. Q4/2010

PM Peak (3 – 7 PM)

236%
of free flow travel time
+11 pp*
vs. Q4/2010

*pp: percentage points.
**This is compared to free flow travel time. For example, a 20-minute free flow travel with 200% extra time for on-time arrival indicates one has to budget a total of 20 * 200% = 40 minutes to arrive on time (this measure essentially is Planning Time Index).

(see p. 4)

Percentages of Freeway Lane-Miles by Congestion Level in Q4/2011

AM Peak (6 – 10 AM)

Severe 4%
Moderate 15%
Light 9%
Uncongested 72%

+1 %
The change of moderate & severe congested lane-miles in Q4/2011 vs. Q4/2010.

PM Peak (3 – 7 PM)

Severe 8%
Moderate 19%
Light 14%
Uncongested 59%

+3 %
The change of moderate & severe congested lane-miles in Q4/2011 vs. Q4/2010.

Congestion level	Ratio of experienced travel time to free flow travel time
Uncongested	< 1.15
Light	1.15 - 1.3
Moderate	1.3 - 2
Severe	> 2

(see p. 5, 6 & 7)

Spotlight

Traffic on "Black Friday"

The region's overall freeway traffic was examined for the day after Thanksgiving in the past 4 years and the results revealed significant changes in 2011.

(see p.15)

Powered by the I-95 Corridor Coalition Vehicle Probe Project and expansions made available by MDOT and VDOT, and the Transportation Technology Innovation and Demonstration (TTID) Program of FHWA.

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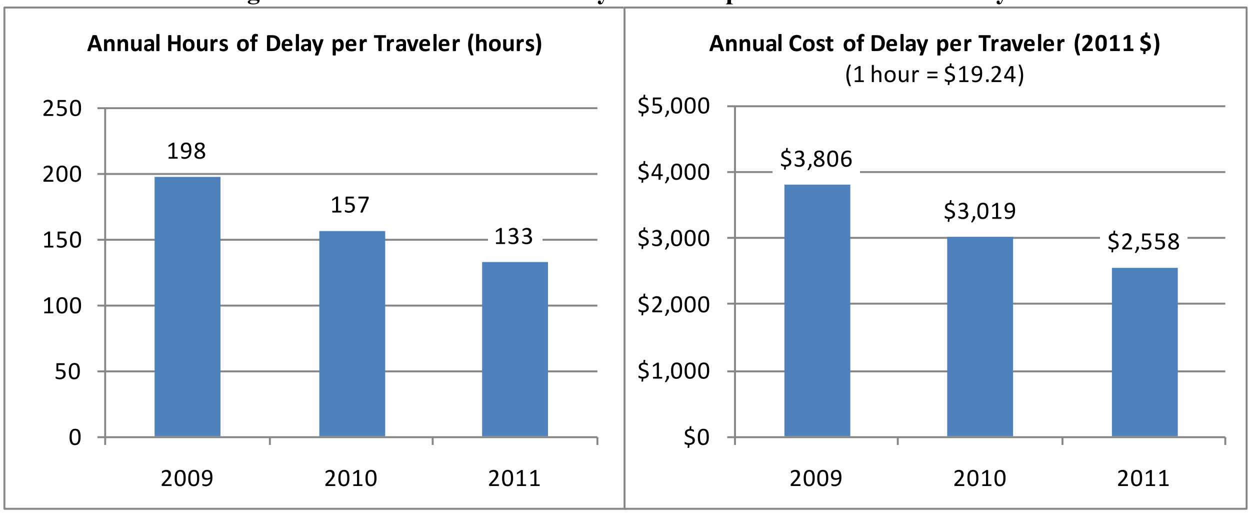
Delay

Freeway travelers in the Washington region on average experienced decreasing delays from 2009 to 2011, as illustrated by the annual hours of delay and its monetary cost per traveler shown in Figure 22.

Figure 22: Annual Hours of Delay and Cost per Traveler on Freeways

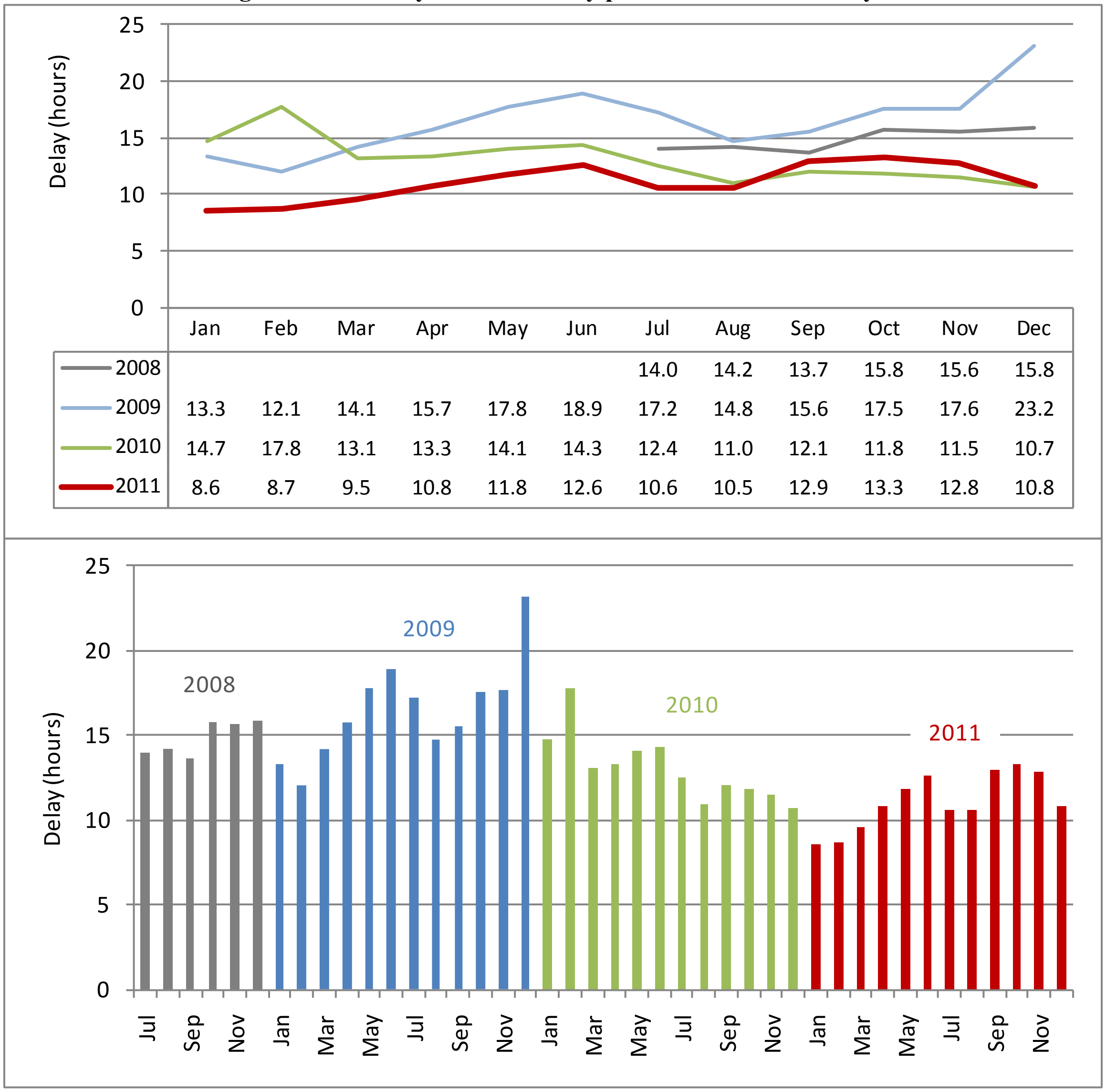


The 2011 total hours of delay of a typical traveler who commuted on freeways was 133 hours (or 5.5 days, or 32 minutes per workday per traveler), decreased by 15% and 33% compared to 2010 and 2009, respectively. If converted to a monetary value, the 2011 total delay cost was $2,558 per traveler (or 7 dollars per day per traveler; 1 hour = $19.24, a value derived from the TPB travel demand model and the 2007/2008 Household Travel Survey).

The delay varied month to month, as shown in Figure 23. June usually experienced the longest delay in a year, while the winter months and August had only moderate delays, except when adverse weather conditions were in presence, such as the winter storms occurred in December 2009 and February 2010. Compared with the same months from 2009 to 2011 (upper chart), the 2009 months, except for January and February, had the longest delays. Chronologically (lower chart), the higher level delay existed from early summer 2009 to February 2010; then it started to decrease until early 2011; thereafter the delay started increasing and even exceeded the 2010 level in the second half of the year, but still lower than that of 2009 and 2008.

The delay experienced on a freeway segment is calculated as the difference between experienced travel time and free flow travel time, and times the number of travelers traversed the segment. The average delay per traveler on all the monitored freeway segments is obtained by the total number of person-hours of delay divided by the total number of travelers.

Figure 23: Monthly Hours of Delay per Traveler on Freeways



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008							14.0	14.2	13.7	15.8	15.6	15.8
2009	13.3	12.1	14.1	15.7	17.8	18.9	17.2	14.8	15.6	17.5	17.6	23.2
2010	14.7	17.8	13.1	13.3	14.1	14.3	12.4	11.0	12.1	11.8	11.5	10.7
2011	8.6	8.7	9.5	10.8	11.8	12.6	10.6	10.5	12.9	13.3	12.8	10.8

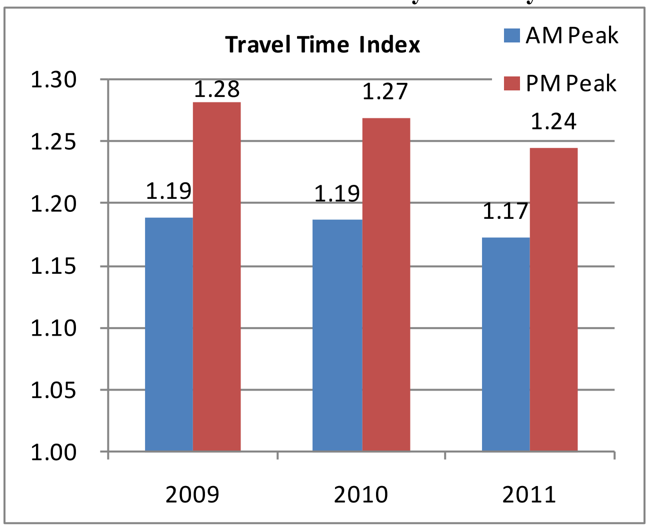
Travel Time Index

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.

The annual average travel time index on monitored freeways during non-holiday workday AM peak (6:00-10:00 am) and PM peak (3:00-7:00 pm) are shown in Figure 24. Similar to what was found in delay, the Washington region generally experienced decreasing intensity of congestion from 2009 to 2011 in both AM and PM peak periods.

When comparing the Travel Time Index to delay, one should be aware of an important temporal difference in reporting the two performance measures: the delay was recorded for all time periods throughout a year including workdays, weekends, holidays and nighttime, while the Travel Time Index was only calculated for non-holiday workday AM and PM peak periods.

Figure 24: Annual Travel Time Index for Non-Holiday Workday Peak Periods on Freeways

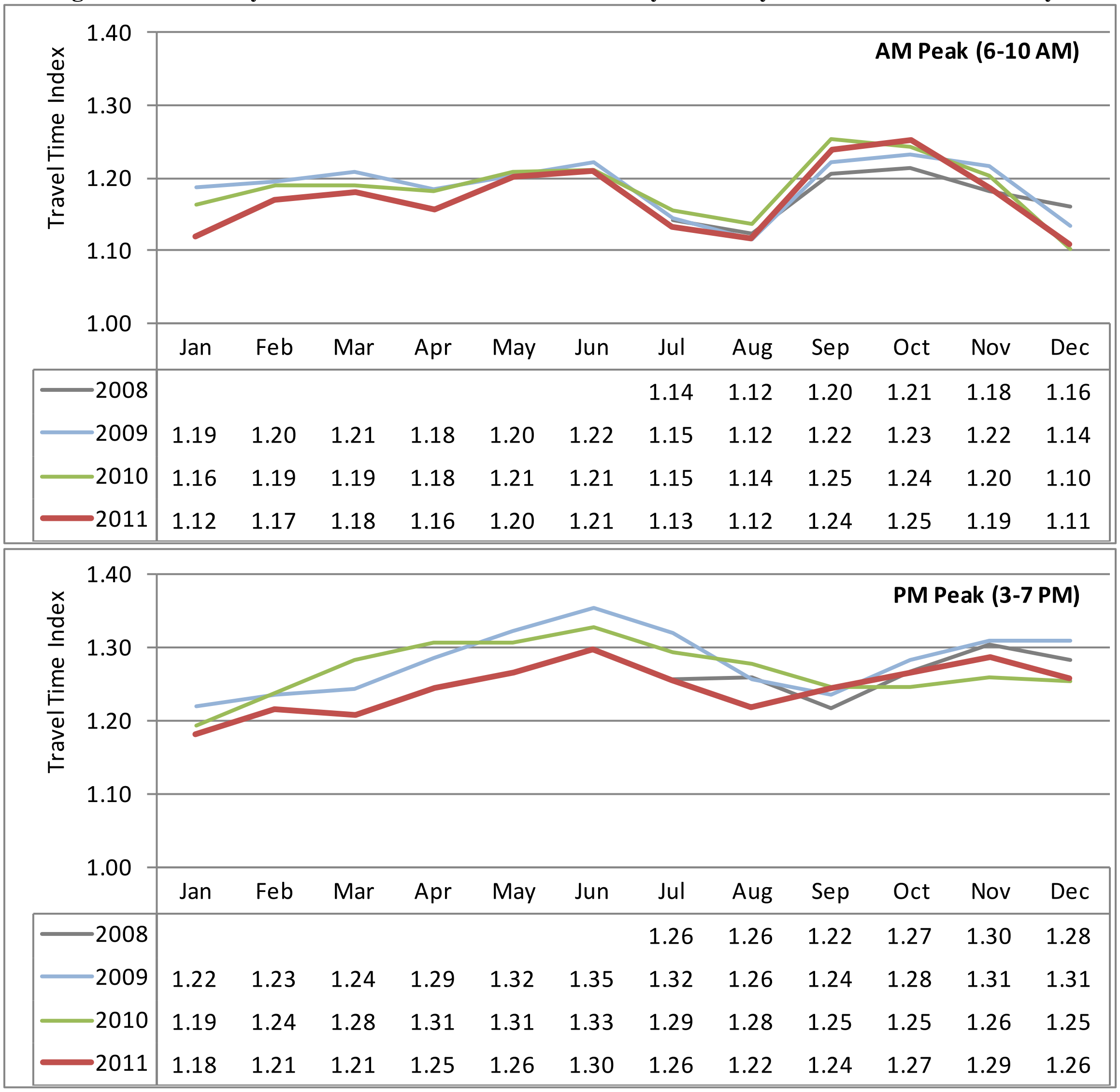


The monthly average Travel Time Index on monitored freeways during non-holiday workday AM peak and PM peak are shown in Figure 25.

There was clear seasonal trend over the course of a year, but the AM and PM peaks varied not exactly consistently. For the AM peak, December, August and July were usually less congested compared to other months; October, September and June seemed to be more congested than others. For the PM peak, the least congested three months would be January, February and September, and the most congested three would be June, May and July. September was a special month, in which the AM peak congestion increased significantly from the previous month (due to a number of factors, including back to school, back to work and the congress is back in session) while the PM peak was almost about the same or even less congested compared to August.

Comparing the Travel Time Index of the AM and PM peaks in the same month reveals that in September both peaks experienced almost the same congestion intensity, and December had the biggest difference between the two peaks (with the PM peak was the higher one).

Figure 25: Monthly Travel Time Index for Non-Holiday Weekday Peak Periods on Freeways



AM Peak (6-10 AM)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008							1.14	1.12	1.20	1.21	1.18	1.16
2009	1.19	1.20	1.21	1.18	1.20	1.22	1.15	1.12	1.22	1.23	1.22	1.14
2010	1.16	1.19	1.19	1.18	1.21	1.21	1.15	1.14	1.25	1.24	1.20	1.10
2011	1.12	1.17	1.18	1.16	1.20	1.21	1.13	1.12	1.24	1.25	1.19	1.11

PM Peak (3-7 PM)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008							1.26	1.26	1.22	1.27	1.30	1.28
2009	1.22	1.23	1.24	1.29	1.32	1.35	1.32	1.26	1.24	1.28	1.31	1.31
2010	1.19	1.24	1.28	1.31	1.31	1.33	1.29	1.28	1.25	1.25	1.26	1.25
2011	1.18	1.21	1.21	1.25	1.26	1.30	1.26	1.22	1.24	1.27	1.29	1.26

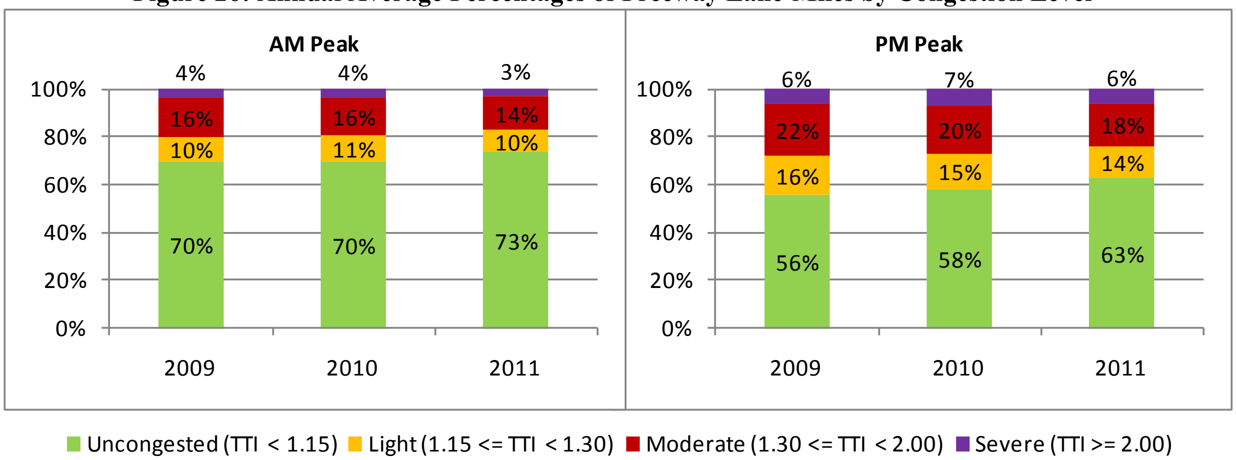
Percentages of Freeway Lane-Miles by Congestion Level

The Percentages of Freeway Lane-Miles by Congestion Level is a system-wide measure that captures the spatial extent of congestion. This measure is calculated for both annual and monthly averages for non-holiday workday AM peak (6:00-10:00 am) and PM peak (3:00-7:00 pm) from 2009 to 2011. A total of about 2,000 lane-miles of freeways in the TPB region are monitored. The congestion level is determined by Travel Time Index:

- Uncongested: TTI < 1.15
- Lightly congested: 1.15 <= TTI < 1.30
- Moderately congested: 1.30 <= TTI < 2.00
- Severely congested : TTI >= 2.00

Figure 26 is the annual average percentages of freeway lane-miles by congestion level. There was generally a slight decrease of the extent of congestion during both the AM and PM peak periods from 2009 to 2011, but the percentage of severely congested freeway lane-miles almost kept constant during the AM and PM peak periods respectively over the three years. On average, the "Uncongested" portion (in green) in the three years accounts for about 70% in the AM peak and 60% in the PM peak of the total 2,000 freeway-lane miles, which include all directions of travel and usually uncongested freeways in Frederick County, Maryland such as I-70, US-15 and US-340.

Figure 26: Annual Average Percentages of Freeway Lane-Miles by Congestion Level

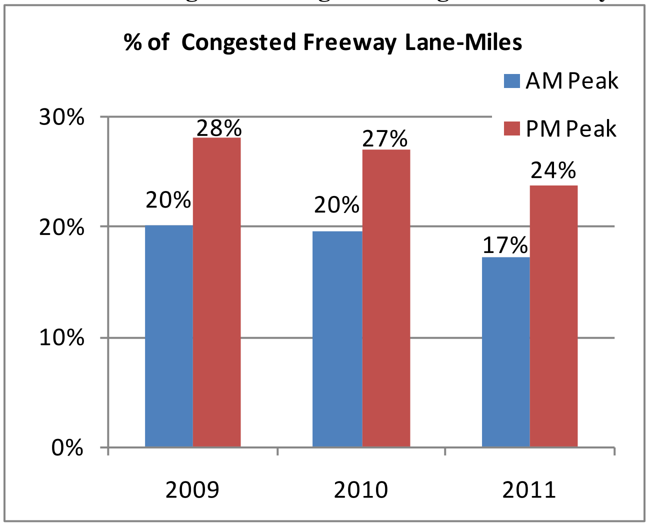


If using only one threshold to differentiate congested and uncongested traffic conditions, this report adopts a recommendation made by the National Transportation Operations Coalition (NTOC) in its 2005 r eport titled "National Transportation Operations Coalition (NTOC) Performance Measures Initiative"[35]: if travel time is 30% longer than the free flow travel time then congestion is defined (i.e., Travel Time Index = 1.3).

Applying this threshold, the "Moderate" and "Severe" two levels of congestion defined above fall into the category of "congestion". The annual average percentage of congested freeway lane miles during peak periods is then shown in Figure 27. Consistent with the findings revealed by delay and Travel Time Index, the extent of congestion continued decrease from 2009 to 2011 in both AM and PM peak periods – a slight drop from 2009 to 2010 and a more significant drop from 2010 to 2011. In 2009 and 2010, the congested portion accounted for about 20% (400 lane-miles) in the AM peak and 28% (560 lane-miles) in the PM peak of the total; in 2011, these numbers decreased to 17% and 24%, respectively.

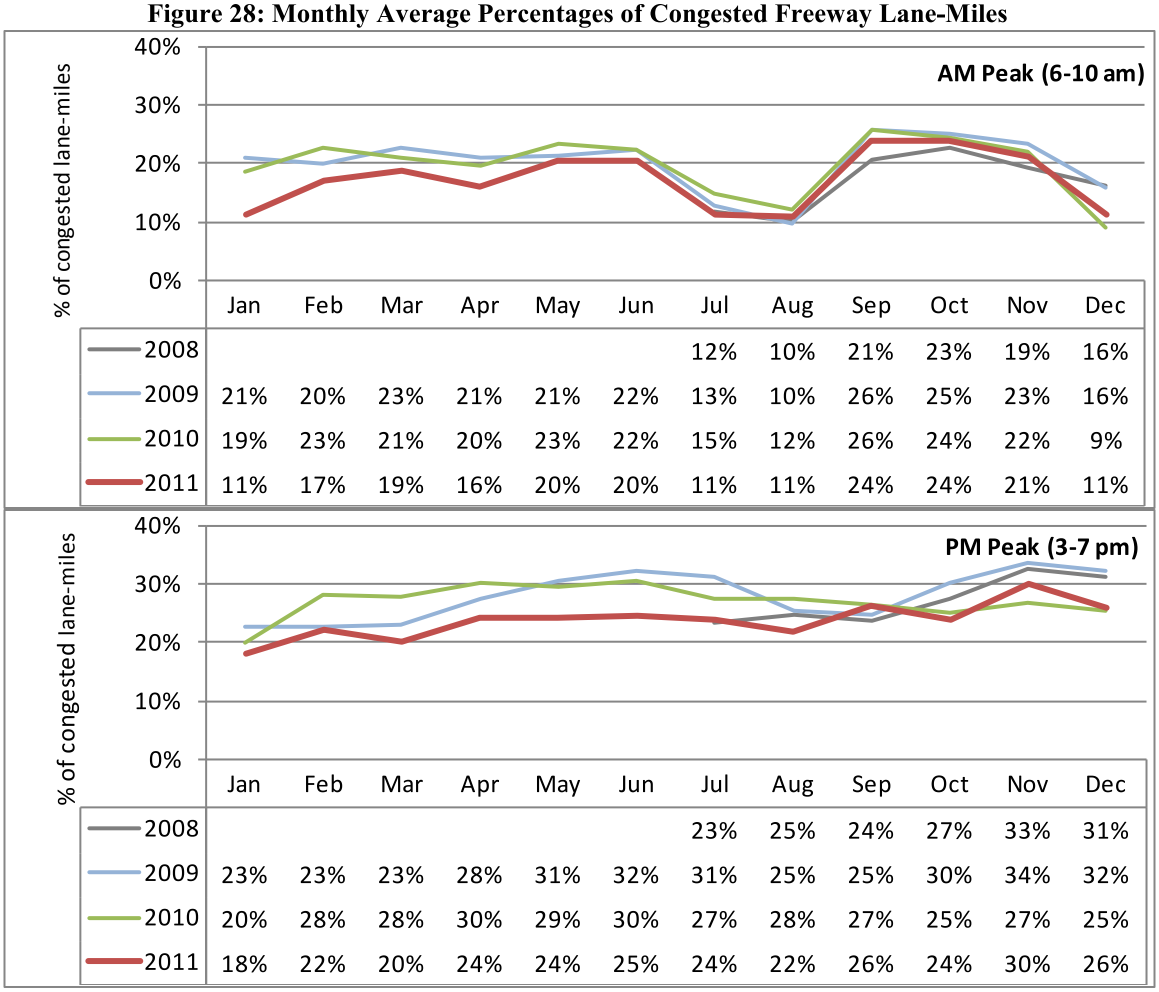
[35] Available at http://www.ntoctalks.com/action_teams/ntoc_final_report.pdf

Figure 27: Annual Average Percentages of Congested Freeway Lane-Miles



The monthly average percentages of congested freeway lane-miles are shown in Figure 28. It reflects similar seasonal congestion trending to what Travel Time Index has shown.

Figure 28: Monthly Average Percentages of Congested Freeway Lane-Miles



AM Peak (6-10 am)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008							12%	10%	21%	23%	19%	16%
2009	21%	20%	23%	21%	21%	22%	13%	10%	26%	25%	23%	16%
2010	19%	23%	21%	20%	23%	22%	15%	12%	26%	24%	22%	9%
2011	11%	17%	19%	16%	20%	20%	11%	11%	24%	24%	21%	11%

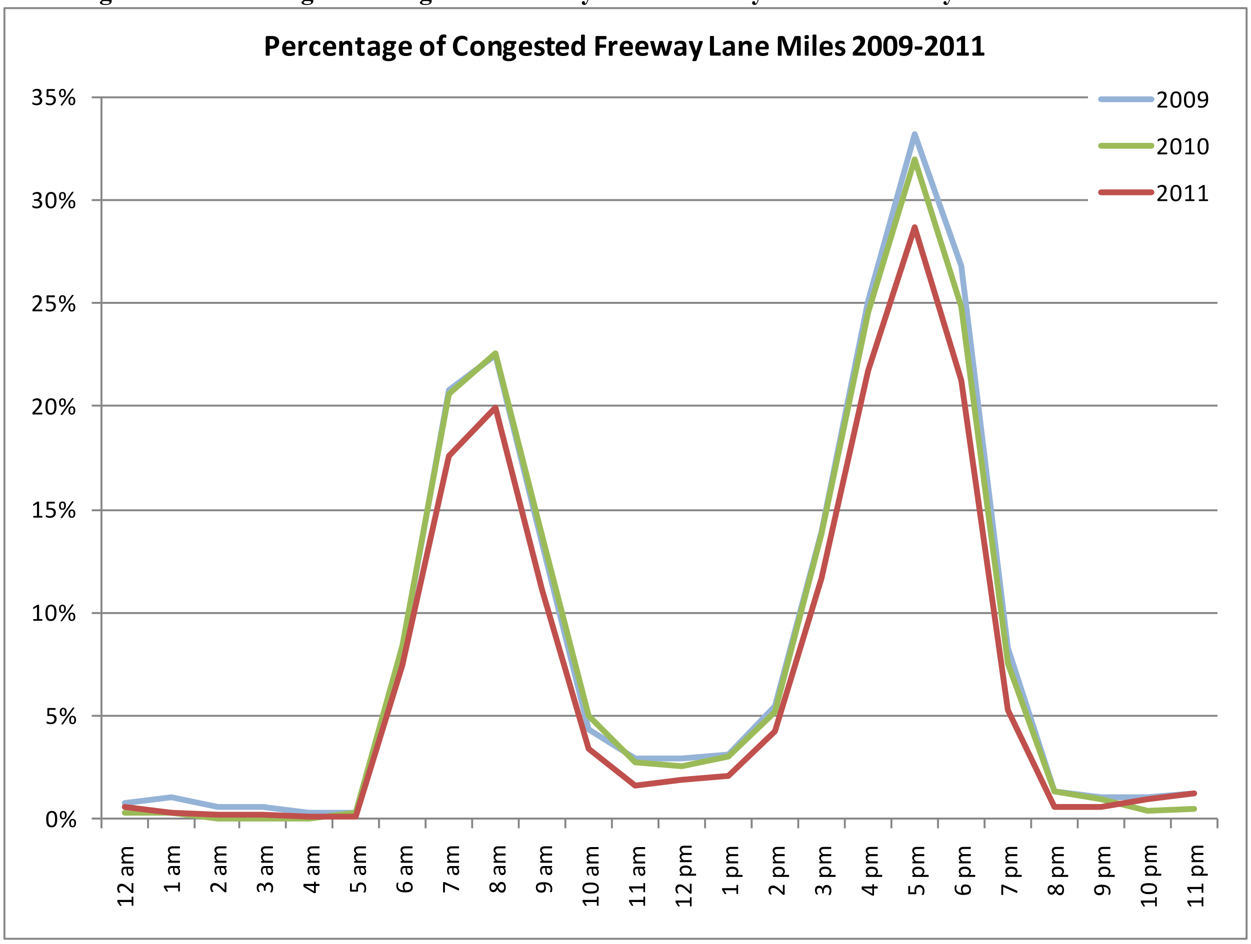
PM Peak (3-7 pm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008							23%	25%	24%	27%	33%	31%
2009	23%	23%	23%	28%	31%	32%	31%	25%	25%	30%	34%	32%
2010	20%	28%	28%	30%	29%	30%	27%	28%	27%	25%	27%	25%
2011	18%	22%	20%	24%	24%	25%	24%	22%	26%	24%	30%	26%

The percentages of congested freeway lane miles by time of the day from 2009 to 2011 are provided in Figure 29. All Mondays through Fridays (federal holidays excluded) were used in this analysis. This chart is particularly useful to reveal any possible peak spreading phenomenon. After examining the chart, no such phenomenon is found from 2009 to 2011; on the contrary, 2011 had less congested free lane miles than 2009 and 2010 during AM peak, PM peak and midday. This is in consistency with previous findings discovered by delay and Travel Time Index. However, this regional overall picture does not preclude any peak spreading phenomena on particular facilities or corridors.

This chart also identified the most congested AM peak hour is 8:00-9:00 AM and the most congested PM peak hour is 5:00-6:00 PM.

Figure 29: Percentages of Congested Freeway Lane-Miles by Hour of the Day from 2009 to 2011



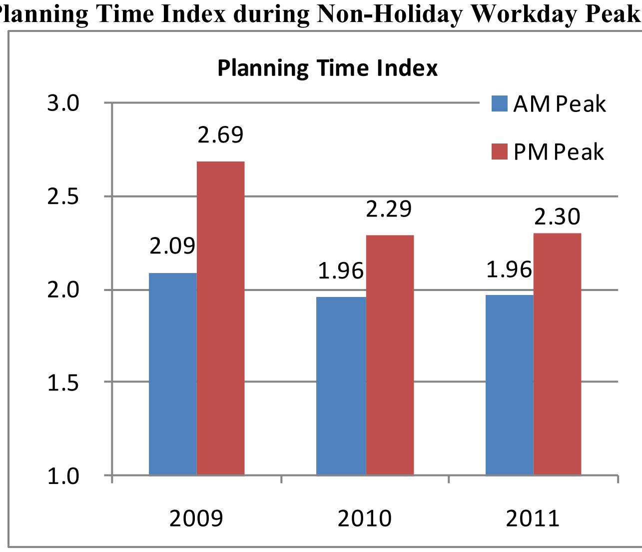
Planning Time Index

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 trouble travelers most are unexpected or much-worse-than-expected delays, which can be caused by incidents, inclement weather and temporal work zone, etc. 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[36] - to just avoid being late.

To quantify travel time reliability, this report adopts Planning Time Index, the ratio (which could also be expressed as percentage) 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 needs 60 minutes in budget to ensure on-time arrival, and here the Planning Time is 30 minutes.

Figure 30 provides annual Planning Time Index of the region's freeways for non-holiday workday AM peak (6:00-10:00 am) and PM peak (3:00-7:00 pm) from 2009 to 2011. Comparing this reliability measure with the congestion intensity (delay) and extent (% of moderately and severely congested lane-miles) measures, one could find that as the congestion improved from 2009 to 2011, so did the reliability generally. But the magnitudes of improvements between two adjacent years are not exactly the same. For example, from the congestion perspective, 2010 was closer to 2009 than to 2011, while from the reliability perspective 2010 was closer to 2011 than to 2009. The consistency and nonlinearity between reliability and congestion measures are also echoed by the monthly average Planning Time Index shown in Figure 31, in which the summer and winter 2009 congestion/weather events nonlinearly increased the Planning Time Index.

Figure 30: Annual Planning Time Index during Non-Holiday Workday Peak Periods on Freeways



An useful of rule of thumb about travel time reliability can be drawn from examing the Planning Time Index: travelers have to budget about 2 times of the free flow travel time in the AM peak and about 2.5 times in the PM peak to arrive their destinations on time. These numbers are based

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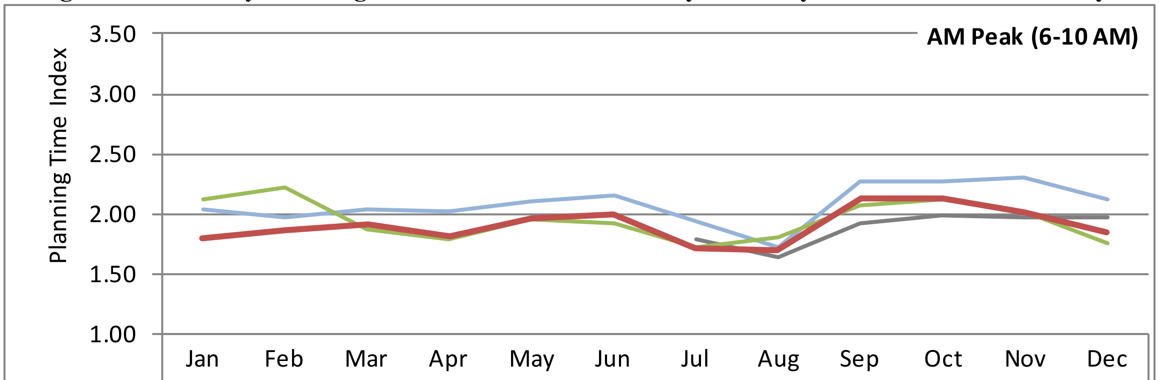
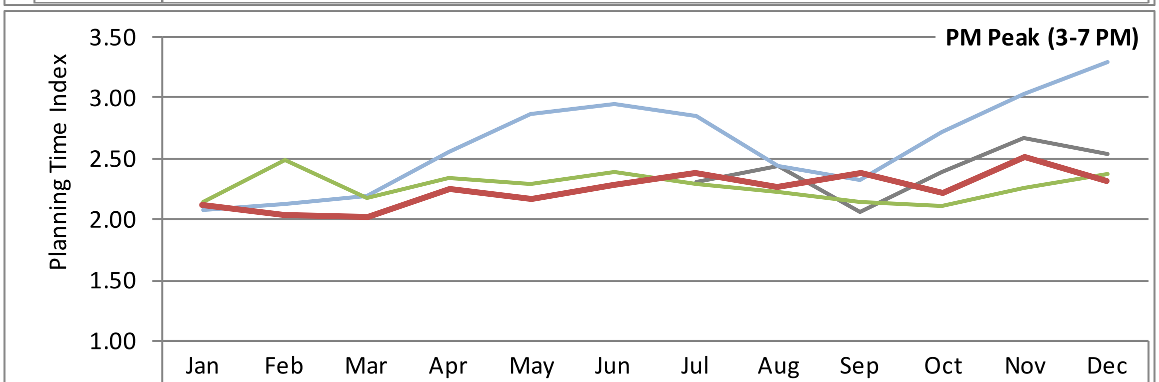
[36] Federal Highway Administration, *Travel Time Reliability Measures*, http://ops.fhwa.dot.gov/perf_measurement/reliability_measures/index.htm

on all directions of travel, therefore for those who traveling in the peak direction should even budget more.

Figure 31: Monthly Planning Time Index for Non-Holiday Workday Peak Periods on Freeways



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008							1.78	1.64	1.92	1.98	1.96	1.97
2009	2.03	1.97	2.03	2.02	2.10	2.15	1.95	1.72	2.26	2.27	2.30	2.13
2010	2.13	2.22	1.87	1.78	1.95	1.92	1.72	1.81	2.07	2.12	2.02	1.75
2011	1.80	1.86	1.91	1.82	1.96	2.00	1.71	1.69	2.13	2.14	2.02	1.85



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008							2.30	2.44	2.07	2.39	2.67	2.53
2009	2.07	2.13	2.19	2.55	2.87	2.95	2.86	2.44	2.32	2.73	3.03	3.29
2010	2.15	2.49	2.18	2.34	2.29	2.39	2.30	2.22	2.14	2.11	2.26	2.38
2011	2.13	2.04	2.02	2.25	2.17	2.28	2.37	2.27	2.38	2.21	2.51	2.32

VMT and VHT

Vehicle miles of travel (VMT) and vehicle hours of travel (VHT) provide important information on quality of service. For the same system, the ratio of VMT to VHT (be sure to use the same units) is also the system-wide average speed. The annual VMT and VHT on t he region's monitored freeway system are provided in Figure 32. Monthly averages are shown in Figure 33. Similar to the delay, the VMT and VHT were calculated from all time periods (workdays, weekends, nighttime, holidays).

The changes in VMT and VHT from 2009 to 2011 imply that the congestion (and reliability) improvements observed over the three years might be largely attributed to the decrease in the quality of service (demand). Further investigations are needed to identify the causes of demand changes, but a noticeable factor would be the economy.

Figure 32: Annual VMT and VHT

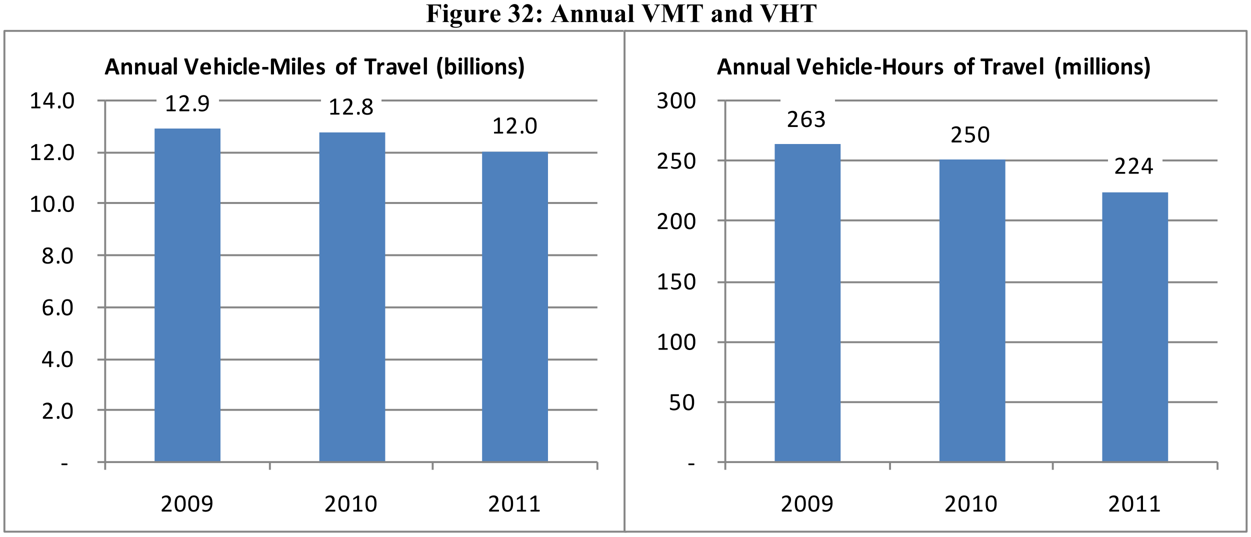
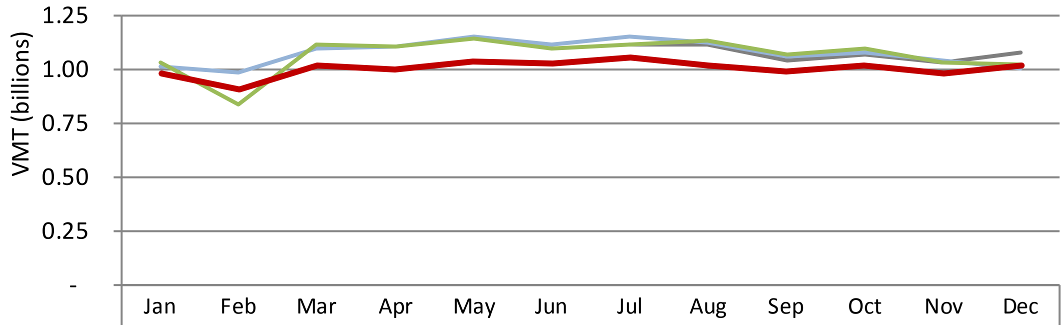
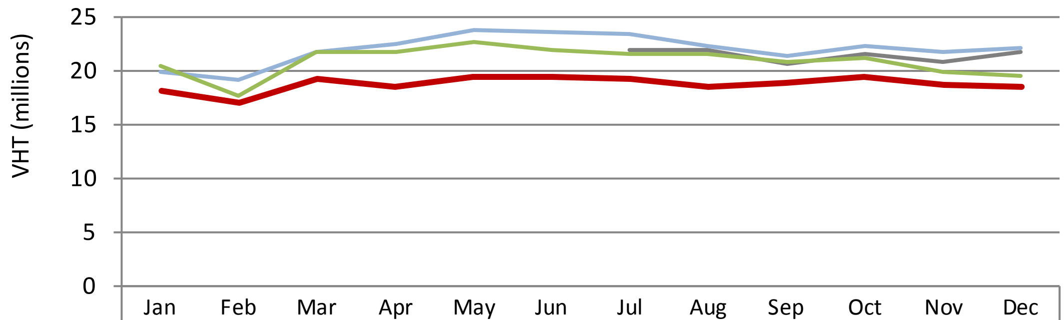


Figure 33: Monthly VMT and VHT



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008							1.11	1.11	1.04	1.07	1.03	1.08
2009	1.01	0.98	1.09	1.10	1.15	1.12	1.15	1.12	1.05	1.07	1.04	1.00
2010	1.02	0.83	1.11	1.10	1.14	1.10	1.11	1.13	1.07	1.10	1.03	1.02
2011	0.98	0.91	1.02	1.00	1.04	1.02	1.05	1.01	0.99	1.02	0.98	1.01



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008							21.94	21.95	20.57	21.49	20.86	21.77
2009	19.83	19.17	21.66	22.38	23.66	23.48	23.44	22.25	21.38	22.18	21.62	22.06
2010	20.45	17.60	21.76	21.65	22.57	21.89	21.59	21.57	20.80	21.15	19.82	19.44
2011	18.08	17.05	19.11	18.53	19.37	19.37	19.19	18.53	18.74	19.33	18.55	18.47

Top 10 Bottlenecks

Table 5 and Figure 34 provide the top 10 bottlenecks in 2011 on monitored freeways in the Washington region. The ranking is based on both the duration (Hours of Congestion in a Week) and intensity (Travel Time Index) of congestion. Over the three years from 2009 to 2011, there were 7 bottlenecks always in the top 10 list, and they should be further examined in relevant studies.

Table 5: Top 10 Bottlenecks in 2011 (based on INRIX data)

Road/Direction	Segment/Interchange	Hours of Congestion in a Week*	Average Speed when Congested (mph)	Travel Time Index	Rank**		
					2009	2010	2011
I-95 SB	US-1/EXIT 161	40	29	2.83	1	8	1
I-395 NB	11TH ST/EXIT 11	48	25	2.17	6	1	2
MD-295 NB	POWDER MILL RD	43	32	2.30	5	5	3
I-66 EB	VA-267/EXIT 67	43	32	2.26	10	4	4
I-95 HOV SB	End of HOV	42	34	2.19	7	3	5
I-495 IL	MD-355/EXIT 34	32	29	2.70	3	7	6
I-495 OL	VA-193/EXIT 44	39	32	2.16	>10	>10	7
I-495 OL	MD-650/EXIT 28	31	30	2.74	8	9	8
I-495 IL	US-50/EXIT 50	39	34	2.10	>10	>10	9
I-66 WB	FAIRFAX DR/EXIT 71	42	35	1.92	>10	6	10

*This number is out of the 168 hours of a full week – 24 hours a day and 7 days a week.
**Rank is based on the product of Hours of Congestion in a Week (duration of congestion) and Travel Time Index (intensity of congestion).

The top 10 bottlenecks were identified by the following method:

1. Obtain annual average data by hour of the day and day of the week, resulting 168 hours data (24 hours a day, 7 days a week) for each TMC (Traffic Message Channel – an industry convention for roadway segmentation).

2. Calculate Travel Time Index (TTI) for each of the 168 hours and TMC.

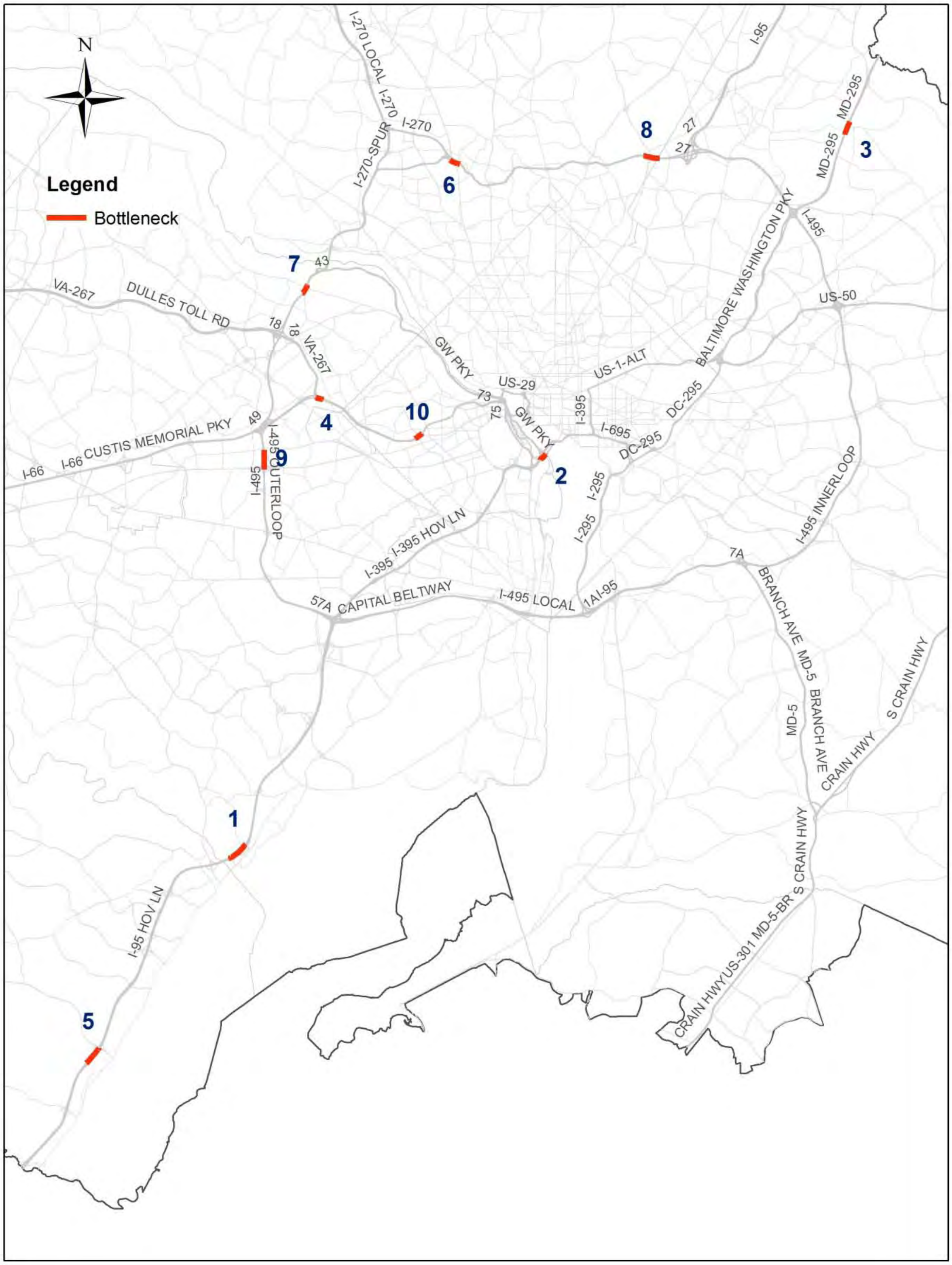
3. Delete "uncongested" hours. An hour is congested if the TTI > 1.30, according to the National Transportation Operations Coalition Performance Measurement Initiative (2005).

4. Calculate the average TTI of the congested hours for each TMC.

5. Rank all TMCs using the product of the average TTI calculated in step 4 and the number of congested hours obtained in step 3.

6. Post process: if there are several spatially adjacent TMCs ranked very closely, the most severe one is chosen as the bottleneck. The rationale behind is that a bottleneck, rather than a congested stretch or corridor, is of interest.

Figure 34: Top 10 Bottlenecks in 2011 (based on INRIX data)



Top 10 Most Unreliable Segments

Table 6 and Figure 35 provide the top 10 most unreliable segments in 2011 on monitored freeways in the Washington region. The ranking is solely based on Planning Time Index. In 2011, 8 out of the 10 most unreliable segments were also (or in the vicinity of) the top 10 bottlenecks. Over the three years from 2009 to 2011, there were 6 segments always in the top 10 list, and they should be further examined in relevant studies.

Table 6: Top 10 Most Unreliable Segments in 2011 (based on INRIX data)

Road/Direction	Segment/Interchange	Planning Time Index*	Also a Top 10 Bottleneck in 2011?	Rank		
				2009	2010	2011
I-495 IL	I-270/EXIT 35	5.33	Yes	1	1	1
I-95 SB	US-1/EXIT 161	5.02	Yes	>10	>10	2
I-95 SB	VA-234/EXIT 152	4.76	Yes	6	3	3
I-495 OL	MD-650/EXIT 28	4.67	Yes	3	2	4
I-395 NB	11TH ST/EXIT 11	4.31	Yes	10	5	5
I-495 IL	US-50/EXIT 50	4.09	Yes	9	7	6
I-95 NB	I-395/I-495	4.08	No	>10	>10	7
I-66 WB	VADEN DR/EXIT 62	4.02	No	>10	8	8
I-66 EB	VA-267/EXIT 67	4.01	Yes	7	6	9
I-495 OL	GW PKWY/EXIT 43	3.83	Yes	>10	>10	10

*Planning Time Index is the ratio of 95^{th} travel time to free flow travel time. This measure is used for ranking.

The top 10 most unreliable segments were identified by the following method:

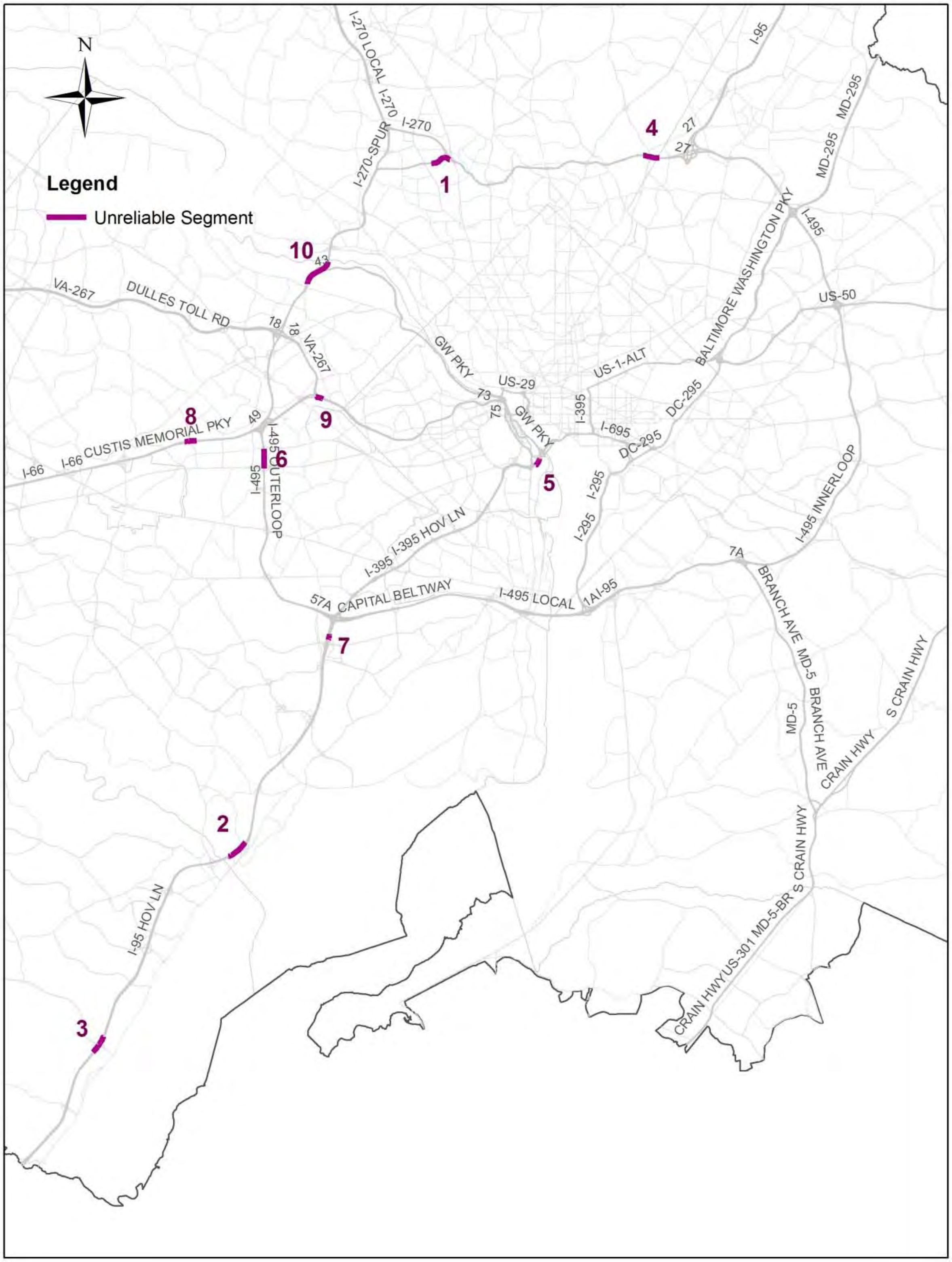
1. Obtain hourly data for the entire year (365*24 = 8,760 hours for each TMC).

2. Calculate Planning Time Index (PTI) for each of the 8,760 hours of a TMC.

3. Rank all TMCs using the PTI obtained in step 2.

4. Post process: if there are several spatially adjacent TMCs ranked very closely, only the most unreliable one is selected. The rationale behind is that a segment, rather than a stretch or corridor, is of interest.

Figure 35: Top 10 Most Unreliable Segments in 2011 (based on INRIX data)



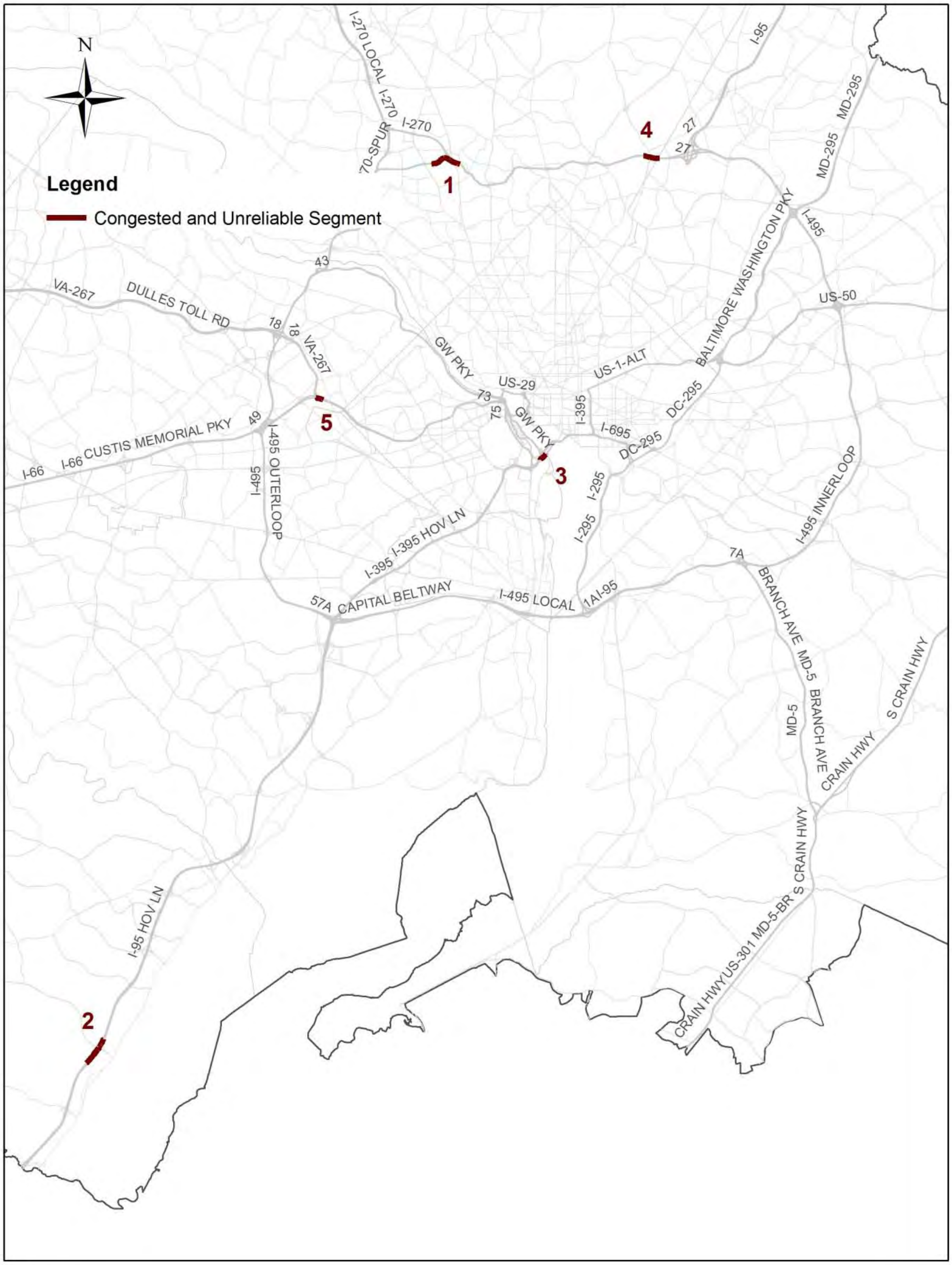
Top Congested and Unreliable Locations

The most congested and unreliable locations in 2009-2011 can be obtained by selecting the top bottlenecks (Table 5) and the most unreliable segments (Table 6) that ranked within 1-10 from 2009 to 2011. There are five such locations identified, as listed in Table 7 and shown in Figure 36.

Table 7: Top Congested and Unreliable Locations in 2009-2011 (based on INRIX data)

		Congestion					Reliability				
Road/ Direction	Segment/Interchange	2011 Hours of Congestion in A Week	2011 Travel Time Index	2009 Rank	2010 Rank	2011 Rank	2011 Planning Time Index	2009 Rank	2010 Rank	2011 Rank	2009 - 2011 Overall Rank
I-495 IL	I-270/MD-355	32	2.70	3	7	6	5.33	1	1	1	1
I-95 SB	End of HOV/Exit 152	42	2.19	7	3	5	4.76	6	3	3	2
I-395 NB	11TH ST/EXIT 11	48	2.17	6	1	2	4.31	10	5	5	3
I-495 OL	MD-650/EXIT 28	31	2.74	8	9	8	4.67	3	2	4	4
I-66 EB	VA-267/EXIT 67	43	2.26	10	4	4	4.01	7	6	9	5

Figure 36: Top Congested and Unreliable Locations in 2009-2011 (based on INRIX data)



Major 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 22 major freeway commute routes are defined between major interchanges and/or major points of interest for each peak period. Three performance measures are calculated for the AM and PM peaks respectively from 2009 to 2011: the most congested 5 minutes, average travel time, and reliable (95^{th}) travel time (with which the majority of trips can finish the trip on the specified route). The results are provided in Table 8 and Table 9 and the highlights are summarized as below:

In the AM peak period (6:00-10:00 am):

- In term of the most congested time period, I-270 southbound had the most significant changes in all of the inbound freeway routes: the most congested time was advanced by 50 minutes from 7:35 am in 2009 to 6:45 am in 2011 for the section from I-70 to I-370, and by 40 minutes from 8:30 am in 2009 to 7:50 am in 2011 for the section from I-370 to the Beltway I-495.

- The average and reliable travel times generally reduced comparing 2011 to the previous two years, which is consistent with the regional overall congestion trend in the past three years – decrease. The most significant improvement was observed on I-95 northbound in Virginia from VA-234 to the beltway.

In the PM peak period (3:00-7:00 pm):

- In term of the most congested time period, I-95 southbound HOV lanes from the Beltway to VA-234 had the most significant changes in all of the outbound freeway routes: the most congested time was delayed by more than 2 hours from 4:40 pm in 2009 to 6:45 pm in 2011.

- The average and reliable travel times generally reduced comparing 2011 to the previous two years, which is consistent with the regional overall congestion trend in the past three years – decrease. The most significant improvement was observed on I-95 southbound in Virginia from the Beltway to VA-234.

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 8: Travel Time on Major Freeway Commute Routes in AM Peak (6:00-10:00 am)

Route	Length (miles)	Free Flow Travel Time (min)	Beginning of Most Congested 5 Minutes			Average Travel Time in Peak Period (min)			Reliable (95th) Travel Time* in Peak Period (min)			2011 Change in Average Travel Time (min)		2011 Change in 95th Travel Time (min)	
			2009	2010	2011	2009	2010	2011	2009	2010	2011	vs. 2009	vs. 2010	vs. 2009	vs. 2010
I-270 SB from I-70 to I-370	23	21	7:35	6:50	6:45	36	34	31	60	56	50	-5	-3	-9	-5
I-270 SB from I-370 to I-495	10	9	8:30	8:05	7:50	17	17	15	32	31	27	-2	-2	-5	-3
VA-267 EB from VA-28 to I-66	15	14	7:55	7:50	8:00	24	22	21	43	37	34	-3	-2	-9	-3
I-66 EB from VA-28 to I-495	11	11	7:45	7:35	7:40	28	23	21	47	38	33	-7	-2	-15	-5
I-66 EB from I-495 to TR Bridge	10	9	9:25	9:25	9:30	15	15	15	24	23	23	0	0	-1	0
I-95 NB from VA-234 to I-495	19	18	6:45	6:35	6:35	41	32	27	76	56	54	-14	-4	-22	-1
I-95 NB HOV from VA-234 to I-495	18	16	7:55	7:45	7:35	25	19	18	39	23	22	-7	-1	-16	-1
I-395 NB from I-495 to Ohio Dr	10	10	7:55	7:50	7:55	26	26	25	49	50	49	-1	-2	0	-1
I-395 NB HOV from I-495 to Ohio Dr	11	10	7:55	7:50	7:45	21	18	15	39	26	23	-6	-3	-16	-4
US-50 WB from US-301 to MD-295	14	13	7:55	7:55	7:55	20	19	18	32	29	29	-1	0	-3	0
MD-295 SB from MD-198 to US-50	15	14	7:55	7:50	7:55	22	21	18	38	37	31	-4	-4	-7	-6
I-95 SB from MD-198 to I-495	8	8	7:55	7:50	7:50	12	12	12	24	24	24	0	-1	0	0
I-495 IL from I-270 to I-95	9	8	8:00	8:45	8:00	10	10	9	12	13	11	-1	-1	-1	-1
I-495 IL from I-95 to US-50	8	8	8:00	8:50	8:40	9	9	9	11	10	11	0	1	0	1
I-495 IL from US-50 to I-95	26	24	8:10	8:05	8:05	29	29	29	42	40	38	-1	-1	-4	-2
I-495 IL from I-95 to I-66	7	7	8:40	8:45	8:40	16	16	14	28	27	25	-1	-2	-3	-2
I-495 IL from I-66 to I-270	13	13	8:45	8:40	8:40	16	16	15	26	25	21	-2	-2	-5	-4
I-495 OL from I-270 to I-66	13	13	9:05	8:55	8:55	16	16	16	21	24	25	1	0	4	1
I-495 OL from I-66 to I-95	9	8	8:15	8:25	7:55	9	9	9	11	10	10	0	0	-1	0
I-495 OL from I-95 to US-50	24	23	8:30	8:30	8:20	28	28	28	37	39	40	-1	0	3	1
I-495 OL from US-50 to I-95	8	7	8:30	8:30	8:25	9	9	8	13	12	13	0	0	0	1
I-495 OL from I-95 to I-270	10	10	8:20	8:30	7:55	23	23	22	39	39	38	-1	-1	-1	-1

* The majority of trips spent equal to or less than the reliable (95^{th}) travel time on the specified route.

Table 9: Travel Time on Major Freeway Commute Routes in PM Peak (3:00-7:00 pm)

Route	Length (miles)	Free Flow Travel Time (min)	Beginning of Most Congested 5 Minutes			Average Travel Time in Peak Period (min)			Reliable (95th) Travel Time* in Peak Period (min)			2011 Change in Average Travel Time (min)		2011 Change in 95th Travel Time (min)	
			2009	2010	2011	2009	2010	2011	2009	2010	2011	vs. 2009	vs. 2010	vs. 2009	vs. 2010
I-270 NB from I-495 to I-370	9	9	17:50	17:40	17:50	14	14	12	25	22	20	-2	-2	-4	-2
I-270 NB from I-370 to I-70	24	22	17:30	17:35	17:30	36	33	32	56	51	49	-3	-1	-7	-2
VA-267 WB from I-66 to VA-28	15	14	17:55	17:55	17:50	18	17	16	26	23	20	-2	-1	-5	-2
I-66 WB from TR Bridge to I-495	10	10	15:50	15:00	15:45	16	15	16	26	25	27	0	1	1	2
I-66 WB from I-495 to VA-28	12	11	17:50	17:40	17:35	20	22	19	31	34	33	-1	-3	2	-1
I-95 SB from I-495 to VA-234	19	18	17:30	17:35	17:30	53	49	41	120	107	87	-11	-8	-34	-20
I-95 SB HOV from I-495 to VA-234	18	16	16:40	18:40	18:45	29	23	21	56	33	33	-8	-1	-22	0
I-395 SB from Ohio Dr to I-495	11	11	17:35	17:30	17:35	23	21	19	38	32	29	-4	-2	-9	-2
I-395 SB HOV from Ohio Dr to I-495	11	10	18:25	18:25	18:25	17	14	12	27	17	16	-4	-2	-11	-1
US-50 EB from MD-295 to US-301	14	13	17:30	17:30	17:25	16	16	15	20	20	19	-1	-1	-1	-1
MD-295 NB from US-50 to MD-198	12	12	17:35	17:45	17:35	31	26	24	52	39	39	-7	-2	-13	0
I-95 NB from I-495 to MD-198	8	7	17:25	17:30	17:25	12	11	10	18	16	17	-1	0	-1	1
I-495 IL from I-270 to I-95	9	8	17:35	17:40	17:40	17	16	15	28	27	24	-2	-1	-3	-3
I-495 IL from I-95 to US-50	8	8	17:40	17:40	17:40	12	12	13	20	19	23	1	1	3	4
I-495 IL from US-50 to I-95	26	24	17:40	17:30	17:35	31	31	29	44	38	37	-2	-2	-7	-2
I-495 IL from I-95 to I-66	7	7	17:50	15:35	15:00	11	10	9	23	19	15	-2	-1	-8	-4
I-495 IL from I-66 to I-270	13	13	17:50	17:40	17:05	45	39	36	90	70	67	-9	-3	-23	-3
I-495 OL from I-270 to I-66	13	13	17:50	17:40	17:05	29	29	29	53	51	53	0	0	0	1
I-495 OL from I-66 to I-95	9	8	17:45	17:55	17:45	11	11	11	14	16	16	0	0	2	-1
I-495 OL from I-95 to US-50	24	23	17:00	17:30	17:30	30	30	29	46	45	46	-1	0	0	1
I-495 OL from US-50 to I-95	8	7	17:45	17:50	17:50	11	10	10	19	17	17	-1	0	-2	0
I-495 OL from I-95 to I-270	10	10	17:55	17:35	17:40	17	17	15	38	33	31	-3	-2	-7	-2

* The majority of trips spent equal to or less than the reliable (95^{th}) travel time on the specified route.

2.2 Congestion 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 than that of freeways.

The TPB's arterial highway monitoring program consists of two major components:

- Aerial floating car travel time study
- Procured INRIX data for calendar year 2010

Unlike for freeways, there had been no comprehensive data set of roadway congestion for arterials in the region in the past. There were a number of data sources that were informative, but data were collected different years, for different lengths of time, and using different methodologies. Therefore, for the purpose of identifying congestion on regional arterials, TPB has looked at these data sources plus has regularly undertaken specialized arterial data collection on a sample basis – the arterial floating car travel time study. The samples can then be used as a means to understand the congested conditions that may be occurring on similar arterial roadways throughout the region, as well as the ways congestion management strategies are impacting or may impact those types of congested conditions.

As part of the effort of the I-95 Corridor Coalition Vehicle Probe Project, about 400 route (not centerline) miles of arterials in the TPB Planning Area are monitored by the project since July 1, 2008. These monitored arterials are mainly major parallel routes along the I-95 Corridor, such as US-1 and US-29. To obtain a more comprehensive data coverage of the arterials and a few key freeways not monitored by the Vehicle Probe Project (e.g., George Washington Memorial Parkway), the TPB followed VDOT's procurements and purchased complementary INRIX datasets for calendar year 2010. The procured data cover an approximate total of 4,600 route miles of arterials in the TPB Planning Area (cover a total of 8,300 route miles of all roadway types in the TPB Modeled Area). This is the first time for this region to have such a comprehensive arterial travel time and speed coverage. This report will utilize the procured data to draw a baseline of arterial congestion, which can be compared to if similar third-party datasets will be procured in the future.

2.2.1 Arterial Floating Car Travel Time Study

Methodology

To identify the location, severity, and extent of congestion along selected National Highway System arterial highways in the region, a regional arterial highway performance monitoring study has been underway since FY 2000. Over the past decade staff has 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 FY 2011, the study monitors 57 (9 new) major arterial highway routes in the District of Columbia, Maryland, and

Virginia, totaling 430 centerline miles (Table 10). The level of service (LOS)[37] was used to characterize the extent of congestion during the PM peak hour, PM peak period and PM off-peak period of travel[38].

Table 10: Schedule and Routes of the Arterial Travel Time Study

State	FY 2000 FY 2003 FY 2006 FY 2009		FY 2001 FY 2004 FY 2007 FY 2010		FY 2002 FY 2005 FY 2008 FY 2011		Total
	Routes	Miles	Routes	Miles	Routes	Miles	
MD	MD 355	15.3	MD 4	11.5	MD 97	9.5	
	MD 117	6.8	MD 586	5.4	MD 5	11.9	
	MD 198	5.0	MD 450	12.8	MD 28	9.0	
	MD 197	14.7	MD 144	4.2	MD 193	4.2	
	US 1*	13.4	Indian Head Hwy*	11.0	Randolph Road	9.1	
	MD 193*	4.6			Colesville Rd/US29*	7.1	
		59.8		44.9		50.8	155.5
VA	US 50	23.0	VA 234	22.6	Fairfax County Pkwy	19.7	
	US 15	12.5	VA 28	17.0	US 1	18.8	
	VA 123	27.7	VA 120	8.1	US 29 Seg1,2&3	21.0	
	Wilson Blvd*	4.9	VA 7	29.3	US 29 Seg 4*	11.1	
			VA 28*	7.0			
		68.1		84.0		70.6	222.7
DC	Wisconsin Ave	4.1	Canal Rd	3.7	14th Street NW	1.0	
	Pennsylvania Ave	1.1	7th St NW	3.4	16th Street NW	6.1	
	17th Street NW	0.7	Georgia Ave	3.3	Connecticut Ave	4.0	
	Independence Ave	1.9	Constitution Ave	2.4	K Street NW	4.2	
	I Street NW	0.8	Pennsylvania Ave	3.7	Military Road	2.5	
	H Street NW	0.6			Pennsylvania Ave NW	0.8	
	15th Street NW	0.7			L Street NW	1.1	
	16th Street NW**	6.1			South Dakota*	2.7	
	L Street NW**	1.2					
	Rhode Island Ave*	3.3					
		20.5		16.5		22.4	59.4
Total		148.4		145.4		143.8	430.3

* New Routes studies since FY 2009 & constitute 65.1 miles.
** Due to construction these routes were shifted to a different year since FY 2006.

Each of the routes studied was driven by staff with the intent of verifying that the reference points were signalized intersections, and whether there were any turning movement restrictions at the beginning or end of each tour. The length of each segment and tour were verified. This

[37] 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.
[38] PM peak hour is 5:00 – 6:00 PM, PM peak period is 4:00 PM – 7:00 PM, and PM off-peak period is 1:00 – 4:00 PM and 7:00 – 8:00 PM.

was critical to assure the accuracy of the travel speeds that would be arrived at during the data analysis phase.

Another motivation was to determine if the pre-designed tours could be driven within a 20-minute period or less. This condition would determine the number of complete bi-directional runs that could be completed in an hour. In the analysis phase, the number of runs per hour would determine if the data were statistically significant. During the verification phase, changes were made to the beginning and end of each tour, and reference points were modified as needed.

A tour is a section of a roadway, approximately 5 to 6 miles long, which can be driven in 20 minutes, but tours vary in length depending on location and travel accessibility. Staff assembled tours from the selected corridors. A segment is a section of a tour approximately a mile long, with similar operating characteristics, and with the limits made up of major intersecting roadways used to specify data collection operations within each tour.

The travel time data collected in the field were used in validating the tours and the segments. Changes were made to tours and segments where necessary. This enabled us to obtain 3 to 4 travel speed measurements during an hour using two data collection vehicles. Some corridors such as Virginia Route 7, Virginia Route 234, and 7th Street/Georgia Avenue were broken into multiple tours. Speed data were collected at the segment level, enabling us to identify potential bottlenecks along a tour.

Arterial monitoring shows 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.

More detailed results of the studies can be obtained from MWCOG through request. Highlights of the most recent two studies (FY 2010 and FY 2011 studies) can be found in Appendix A. The studies consider LOS E and F as “congested” conditions and calculate the percentage of miles under congestion for different time periods of a normal workday.

Although congestion occurs on arterials throughout the region, there are also common trends that are generally associated with the land uses 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. Conditions in general for these types of roadways will be reported, and illustrative examples provided.

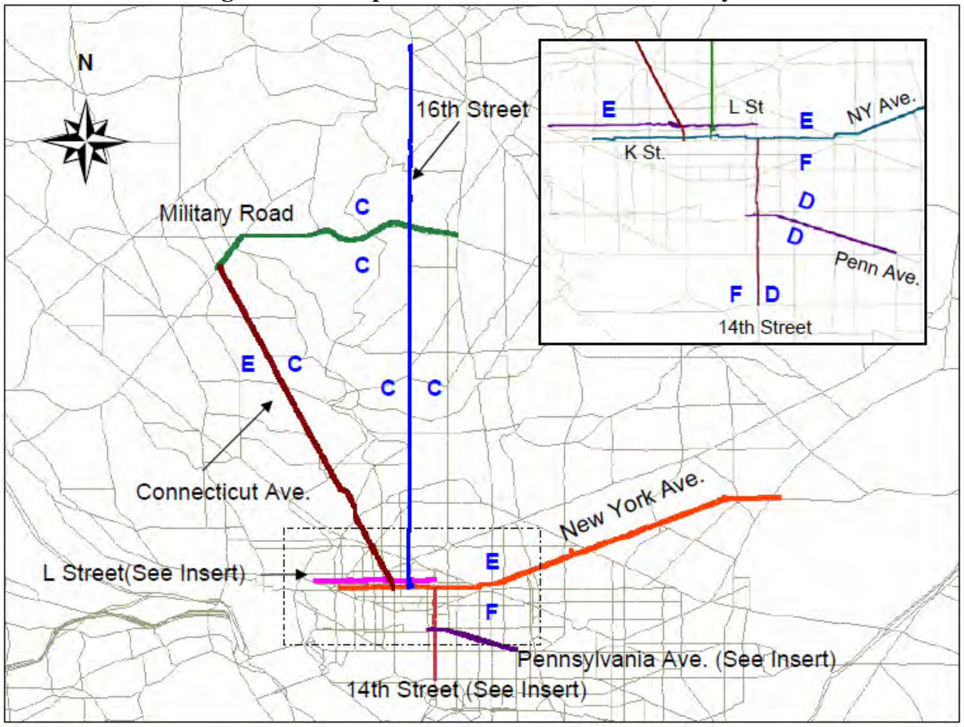
Arterials in the Inner Core

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 (shown in Figure 37 in brown). When surveyed during the 2008 arterial monitoring study, the segment experienced the second lowest LOS (E) during the PM peak hour and the PM peak period. 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.

Figure 37: Sample Inner Core Arterials Surveyed



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

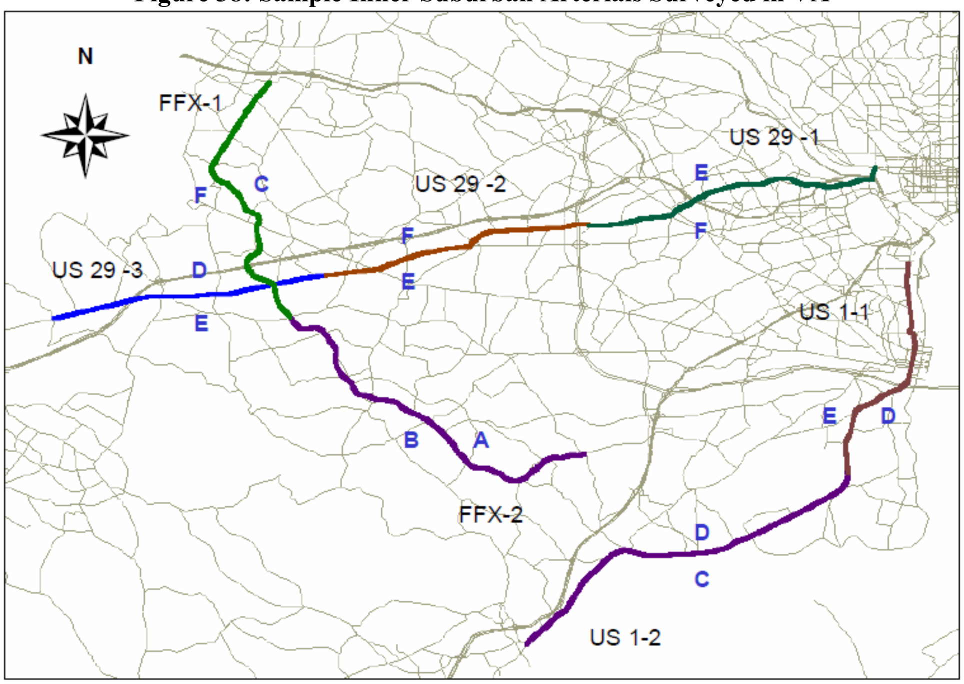
Arterials in the inner suburbs have characteristics combined from that of the inner core and outer suburban arterials.

- 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, w hich extends from Arlington, VA to Centreville, VA (shown in Figure 38). Different colors represent different segments of US 29. The segment between M Street NW in DC and Harrison Street in Arlington is lined with several strip retail areas.

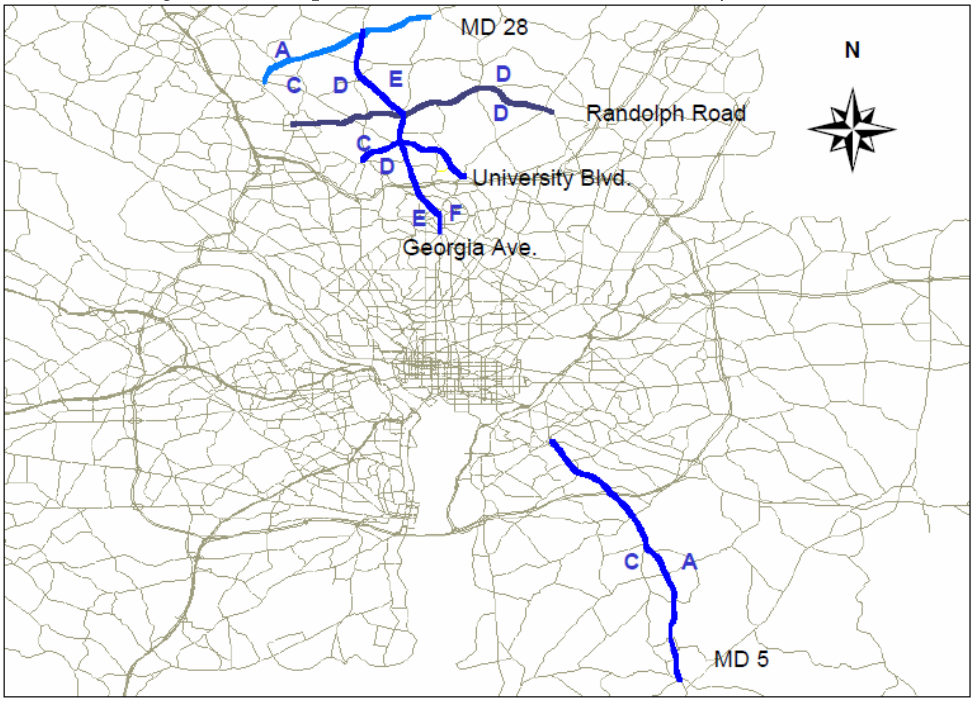
US 29 is also a major alternative commuting route of I-66, and it provides access to I-66 at several different locations. US 29 experiences spillover from several major freeways in the vicinity, including I-66 and the Beltway. The 2008 arterial monitoring study determined that the segments of US 29 from Park Road to M Street NW (eastbound) and from Park Road to Village Drive (westbound) experienced the worst LOS in the corridor during PM peak hour and PM peak period.

Figure 38: Sample Inner Suburban Arterials Surveyed in VA



Georgia Ave, between Eastern Ave NW (DC boundary) and MD 28 also experiences situations typical of inner suburban arterials (shown in Figure 39). 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. The worst LOS was observed during the FY 2008 study for the northbound segment from Eastern Ave NW to University Blvd for the PM peak hour.

Figure 39: Sample Inner Suburban Arterials Surveyed in MD



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).

2.2.2 INRIX 2010 Scan of Arterials

Procured INRIX 2010 Data

Neither the TPB Arterial Floating Car Travel Time Study nor the I-95 Corridor Coalition Vehicle Probe Project (VPP) provides a comprehensive coverage for the region's arterials. In order to capture more data on arterials, VDOT procured INRIX 2010 data for all the TMC-coded roads for the entire state in early 2011. Following this procurement, the TPB acquired additional INRIX data for the rest of TMC-coded roads in the TPB Modeled Area, which includes a total of 8,300 route miles of all roadway types in the TPB Modeled Area, of which about 4,600 route miles of arterials are in the TPB Planning Area (the data coverage can be found in Figure 19 on page 51: all red, yellow and blues roads are covered by this dataset). Table 11 below shows the arterial route mileage for the TPB jurisdictions that are (partially) covered by the procured 2010 INRIX data.

Based on the procured INRIX data, the following performance measures are calculated for all the monitored arterials in the TPB Planning Area and for individual jurisdictions (Fall Church, Manassas, Manassas Park are excluded from the analysis as they have very limited number of road miles covered by the procured INRIX data).

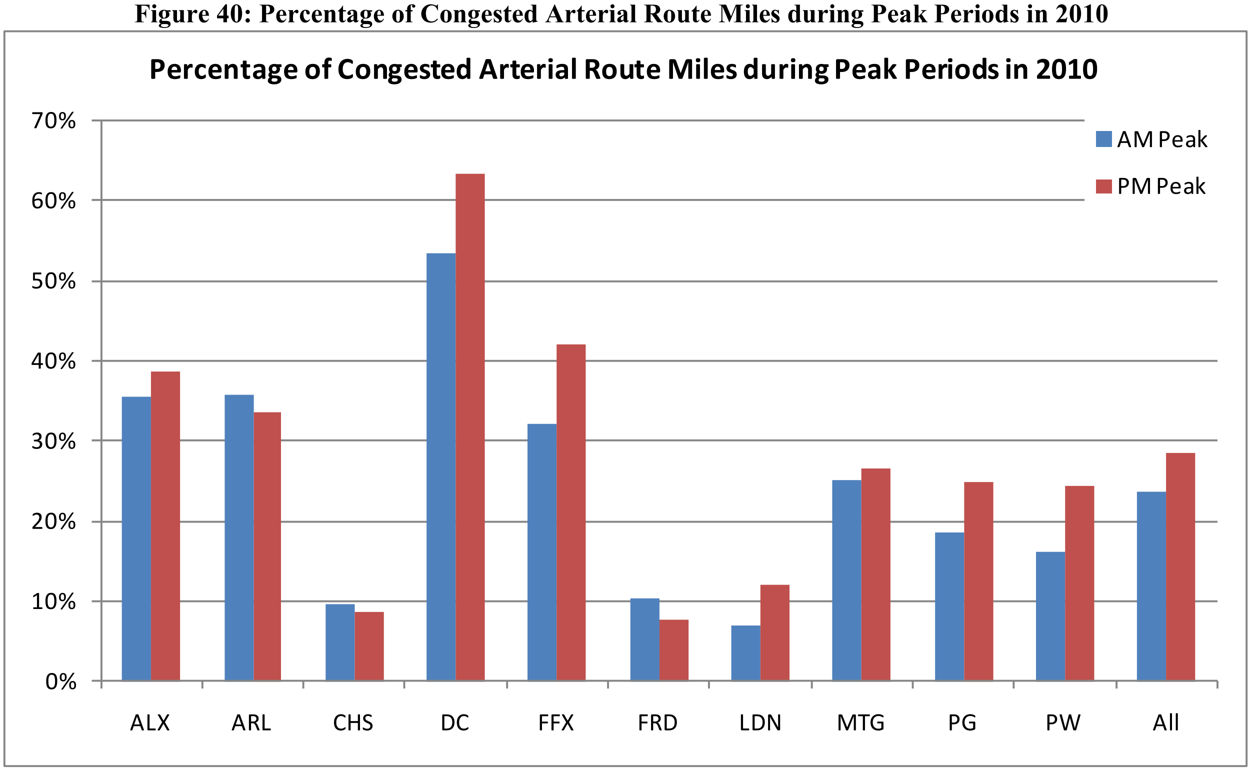
Percentage of Congested Arterial Route Miles

Percentage of congested route miles explains the spatial extent of congestion. Consistent with the freeway analysis, the threshold to label congestion on arterials is also Travel Time Index = 1.30, i.e., if travel time is longer than 30% of free flow travel time then congestion is defined. Figure 40 shows the average and jurisdictional percentages of congested arterial route miles during the AM and PM peak periods in 2010.

Table 11: Arterial Route Miles of INRIX 2010 Data Coverage by Jurisdiction

State	County	Number of TMCs	Route Miles
DC	DISTRICT OF COLUMBIA (DC)	1885	501
MD	CHARLES (CHS)	126	128
MD	FREDERICK (FRD)	431	515
MD	MONTGOMERY (MTG)	1722	967
MD	PRINCE GEORGE'S (PG)	1500	867
VA	ALEXANDRIA (ALX)	168	67
VA	ARLINGTON (ARL)	444	146
VA	FAIRFAX (FFX)	905	561
VA	FALLS CHURCH (FCH)	15	7
VA	LOUDOUN (LDN)	418	446
VA	MANASSAS (MNS)	65	36
VA	MANASSAS PARK (MNS PK)	6	4
VA	PRINCE WILLIAM (PW)	389	333
All		**8074**	**4579**

Figure 40: Percentage of Congested Arterial Route Miles during Peak Periods in 2010

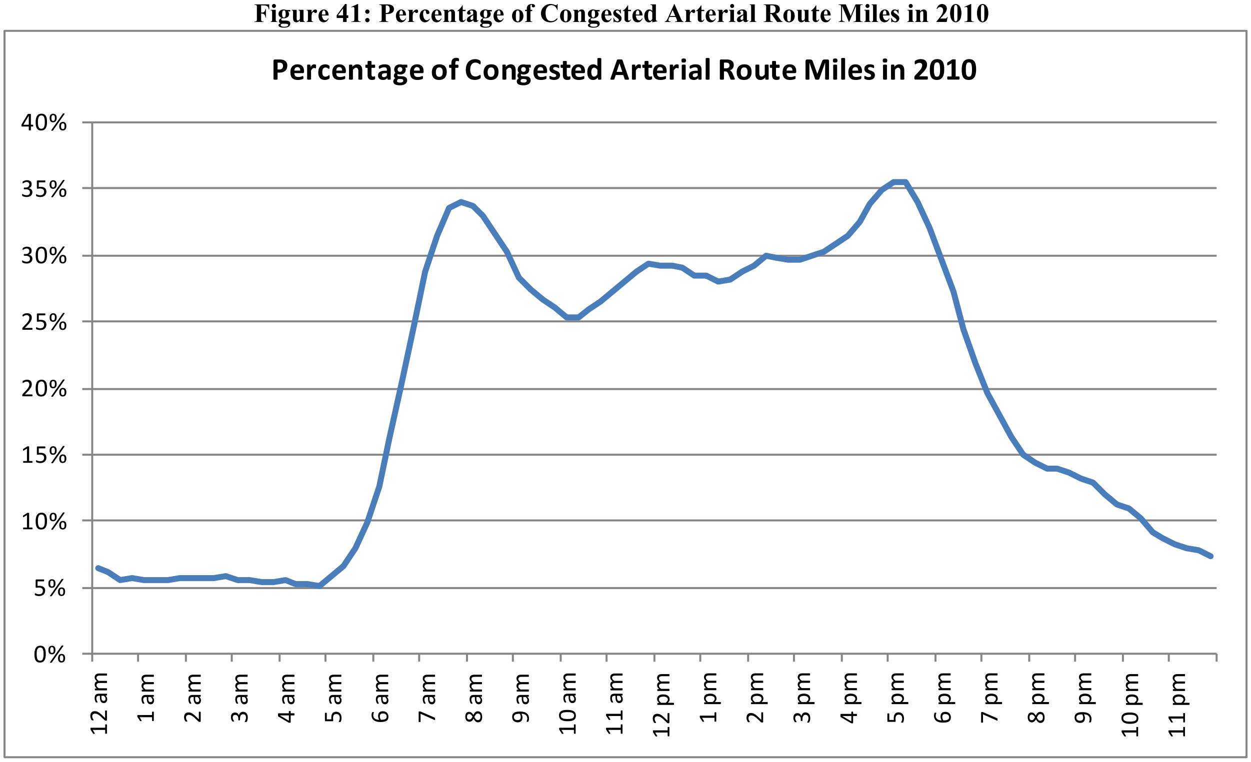


Some notable observations from this performance measure are:

- DC had the highest percentage of congested arterials in 2010: more than half in the AM peak and two thirds in the PM peak;
- Alexandria, Arlington and Fairfax had about 30% - 40% congested arterials;
- Montgomery, Prince George's and Prince William had about 20%-30% congested arterials;
- Charles, Frederick and Loudoun were the least congested counties and had only about 10% of congested arterials;
- Overall, this region had 24% congested arterials in the AM peak and 28% in the PM peak, which were relatively higher compared to congested freeway percentages in the same year (20% in the AM and 27% in the PM, according to Figure 29 on page 63).

A 24-hour percentage of congested arterial route miles in the region is shown in Figure 41. There were more than a quarter of all the monitored arterial route miles in congested conditions in all the daytime periods (AM peak, Midday and PM peak). This is different from freeways on which only a small percentage of congested lane miles found during the midday time period. The chart below also revealed a "lunch peak" on a rterials around 12:00 PM. Consistent with the freeways, the most congested AM and PM peak hours were 8:00-9:00 AM and 5:00-6:00 PM respectively.

Figure 41: Percentage of Congested Arterial Route Miles in 2010

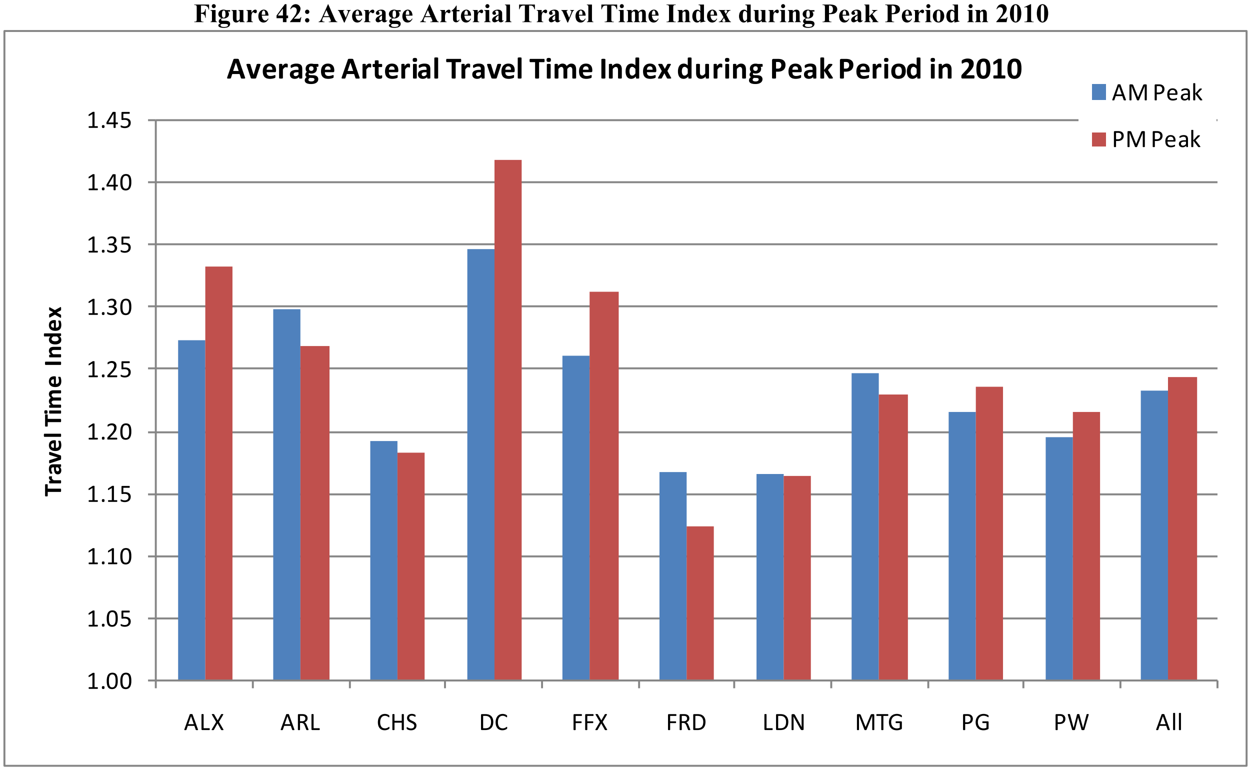


Travel Time Index

Travel Time Index explains the intensity of congestion. The peak period Travel Time Index is shown below in Figure 42 for individual jurisdictions and the whole region. The congestion pattern revealed by this performance measure is very similar to what discovered by the percentage of congested miles: DC was the most congested, followed by the second tier – Alexandria, Arlington and Fairfax, and then the third tier – Montgomery, Prince George's and Prince William, and the least congested jurisdictions were Charles, Frederick and Loudoun.

Out of the 10 jurisdictions evaluated by Travel Time Index, half of them had more intense congestion in the AM peak than the PM peak (including Arlington, Charles, Frederick, Loudoun and Montgomery) and the other half was on the contrary: the AM peak period was the most congested period (including Alexandria, DC, Fairfax, Prince George's and Prince William). Overall, this region experienced a little more severe arterial congestion in the PM peak period compared to the AM peak in 2010.

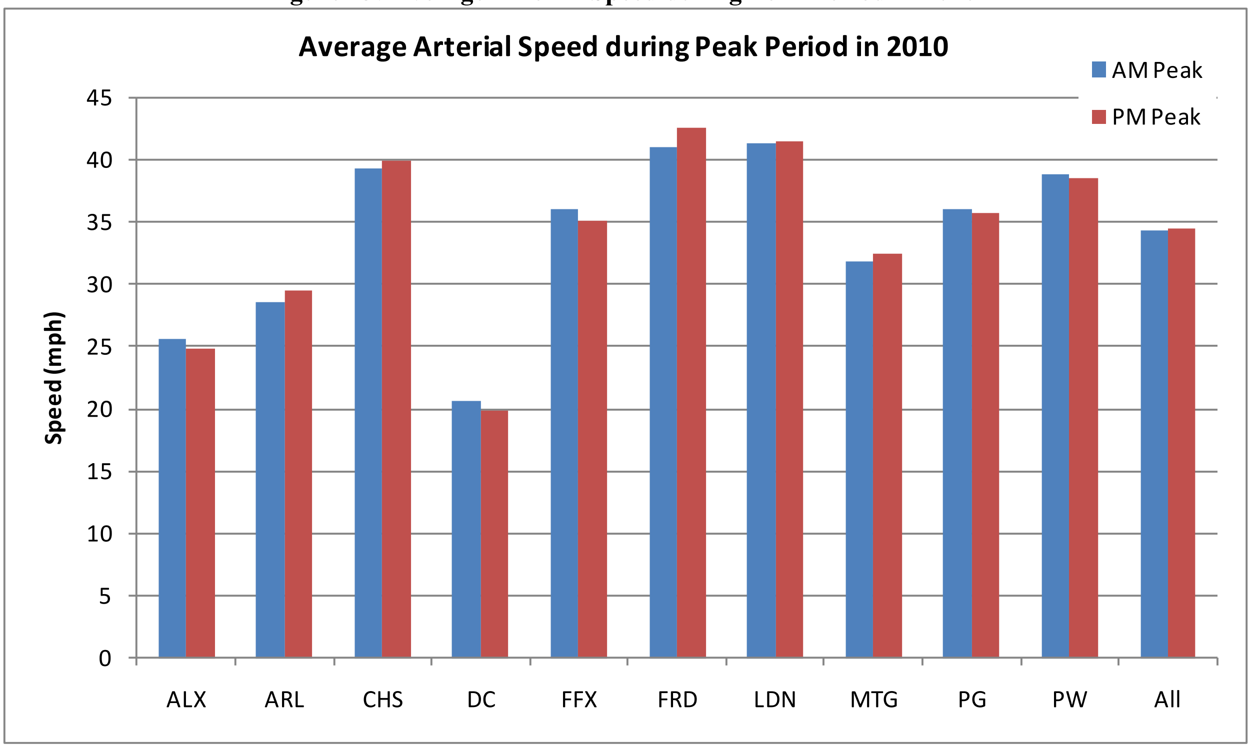
Figure 42: Average Arterial Travel Time Index during Peak Period in 2010



Speed

Speed is one of the three fundamental traffic flow parameters (the other two are volume and density) and can be of high interest in assessing arterial performance. The average peak period speeds for individual jurisdictions and the whole region are shown in Figure 43. Consistent with previous two performance measures, the most congested jurisdictions and time periods had the lowest speeds.

Figure 43: Average Arterial Speed during Peak Period in 2010



2.2.3 Traffic Signal Timing

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 two surveys of the status of signal optimization in 2005[39] and 2009[40]. The 2009 survey found that of the total 5,400 signalized intersections in the region, 80 percent were computer optimized (56%) or checked or adjusted (24%). If a weighted average methodology was used to describe the results, giving half weights to non-computer methods, then 68 percent of signals were "optimized". This percentage is the same as what was found in 2005 but better than the 2002 result, 45 percent.

[39] http://www.mwcog.org/uploads/committee-documents/tVtXWlY20051110144208.pdf
[40] http://www.mwcog.org/uploads/committee-documents/bV5cXFhc20090312161527.pdf

Even though the percentage of optimized signals kept unchanged from 2005 to 2009 , the region may have better results than that may indicate because: 1) the most critical signals in many cases were being checked and optimized even more frequently than once every three years; 2) all major agencies (with more than 50 s ignals) reported that they had optimized or checked significant numbers of their signals within the reporting period – no major agency reported not optimizing or checking; and 3) there were anecdotal reports of more resources annually being put into optimization in recent years than in previous years – this will be beneficial if continued.

In late 2011, in response to a request made by the COG Incident Management and Response (IMR) Steering Committee, the Traffic Signal Subcommittee conducted a regional survey on traffic signals power back-up systems[41]. This survey found that about 20% of the region's 5,000+ signals are already equipped with a back-up system, of which 15% are battery-based systems and 5% are generator-ready systems. These back-up systems are critical in the event of an emergency, particularly if the event involves a lack of power.

2.2.4 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, as noted above, 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.

2.2.5 Potential for Future Data and Analysis of Arterial Congestion

As of the end of FY 2012, the TPB region's arterials are (or had been) monitored by the following sources:

- Arterial Floating Car Travel Time Study, which ended in FY 2012 and the last study was carried out in FY 2011;
- Procured CY 2010 INRIX Data, which provides the unprecedented spatial and temporal coverage for arterials;
- The I-95 Corridor Coalition Vehicle Probe Project monitors about 200 centerline miles of arterials in real-time in the TPB Planning Area since July 1, 2008;
- Virginia added INRIX real-time monitoring for high profile TMC-coded arterials in early 2012;
- Anticipated Maryland procurement of CY 2011 INRIX data for all TMC-coded arterials in MD; and
- The HPMS.

[41] http://www.mwcog.org/uploads/committee-documents/bV1eW1lb20120215174845.pdf (slides 8-13).

The above sources of arterial monitoring represented an enhanced dependence on the private-sector probe-based technologies, which are expected to become more universal and cost-effective. For future report improvements, the region may expand the temporal and spatial coverage of the probe data, examine the validity of such data, explore the integration of probe-based speed data and detector-based volume data, and identify the possibility of using Bluetooth data or video images to enhance arterial monitoring.

2.3 Safety and Congestion

2.3.1 Overview

Transportation safety is a serious concern in the Washington region. There is shown to be a strong correlation between traffic safety and traffic congestion. Incidents, including those in work zones, secondary incidents, involve adverse weather events, or bicycle and pedestrian incidents, all can contribute to non-recurring congestion. Sources indicate that approximately half of all congestion is caused by non-recurring congestion.[42] Raising awareness about such things as transportation safety can help address an issue at the root of incident management.

Engineering and operational management activities can help improve safety and therefore lessen the impact of crashes and other safety problems on congestion. Many transportation agencies in the region have active incident management programs that quickly respond to incidents, help reduce their duration, and lessen the likelihood of secondary accidents in traffic backups. These programs are further integrated into the Metropolitan Area Transportation Operations Coordination (MATOC) program, to undertake day-to-day, real-time multi-agency coordination and information sharing regarding transportation systems conditions during major incidents in the Washington region. Furthermore, transportation agencies look for ways to improve the safety of the physical roadway infrastructure, again to improve safety and therefore lessening its impacts on congestion. Such engineering improvements may include turn lanes, improvements of site lines, lighting, guardrails, and pedestrian enhancements.

The TPB is addressing transportation safety through a variety of programs and activities:

- Transportation safety is encouraged and tracked by TPB member agencies through the ***Transportation Improvement Program (TIP)***, which provides information on projects to be completed over the next six years. The TIP contains projects whose primary purpose is to enhance safety, and explains how other projects will support transportation safety.
- The ***TPB's transportation safety planning activities*** helps facilitate regional traffic data compilation, sharing this data among member agencies, and identifying regional safety problems.
- The ***Transportation Safety Subcommittee*** is a newly-formed subcommittee of the TPB Technical Committee. The Subcommittee will focuses on advising staff on the federally-required transportation safety portion of the long-range transportation plan. The diversity of the Subcommittee, which is comprised of stakeholders from the State Departments of Transportation Planning, planning staff of the TPB member agencies, law enforcement

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

officials, and public health representatives, will be essential to providing a wide-range of safety perspectives. Another key objective of the Subcommittee will be exchanging information on ongoing safety activities and best practices.

- The ***Street Smart Pedestrian and Bicycle Safety*** campaign is an annual region-wide campaign to raise public awareness on pedestrian and bicycle safety.[43] 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 motorist and pedestrian behavior and reducing pedestrian and bicycle deaths and injuries.

Transportation Safety remains a key focus of transportation planning in the region. The TPB's transportation safety work program acts as a home for facilitating discussion of transportation safety issues in our region, and raising awareness about those issues. Continuing safety planning activities in the Washington region will continue to be important to the CMP.

2.3.2 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.[44]

- Total traffic fatalities in the Washington region had significantly gong down from 426 in 2005 to 283 in 2010;
- Traffic deaths per 100,000 population in the Washington region had also significantly gone down from 8.94 in 2005 to 5.76 in 2010, the lowest level since 2002;
- Traffic injuries per 100,000 population had also declined since 2002, reach its lowest level of 809 in 2008;
- Both total crashes and crashes per 100,000 population had gradually gone down since 2003, reach their lowest levels of 82,054 and 1,678 respectively in 2007;
- In terms of jurisdictional average annual crashes per 100,000 population, District of Columbia had the highest rate (8,421) during the period from 2003 to 2007, followed by Northern Virginia (5,255) and suburban Maryland (4,740);
- Crashes involved young drivers (age < 21) and occurred at signalized intersections stood out as traffic safety issues according to 2007 crash data.

The above facts reveal that traffic safety is something that needs to be taken very seriously. The incident-related and non-recurring strategies our region undertakes not only manage congestion that commonly occurs after an incident happens, but these strategies can also prevent subsequent incidents from occurring. Our region's strategies aim at improving safety on our roadways, and ultimately contribute to making a nationwide difference.

[43] http://www.bestreetsmart.net/
[44] The Regional Transportation Safety Picture, presentation to the Transportation Safety Subcommittee meeting, 2012-03-16: http://www.mwcog.org/uploads/committee-documents/a11eWF1Y20120316080658.pdf.

2.3.3 Incident-Related and Non-Recurring Congestion

Fifty percent of congestion is said to be non-recurring, which is congestion due to incidents such as crashes, disabled vehicles and special events, work zones and bad weather.[45] On average, there were more than 200 traffic related incidents on the region's roadways every day, the most severe of which can disrupt traffic for hours, cause secondary incidents, and overall cause major disruptions to the transportation system. Heavily-trafficked areas and construction areas are especially prone to incidents. Nonrecurring events dramatically reduce the available capacity and reliability of the entire transportation system. Travelers and shippers are especially sensitive to the unanticipated disruptions to tightly scheduled personal activities and manufacturing distribution procedures.

The Federal Highway Administration breaks down non-recurring congestion into three primary causes: 1) incidents ranging from a flat tire to an overturned hazardous material truck (25%), work zones (10%), and weather (15%).

A number of TPB's member agencies, including DDOT, MDOT, VDOT, and some local jurisdictions operate incident-management programs. These programs are further coordinated and facilitated by the Metropolitan Area Transportation Operations Coordination (MATOC) program, which has more emphasis on regional-significant incidents. The MATOC program and the local jurisdictional programs help minimize the impact the events have on the transportation network and traveler safety. If an incident disrupts traffic, it is important for congestion that normal flow resumes quickly. The TPB compiles and analyzes data associated with these incident management programs.

2.4 Congestion on the Metropolitan Area's Transit Systems

2.4.1 Impacts of Highway Congestion on Transit Systems

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).

One way to analyze the performance of one mode's impact on another is to identify key linkages between one or more modes of transportation. In 2008 the TPB conducted a Regional Bus Survey throughout our region. This survey found about 23% of the region's bus passengers accessed bus system via buses or autos and about 67% of all passengers had one or more transfers to reach their final destinations[46]. These passengers were subjected to the impact of highway congestion if it occurs on pertinent routes.

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

[46] 2008 Regional Bus Survey, Final Technical Report, http://www.mwcog.org/uploads/committee-documents/a15aXldb20091029142551.pdf.

Another way to assess the impacts of highway congestion on transit is to investigate bus travel speed along roads carrying both buses and other vehicles. Figure 44, Figure 45, and Figure 46 show bus speed maps created using GPS data obtained from WMATA's November, 2009 Automatic Vehicle Location (AVL) system log and reflect well over 1,000,000 separate GPS data points[47]. A GIS application was used to determine average bus speeds by calculating the elapsed time and distance between AVL time points, resulting in analysis of nearly 21,000 roadway segments. These segment speeds were calculated and summarized to illustrate average speeds for all-day, weekday AM peak (6am – 9am), and weekday PM peak (3pm – 6pm) conditions. The maps depict the slower of the two directions during the given period. With few exceptions, this represents "outbound" buses during the PM period and "inbound" buses during the AM.

The maps show that there are numerous transit corridors within the WMATA system that average operating speeds of less than 10 mph and several with speeds of under 5 mph. The vast majority of these corridors are within the District, but also occur in Maryland and Virginia suburban areas (particularly around Silver Spring and several Arlington County corridors). The maps also show 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. Differences between the peak periods and the all-day speeds seem less significant than might be expected, indicating that mid-day congestion is heavy on many routes in the service area.

In general, the maps show that bus operating conditions vary greatly by corridor within the WMATA system. Many corridors, particularly in the downtown core, have operating speeds below 10mph indicating high amounts of bus delay. Moreover, many of the slowest corridors shown on the map carry very high bus volumes (e.g., I Street in downtown DC has over 400 daily WMATA buses) suggesting that priority improvements on these corridors could provide significant transportation benefits. In particular, WMATA's work to develop a network of priority bus routes, and the recent federal Transportation Investment Generating Economic Recovery (TIGER) grant award to implement much of this network, provides a unique opportunity to address the challenges of congestion-related bus delay.

[47] The maps were created by Kittelson & Associates, Inc., and made available to this report through Sean Kennedy of WMATA on May 27, 2010.

Figure 44: Average Weekday Bus Speeds as Determined by Recorded AVL Data: November 2009

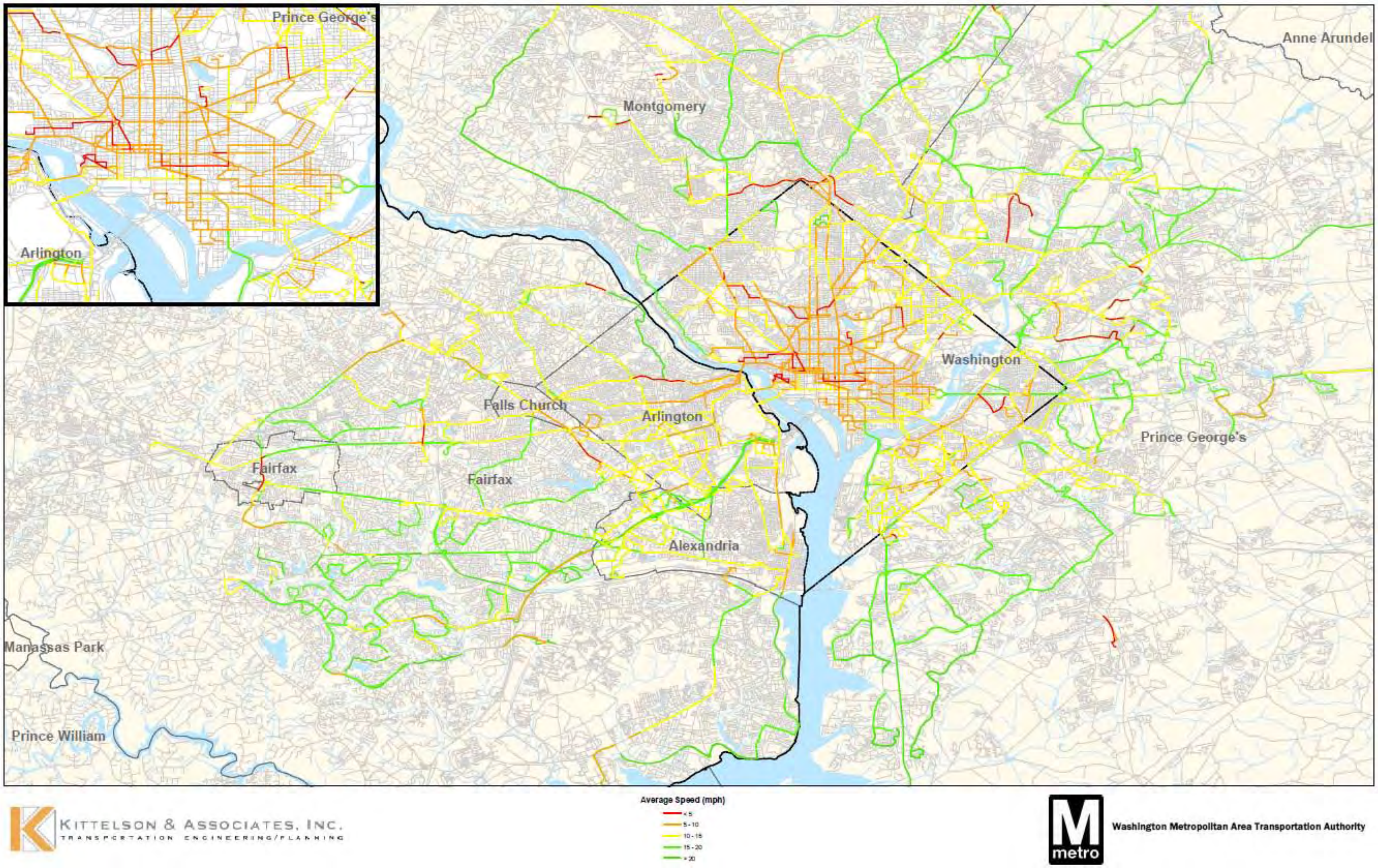


Figure 45: Average AM Peak (6:00 - 9:00 AM) Bus Speeds as Determined by Recorded AVL Data: November 2009

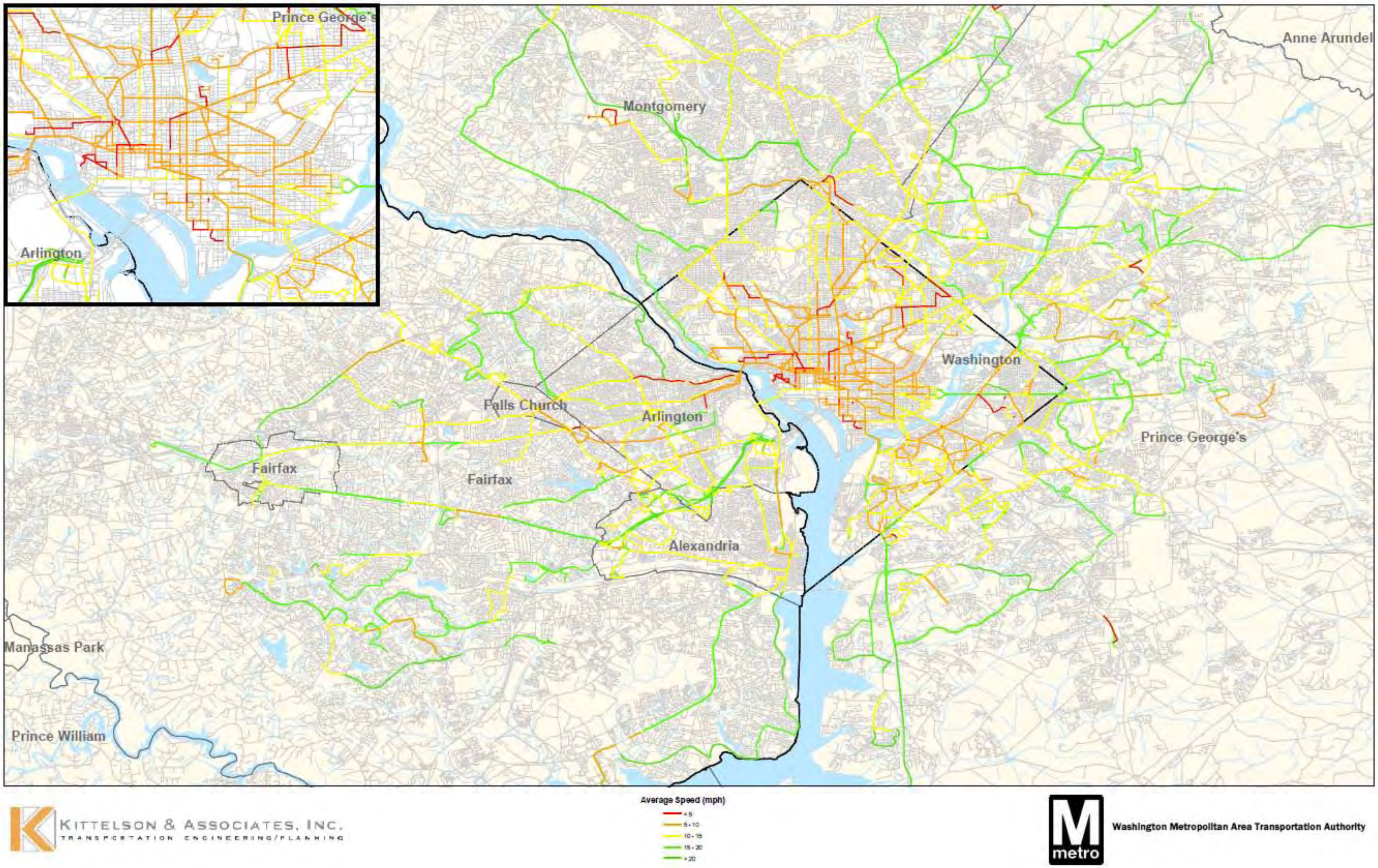
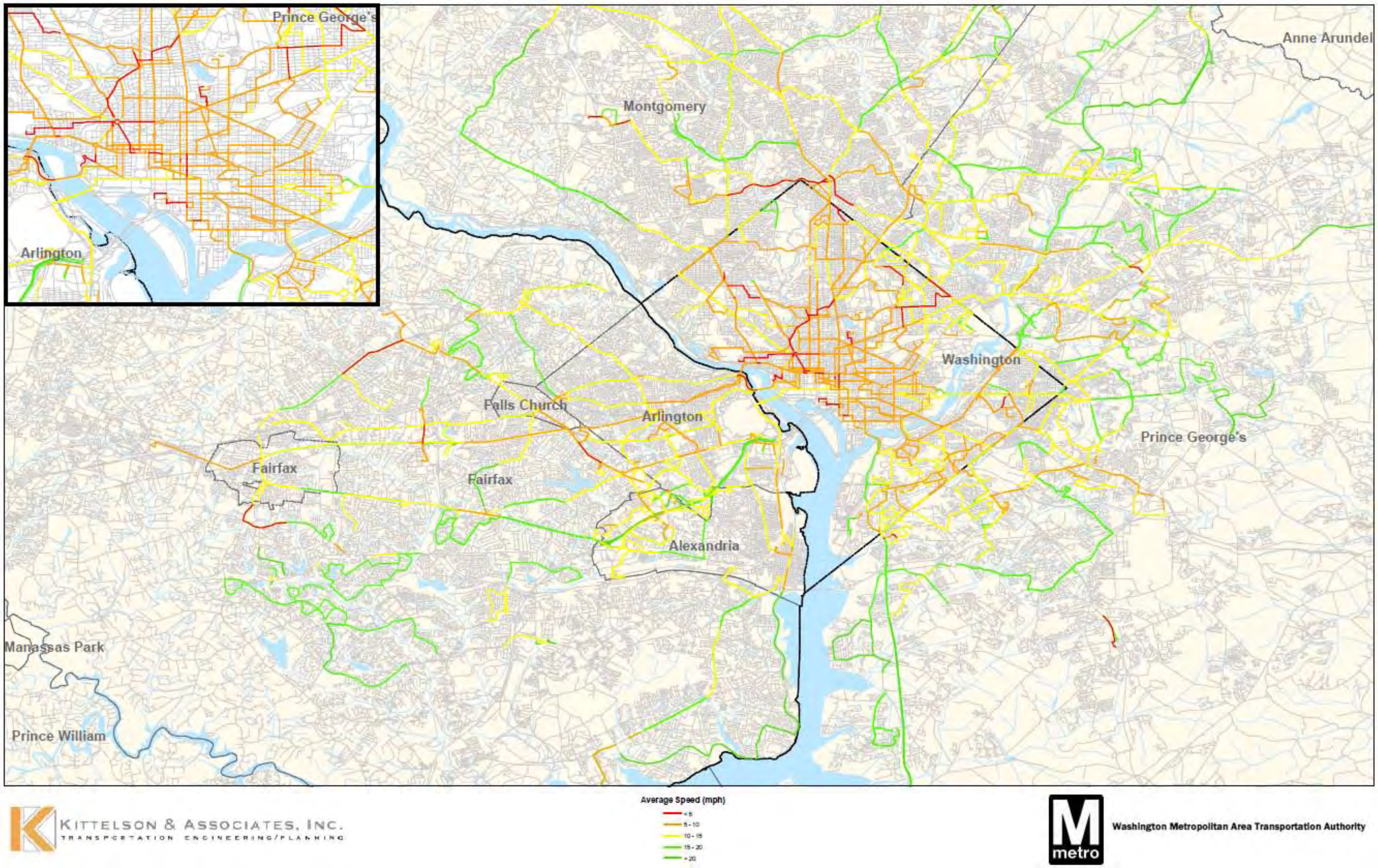


Figure 46: Average PM Peak (3:00 - 6:00 PM) Bus Speeds as Determined by Recorded AVL Data: November 2009



2.4.2 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 70,000 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.

Congestion can not only result on the transit system itself, but on station platforms and around the station. In 2008, WMATA released their findings of the Metrorail Station Access & Capacity Study[50]. This study found that a number of stations need to expand their capacity in order to satisfy the demand imposed by existing large ridership and/or future ridership increases, as listed in Table 12.

According to Metro's Office of Long Range Planning, more than two-thirds of Metrorail daily ridership occurs during the morning and evening peak periods[51]. The graphic (Figure 47) provided by this Office shows the AM peak hour (8AM-9AM) passenger volumes by travel direction. Red and Orange/Blue Lines carry the highest passenger volumes the system morning peak hour, on segments from Woodley Park to Farragut North (eastbound), Gallery Place to Metro Center (westbound), and Rosslyn to Farragut West (eastbound). Please note the 8AM-9AM 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 7,000 from Anacostia to L'Enfant Plaza.

In 2007, an analysis was conducted by TranSystems to gauge the effect traffic congestion and passenger crowding has on WMATA bus operations.[52] The analysis found evidence that traffic

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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] Metrorail Station Access & Capacity Study, Washington Metropolitan Area Transit Authority (WMATA), http://www.wmata.com/pdfs/planning/Final%20Report_Station%20Access%20&%20Capacity%20Study%202008%20Apr.pdf.

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

[52] Memo: Impact of Congestion on Metrobus Operations. March 12, 2007. http://www.mwcog.org/uploads/committee-documents/t1daVl020070509095750.pdf

congestion imposes a cost on WMATA, as the peak vehicle requirement needs to be increased to maintain a sufficient level of service on certain routes. In addition, growth in passenger demand has the same effect, since additional bus trips need to be added to certain routes to avoid overcrowding.

The CMP recognizes the growing concern of congestion within our regional transit systems. As more and more people are living in the outer suburbs and working far from their home, more commuters are 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.

This CMP Technical Report thus recommends: continue to support transit in the Washington region and explore transit congestion measures to address passenger crowding and person delay. 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.

Table 12: Existing and Future Station Capacity Issues

Station	Mezz	Vertical		Faregate	
		2005	*2030*	*2005*	*2030*
Archives-Navy Memorial-Penn Quarter		⊙	⊙		
Bethesda			⊙		
Branch Ave		⊙	⊙		
Cleveland Park					⊙
Court House			⊙		⊙
Farragut North	SE	◎	◎		
Farragut West	W	⊙	⊙		
Foggy Bottom-GWU		⊙	⊙		
Franconia-Springfield			⊙		
Gallery Pl-Chinatown	N	⊙	◎	⊙	◎
	W				⊙
Judiciary Square	E		⊙		
L'Enfant Plaza	E	⊙	◎		
	W		◎		
Metro Center	N	⊙	◎		⊙
	S	◎	◎		
	W		⊙		
Navy Yard*	E				⊙
Shady Grove		⊙	◎		
Takoma				⊙	⊙
Twinbrook					⊙
White Flint					⊙
Union Station	S	⊙	⊙		
	W	⊙	⊙		

Legend

⊙ Needs study ($0.5 \le v/c < 0.75$)
◎ Needs improvement ($v/c \ge 0.75$)

**Note: Both Navy Yard mezzanines will have unique future needs, which may not be reflected in this analysis, due to the opening of the Washington Nationals Ballpark in 2008.*

Source: WMATA, 2008, Metrorail Station Access & Capacity Study.

Figure 47: AM Peak Hour (8:00-9:00 AM) Metrorail Link Passenger Volumes

Source: WMATA, 2010, Peak Hour Passenger Ridership on Metrorail, Data Visualization, Office of Long Range Planning. http://planitmetro.com/data

2.5 Park-and-Ride Facilities

The Washington region has over 300 park-and-ride lots where commuters can conveniently join up with carpools, vanpools, or connect to public transit. Many of these lots are conveniently located for those that commute from the outer suburbs of Virginia or Maryland.

The following statistics provide an idea of why park-and-ride lots play such a popular role in the region's transportation system[53]:

- About one third of Park & Ride Lots have commuter bus service available.
- Approximately one third of the Park & Ride Lots have rail service available, including Metro, MARC, VRE and Baltimore Light Rail.
- Parking is free at 90% of the Park & Ride Lots.
- About 25% of the Park & Ride Lots have bicycle parking facilities (According to Maryland's estimate, about 34% of the Maryland state-owned 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)[54], 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 (SHA) has taken inventory of the SHA owned and maintained ridesharing facilities in the state (Appendix B). Inventory was taken in Spring 2001, and again in 2005, 2006, and 2007. Average use has been gradually increasing over the years, with approximately 51% in 2001, 55% in 2005, and 57% in 2006 and 2007. SHA notes that once their park-and-ride lots fill to 80 percent capacity, locations for new lots are considered.

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.

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[53] Source: Commuter Connections http://www.mwcog.org/commuter2/commuter/ridesharing/prlocations.html
[54] 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

According to the recent WMATA Metrorail Station Access & Capacity Study (April 2008), 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 13 shows parking lot utilization as of October 2006.

Table 13: Metro Parking Lot Utilization, October 2006

Station and Region	Lot Capacity	Average Utilization[12] Mon-Thurs	Average Utilization 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

2.6 Airport Access

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). The majority (94%) of those traveling to the region's airports does so via the highway network (i.e. personal cars, rental cars, taxis, buses)[55]. 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.

In the spring of 2011, COG staff conducted the third Airport Ground Access Travel Time survey[56], during the time periods of 6:00-10:00 AM (for the AM peak period), 10:00 AM - 2:00 PM (for the mid-day period), and 3:30 – 7:00 PM (for the PM peak period). Travel time, speed and delays were collected using Geographical Positioning System (GPS) technology. The findings and evaluation of the data are based on the observed travel time and speed compared with the posted speed limit on the facility. Congested areas and bottlenecks for travel to the three airports are identified, as well as any notable changes in conditions since the 2003 report.

For travel between nearly all activity centers and all three airports for all time periods, travel times have increased between 2003 and 2011. Bottlenecks that impede ground access to the airports, identified when travel speeds along a route are less than 50% of the posted speed limit, occur during the peak periods largely along freeways with recurring regional congestion, such as I-270 between MD 28 and the "split," I-495 between I-395 and I-66 (in the AM peak period), the entire length of I-395 from the Beltway to the Pentagon, and the Beltway between Tysons Corner and the I-270 split (in the PM peak period).

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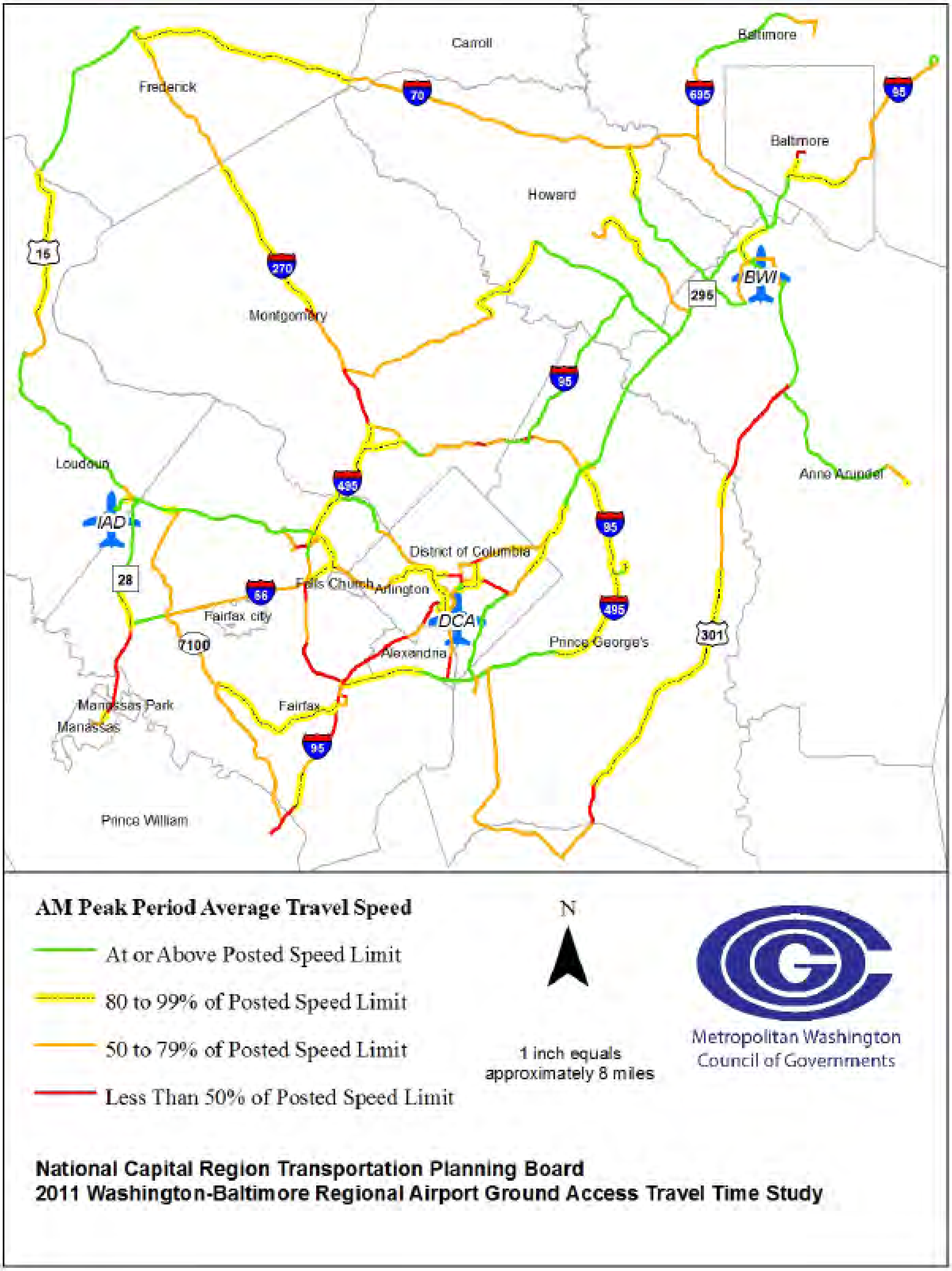
[55] *2009 Washington-Baltimore Regional Air Passenger Survey,* September 2010.
http://www.mwcog.org/uploads/committee-documents/a15XXFle20101203144651.pdf
[56] *2011 Washington-Baltimore Regional Airport Ground Access Travel Time Study,* December 2011.
http://www.mwcog.org/uploads/committee-documents/aF1eXlZW20120113141801.pdf

During the mid-day period, the bottlenecks are mostly limited to a few arterial segments where delays are caused by regular signal cycles and increased cross traffic on streets with mid-day destinations such as restaurants and other retail destinations. Arterial roadway bottlenecks from the mid-day period increase in severity during the AM and PM peak periods, particularly in downtown Washington and across Montgomery County. With a few exceptions, automobile travel times to the airports are much shorter than comparable scheduled times for transit. Those exceptions are activity centers with good access to the Metrorail system for connections to direct bus or rail service to an airport, particularly the core areas of the District of Columbia.

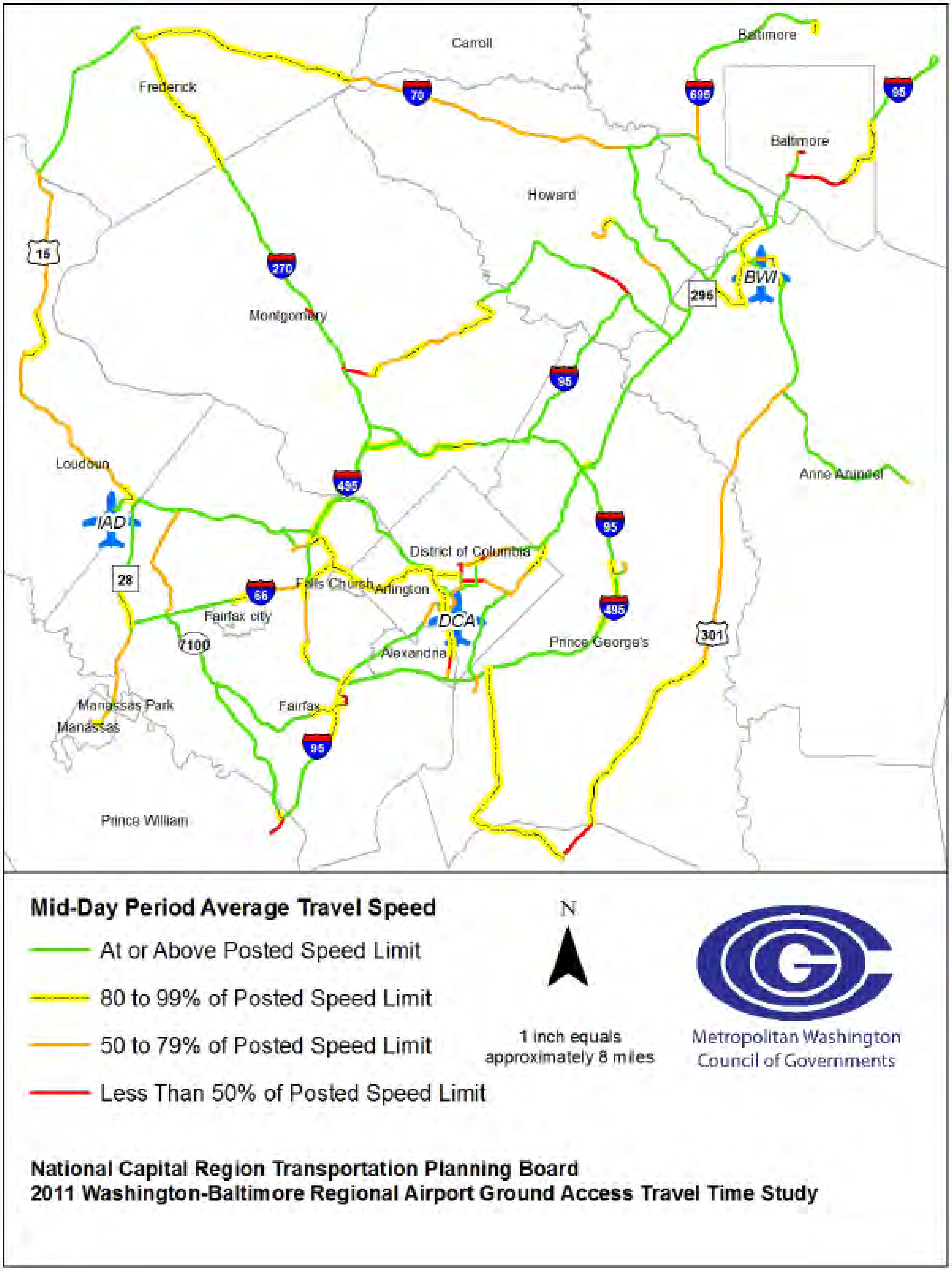
Figure 48, Figure 49 and Figure 50 below show average travel speeds for AM peak period, mid-day, and PM peak period conditions for travel from the activity centers to the three airports. Regionally, the AM peak period has the worst travel conditions. However, travel conditions do vary depending on the destination airport. Travel conditions to DCA in both peak periods are worse than travel to the other two airports; however, since DCA is much closer to the DC core than BWI and IAD, overall travel time from the core areas is less.

Figure 48: AM Peak Period Average Travel Speeds (mph) From Activity Centers to Airports



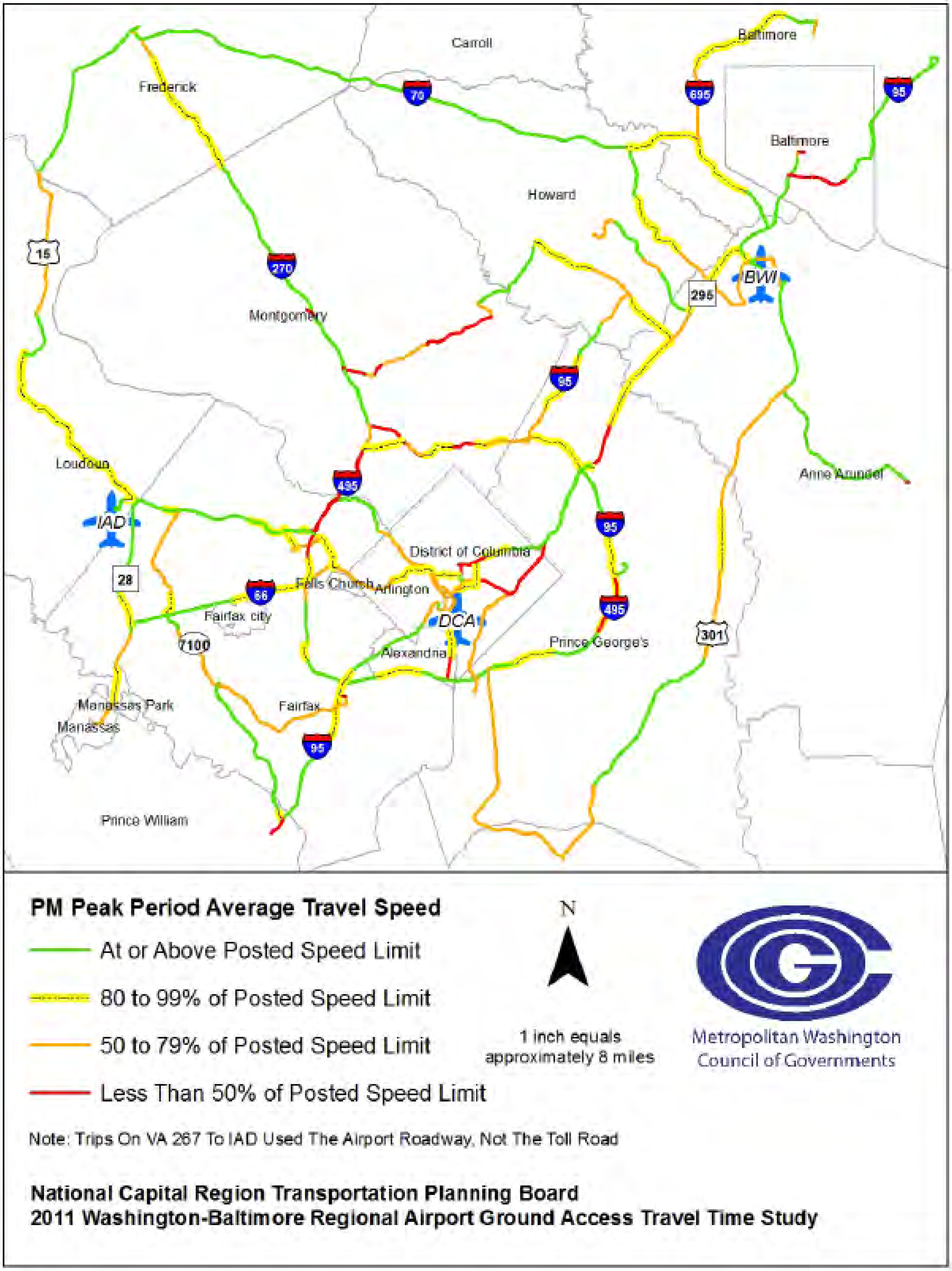
Source: 2011 Washington-Baltimore Regional Airport Ground Access Travel Time Study, December 2011.

Figure 49: Mid-Day Average Travel Speeds (mph) From Activity Centers to Airports



Source: 2011 Washington-Baltimore Regional Airport Ground Access Travel Time Study, December 2011.

Figure 50: PM Peak Period Average Travel Speeds (mph) From Activity Centers to Airports



Source: 2011 Washington-Baltimore Regional Airport Ground Access Travel Time Study, December 2011.

2.7 Freight Movement and Congestion

In addition to surface transportation congestion around airports and congestion's impacts on person movement, congestion in and around major metropolitan regions such as Washington has significant impacts on freight movements. Though freight movements by rail, water, and pipeline are not impacted as much as trucks are by surface transportation congestion, rail freight companies also face bottlenecks and congestion challenges in the Washington region.

Traffic congestion on the region's highways and arterials increasingly slows truck freight deliveries and impacts both shippers and consumers. Shippers are already adjusting their operations to beat congestion. Some impacts of increased congestion to the truck freight industry are:

- Shippers have less flexibility in scheduling when to deliver their shipments;
- Shippers may decide to make fewer deliveries;
- Increased costs in time and fuel result in increased costs to shippers which are passed on to consumers, and ultimately impact the economy
- Truck drivers face longer and more grueling hours for a given trip;
- Businesses (and the jobs they provide) may choose to locate in other less-congested metropolitan areas, in part because of freight movement delays.

In 2007, a freight study was conducted on behalf of the Transportation Planning Board and the region by a team of expert consultants. According to the study, approximately 222 million tons of goods worth over $200 billion are transported to, from, or within the Washington region annually.[57] Approximately three-quarters of this freight movement (by weight) is by truck. An additional 314 million tons of goods were estimated pass through the region annually (through traffic). Therefore, freight movement in the Washington region is significant across the major modes (by both truck and rail) as well as both local freight movement and through movement. It is therefore critical for freight movement to have an efficient surface transportation network to move traffic in, about, and through the region.

Professional and business services (21%), trade and transportation (14%), federal (11%), and state and local government (10%) dominate the employment industries in the Washington region. These industries do not produce many consumer goods; therefore the National Capital Region is highly dependent on truck deliveries into the region, much coming from outside the region. This demand puts pressure on the regional surface transportation system as trucks maneuver the highway and arterial transportation network to make their deliveries on time. In order to make just-in-time deliveries, shippers need a moving transportation network that they can depend upon.

Future trends predict a significant growth in freight for all transportation modes. Since freight trucks operate on a much more expansive transportation network than rail, they are more flexible shippers and will continue to experience growth. By 2030 rail tonnage is projected to grow by

[57] . *Enhancing Consideration of Freight in Regional Transportation Planning,* Cambridge Systematics, Inc., May 2007, p2-1 (GWI Analysis of Bureau of Labor Statistics and Maryland Department of Labor, Licensing, and Regulation 2005, data). http://www.mwcog.org/uploads/committee-documents/bF5fW1pX20080222142629.pdf

50% while the forecast truck tonnage growth rate is 106%. According to the national Freight Analysis Framework (FAF), the Washington metropolitan region is projected to see the amount of total tonnage moving to, from, and within the region to increase by 110% in 2030 and the growth in value to increase by 145%.[58] These rates are higher than those projected for the country as a whole.

The Panama Canal Expansion is anticipated to be complete in 2014. This expansion will allow larger container ships to access ports on the East Coast and the East Coast ports are gearing up in anticipation of the larger ships. This expansion will impact the freight movements on the East Coast and the Washington region is expected to carry more freight in the future over its highway and rail transportation systems.

COG/TPB has recently established a Freight Program with a Freight Subcommittee as a major component of this program. The Freight Subcommittee provides a structured voice for freight issues and concerns within the Metropolitan Washington Region. This forum gives freight stakeholders the opportunity to share freight concerns and information with the TPB and decision-makers. Activities of the Freight Subcommittee include regular meetings with special guest speakers, sites visits, and information sharing. An *Integrated Freight Report*[59] was recently released to enhance the integration of regional freight planning and the CLRP. Staff is also developing the National Capital Region Freight Plan, which will be published soon.

Through the Freight Program, COG/TPB also supports efforts to share information and identify solutions for multi-regional issues such as congestion, such as the I-95 Corridor Coalition's Mid-Atlantic Truck Operations study (MATOps) whose objective is to identify truck bottlenecks in the Mid-Atlantic region and assess the cost of delay, and the similar Mid-Atlantic Rail Operations study (MAROps), a study focused on improving rail movement along the I-95 corridor.

Trucks have impacts on congestion, competing for street and roadway space in congested corridors. Similarly, competition for space along streets in urban environments for goods delivery by truck is also a challenge. Discussions with freight movement stakeholders have revealed that they are already going to great lengths to conduct freight movement at off-peak hours, or to move goods by rail or pipeline to the extent possible and economically feasible. Full consideration of non-highway means of freight movement needs to be continued. However, the projected robust growth in all modes of freight movement in the future will mean that trucks will remain a major presence on the region's roadways.

The I-95 Corridor Coalition's MATOps study identified the following five worst truck bottlenecks in the region based on observed delay in 2006[60]:

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[58] Ibid., May 2007, p2-30 (2002 FAF data).

[59] *Integrated Freight Report*, July 15, 2009. http://www.mwcog.org/uploads/committee-documents/b15aXl1Z20091020141036.pdf

[60] I-95 Corridor Coalition, *Mid-Atlantic Truck Operations study – Final Report*. Cambridge Systematics, Inc. October 2009. http://www.i95coalition.net/i95/Portals/0/Public_Files/pm/reports/DFR1_MATOps_Truck%20Operations%20V3.pdf

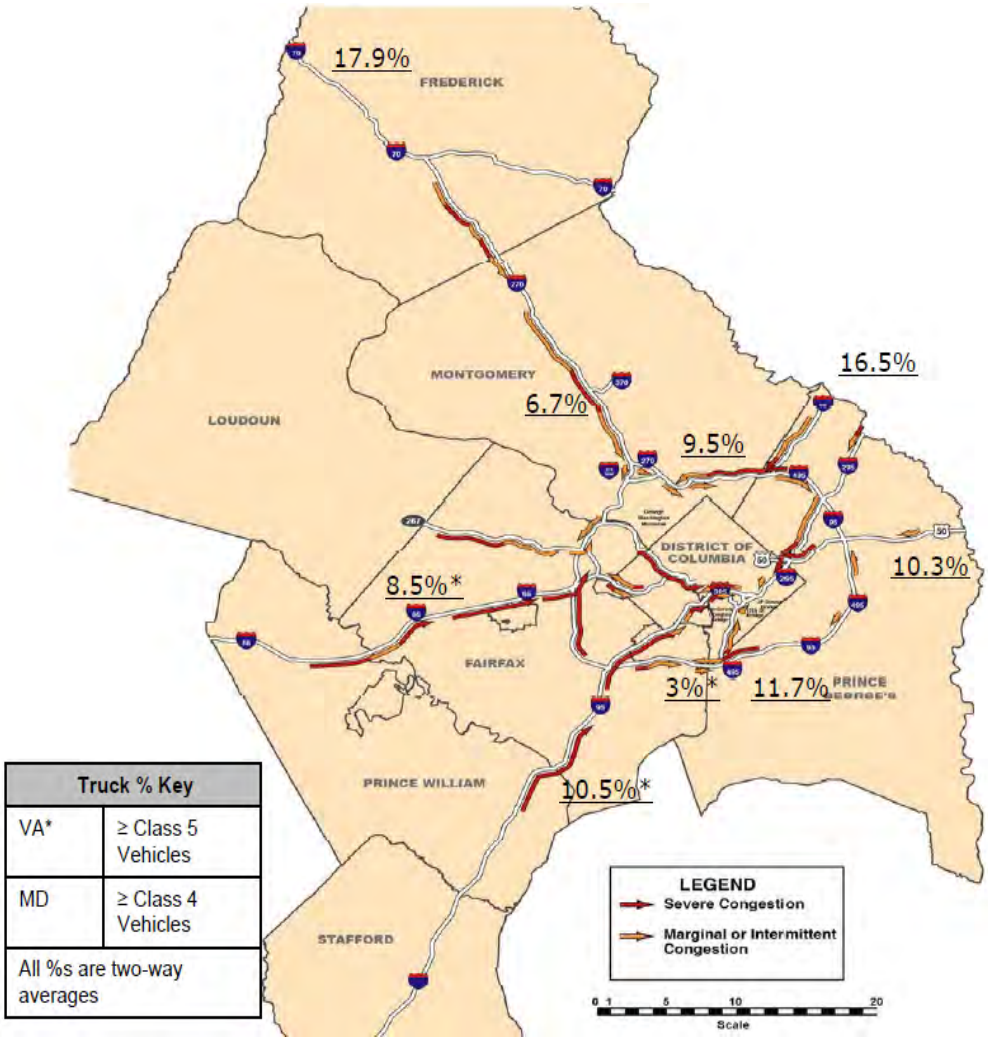
1) I- 95 at VA-7100, Virginia
2) I- 95 at VA-234, Virginia
3) I-95 at I- 495, Maryland
4) I- 495 at American Legion Bridge, Virginia
5) I-495 at I-66, Virginia

The # 3) bottleneck, I-95 at I- 495 in Maryland, was also identified as the 25th worst freight bottleneck in the nation's selected 30 freight bottlenecks[61]. This study was conducted by the American Transportation Research Institute (ATRI) and the 30 bottlenecks were chosen by the Federal Highway Administration Office of Freight.

Several of these bottlenecks are also revealed in Virginia and Maryland Departments of Transportation traffic count data (Maryland 2008 data and Virginia 2007 data). Figure 51 shows truck percentages of total Annual Average Daily Traffic (AADT) on the region's freeway network[62]. 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.

[61] American Transportation Research Institute. *Freight Performance Measures Analysis of 30 Freight Bottlenecks.* March 2009.
[62] *Integrated Freight Report*, July 2009. http://www.mwcog.org/uploads/committee-documents/kV5aXl1a20091020140842.pdf

Figure 51: Percentages of Truck Counts on the Region's Morning Peak Period Network



2.8 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 are also carried out in the Washington region.

2.8.1 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.

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 studies and findings include:

2009 Central Employment Core Cordon Count of Vehicular and Passenger Volumes[63]:

This study collected data for the Spring 2009 Central Employment Core Cordon Count of peak period person and vehicle volumes entering and exiting 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 5:00 AM to 10:00 AM inbound and 3:00 PM to 8:00 PM outbound across the cordon line.

Most comparisons are made with results obtained from the previous Central Employment Core Cordon Count conducted in Spring 2006. Between the 2006 and 2009 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 (please see Chapter I for a discussion of the changes).

Trends and changes in person and vehicle trips by mode are emphasized for the 6:30 - 9:30 AM peak period inbound and the 3:30 - 6:30 PM outbound peak period. The following changes were observed:

1. Total inbound travel increased in the AM peak period from 443,000 person trips in 2006 to about 463,000 in 2009. In the PM peak period, total outbound person travel increased from 427,600 in 2006 to over 444,500 in 2009.

2. Inbound peak period transit trips increased from 191,500 trips in 2006 to about 207,000 in 2009, even though trips by Metrorail were little changed. Outbound peak-period transit trips increased from 177,000 trips in 2006 to about 197,000 in 2009. Metrorail carried about 141,500 of those trips, an increase of about 10,000 trips from 2006.

3. Trips by persons in single-occupant vehicles (SOV) declined in the A.M. and P.M. peak periods.

[63] *2009 Central Employment Core Cordon Count of Vehicular and Passenger Volumes*, Draft, June 30, 2010.

4. The decrease in inbound A.M. person trips by the SOV mode was offset by an increase in persons in vehicles with two or more occupants, but similar changes in outbound P.M. travel were not as large.

5. The number of automobiles entering the Central Employment Core in the A.M. peak period has declined from about 216,200 in 2006 to about 210,000 in 2009. In the P.M. peak period, outbound auto traffic declined from about 208,800 in 2006 to about 197,200 in 2009.

6. Possibly reversing a long-term trend, average auto occupancies in both peak periods increased. In the A.M. peak period, the average number of persons in each vehicle crossing the cordon line inbound increased from 1.21 in 2006 to about 1.26 in 2009. In the P.M. peak period, outbound average auto occupancy increased slightly from 1.27 in 2006 to 1.29 in 2009.

7. Inbound A.M. peak period travel crossing the Arlington, Virginia sectors of the cordon line increased by about 15,100, due to increases in trips by transit and in vehicles with at least two occupants. In the P.M. peak period, travel increased by 8,400 from 166,500 2006 to almost 175,000 in 2009.

Appendix C contains charts that depict the trends in person trips 1999 to 2009, in the inbound and outbound peak periods.

2.8.2 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. These are:

- I-95/I-395 in the Northern Virginia counties of Prince William, Fairfax and Arlington, and the City of Alexandria;
- 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.

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.

COG/TPB has conducted surveys on the HOV system in 1997, 1998, 1999, 2004, 2007 and 2010. Some highlights of the most recent 2010 survey[64] were summarized below; more information can be found in Appendix D.

The following major trends were observed by comparing the 2010 survey to previous surveys:

- During Spring 2010, all of the HOV lanes required fewer cars to carry more persons per lane during the HOV restricted periods than adjacent non-HOV lanes making the HOV lanes more efficient at moving people to their destinations;

- Most of the HOV lanes provide travel time savings when compared to non-HOV alternatives, especially the barrier separated HOV lanes in the I-95/I-395 corridor in Northern Virginia; and

- Average auto occupancy in 2010 was little-changed from 2004 and 2007, even though the HOV lanes in Northern Virginia continue to exempt vehicles with "Clean Special Fuel Vehicle" registration plates from the HOV requirement.

2.8.3 Household Travel Surveys

The Household Travel Survey is a survey of households in the Washington region and adjacent areas to gather updated information on area wide travel patterns. The survey provides 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 latest Household Travel Survey was conducted by TPB staff in 2007-2008, updating the last such survey which was undertaken in 1994. Data is being collected from households across the region and some preliminary 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 house hold travel surveys have been conducted or planned from 2010 to 2013. The objective of the surveys are

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[64] *2010 Performance of High-Occupancy Vehicle Facilities on Freeways in the Washington Region*, September 7, 2011. http://www.mwcog.org/uploads/committee-documents/ll1fXl1b20110908082403.pdf

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).

There were 10 areas have been surveyed so far and the initial results were reported to the TPB in mid 2012[65]. Some distinct features from certain surveyed areas have been discovered.

2.8.4 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.

2008 Regional Bus Survey:

A major regional bus survey was conducted in Spring 2008 on be half of the TPB[66]. 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.

[65] 2011 TPB Geographically-Focused House hold Travel Surveys Initial Results, May 16, 2012. http://www.mwcog.org/uploads/committee-documents/k11dXlle20120517145044.pdf
[66] NuStats, *2008 Regional Bus Survey Technical Report*, June 2009.

- 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.

Regional Travel Trends Report:

The Regional Travel Trends Report summarized major travel trends in the metropolitan region from 2000 – 2006[67]. 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.

The data for the Regional Travel Trends report is not compiled from just one survey or study. Rather, the data is drawn from a variety of different sources. These sources include:

- Population and worker characteristic data from the 2000 Decennial Census and the new American Communities Survey (ACS)
- Population, group quarter, and housing unit estimates from the Federal State Cooperative Program for Population Estimates (FSCPE)
- Employment and labor force data from the Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW)
- Local Area Unemployment Statistics (LAUS) program
- Highway Performance Monitoring System (HPMS)
- Travel monitoring data from:
  - DDOT
  - MDOT
  - VDOT
  - TPB Regional Transportation Data Clearinghouse
- Transit ridership statistics from the Washington Metropolitan Area Transit Authority (WMATA)
- Northern Virginia Transportation Commission (NVTC)
- Montgomery County
- Prince George's County

The Travel Trends report looks at the 2000 – 2006 trends and compares that to the trends of the previous decade, from 1990 – 2000. During the 1990s, the outer suburbs experienced the greatest population changes, with Loudoun County having the largest population increase at 97%. However, both Fairfax County and Montgomery County added more population in absolute terms than Loudoun. During the 1990's there was virtually no net increase in population in the region's Center Area jurisdictions.

Some key findings of the regional travel trends during the 2000 – 2006 time period include:

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[67] *DRAFT Regional Travel Trends Report*, December 28, 2007

- The outer suburbs continue to grow. The greatest amount of population increase in this decade so far have been in the Outer Suburban jurisdictions of Loudoun, Prince William, and Stafford Counties in Virginia, and in Frederick, Charles, and Calvert Counties in Maryland. Loudoun and Prince William counties have already added more population in the first six years of this decade than they did in the entire ten years of the previous decade.
- If the annual growth rates observed in the Outer Suburbs from 2000 – 2006 continue, they will have added almost 500,000 people between 2000 and 2010. This would be significantly more than the 340,000 added in the Inner Suburbs between 1990 and 2000.
- A significant turnaround in the District of Columbia's population growth was seen from 2000 – 2006. Whereas the District lost population between 1990 and 2000, the city experienced a net gain of more than 10,000 residents between 2000 and 2006.
- Similar to the gain in population growth, the Outer Suburbs also experienced the greatest increase in civilian labor force between 2000 and 2006.
- The latest statistics show household vehicle availability growing at the same rate as total population increase. This is different from the 1990's statistics, which show that at that time the number of household vehicles was increasing faster than the total population.
- Weekday Vehicle Miles of Travel (VMT) in the region grew by an average annual rate of 2.4% between 2000 and 2006. This is faster than the increase in population, employment, and vehicle availability.

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.

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)[68]. 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, GPS-based travel time and speed are the performance measures. Each year, a number of "Priority Analysis Corridors" are selected as study targets. Although each corridor is unique, travel conditions between roadways are compared using a calculated measure called "Arterial Mobility". Arterial Mobility is expressed as the ratio (expressed here as a percentage) of the slowest travel time along a given corridor to the speed limit travel time for that same corridor. In 2011, MNCPPC obtained INRIX travel time data through COG, which

[68] Maryland – National Capital Park and Planning Commission (MNCPPC), Mobility Assessment Report (MAR), October, 2011. http://www.montgomeryplanning.org/transportation/reports/mar/

supplemented the traditional GPS floating car travel times, and provided fresh enhancements to the report.

2.8.5 The Regional Transportation Data Clearinghouse

TPB compiles roadway usage data as available, collected from the region's agencies and jurisdictions. These data may come from jurisdictions' regular traffic counting efforts, special studies, permanent count stations, or other sources.

The Regional Transportation Data Clearinghouse program transforms these data into a format associated with the region's travel demand forecasting model. Compiled data are also associated with the estimated capacity of links on the region's roadway network, providing the opportunity to calculate estimated volume-to-capacity (V/C) ratios, a widely-used performance measure.

The goal of the Clearinghouse is to make traffic volume data more accessible, more accurate, and more meaningful. It provides for easy access to a wide variety of traffic volume data for many links in the regional transportation network.

An updated version of the Clearinghouse was released in 2009[69], an update of adding regional transit ridership data has been reported in January 2011[70].

2.9 National Comparison of the Washington Region's Congestion

Regularly since 1982, the Texas Transportation Institute (TTI) releases an *Urban Mobility Report*[71], which outlines and compares urban congestion and mobility in all 439 urban areas across the United States. The most recent report was released in September 2011 and was based on 2010 data from the National Highway Performance Monitoring System (HPMS) and INRIX, Inc.

Since 2007, INRIX, Inc., an independent live traffic information provider based primarily on GPS units equipped on commercial fleets, releases a *National Traffic Scorecard*[72] for the largest 100 metropolitan areas in the U.S. Started in mid-2012, INRIX provides monthly updates to the Scorecard.

Both national reports use several different performance measures, which greatly impacts the rankings of cities (Table 14). For example, the TTI study concludes that the Washington region is ranked as the most congested metro area in the nation, the ranking of the report often cited in the local press. This particular ranking uses travel delay per person as the performance measure.

[69] The *Draft Regional Transportation Data Clearinghouse User Guide* can be found at: http://www.mwcog.org/uploads/committee-documents/al5bXVlY20090627165308.pdf

[70] Regional Transportation Data Clearinghouse – Regional Transit Ridership Data Update, presented to the Travel Forecasting Subcommittee on January 21, 2011. http://www.mwcog.org/uploads/committee-documents/Y15XWVlZ20110121131032.pdf

[71] Texas Transportation Institute (TTI) and the Texas A&M University System. *The 2011Urban Mobility Report*. September, 2011. http://mobility.tamu.edu/ums/report/

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

If a different measure, travel time index (the ratio of travel time in the peak period to travel time under free flow conditions) is used, the Washington region is ranked second. The INRIX report only uses peak period (6 am – 10 am and 3 pm – 7 pm) travel time index[73] as the ranking measure.

Table 14: National Comparison of the Washington Region's Congestion

Measures	Texas Transportation Institute (2010 data)		INRIX National Traffic Scorecard (2011 data)	
	Value	**Rank**	**Value**	**Rank**
Travel time index	1.33	2	**1.16**	**6**
Annul delay per traveler	**74 hours**	**1**	/	/
Total Travel delay	188,650,000 person-hours	4	/	/
Excess fuel consumed	95,365,000 gallons	4	/	/
Congestion cost	$ 3,849 million	4	/	/

There are some limitations to the TTI report. The TTI report provides average conditions across the region, not location-specific information that only a regional congestion monitoring program, such as that done for freeways and arterials in our region, can provide. In addition, even though the methodology has improved over time and attempts to include the impacts of transit, HOV lanes, demand management, and some operational improvements, it tends to apply national average parameters to particular metropolitan areas. For INRIX report, the regional measures are summarized based on segment length rather than vehicle miles of travel (VMT) of the segment (the way TTI does), due mainly to lack of traffic volume information in their data source.

The primary value of the TTI report is not in identifying rankings, but rather in studying how urban areas across the county are doing over time. The report states that the Washington region is not unique in dealing with congestion, stating that congestion is worsening in urban areas of all sizes. However, it also mentions the benefits of congestion management strategies that many cities, such as the Washington, DC area, are considering. Operational and demand management strategies, such as providing more travel options, adding capacity, managing the demand, increasing efficiency of the system, and managing construction and maintenance projects, all noted in the report, are all robust strategies that will continue to be pursued by TPB member agencies.

2.10 Performance and Forecasting Analysis of the 2010 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 30 years. Each year the CLRP is updated to include new projects and programs. TPB produces a performance analysis of every CLRP, which

[73] A term "INRIX Index" is used in the monthly updated INRIX Traffic Scorecard. According to the "Methodology", the INRIX Index represents a percentage point increase in the average travel time of a commute above free-flow conditions during peak hours, i.e., INRIX Index = (Travel Time Index – 1)*100%.

examines trends and assesses future levels of congestion and other performance measures. The 2010 CLRP Performance Analysis[74] 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.

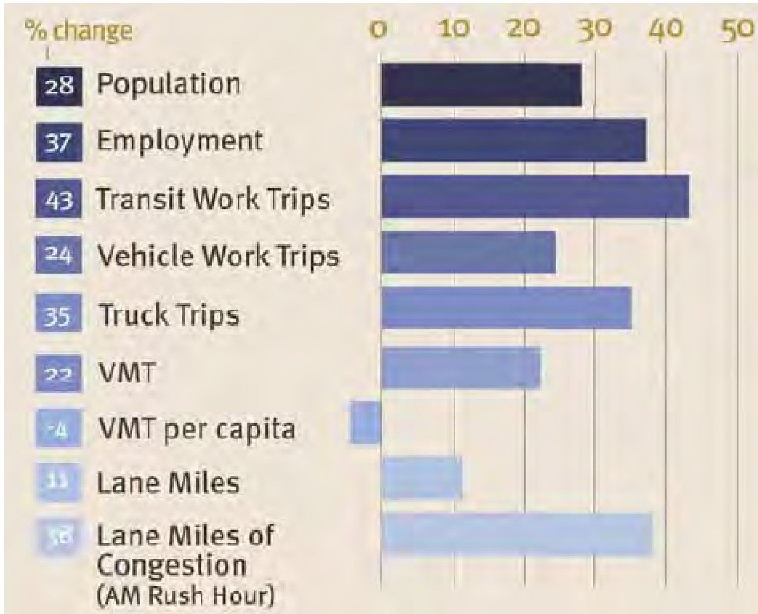
Plan performance analyzes the outlook for growth in the region. One of the cornerstones of plan performance is the forecasting of future congestion. The plan performance looks at where in the region congestion will occur in the future and compares current congestion to future congestion. It looks at 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 2011.

Over the next three decades, increasing population and job growth will lead to additional vehicles, trips, and congestion on the region's transportation system (Figure 52). While vehicle miles of travel (VMT) per capita, which is a measure of how much people drive, is actually forecast to decline slightly, overall VMT is increasing faster than new freeway and arterial lane-miles slated for construction in the plan.

Transit work trips are forecast to increase by 43% as an increasing number of people are expected to use transit to commute to work. This will inevitably create even more crowding on the Metrorail and bus system, since the ability of the system to expand its capacity is limited by funding constraints.

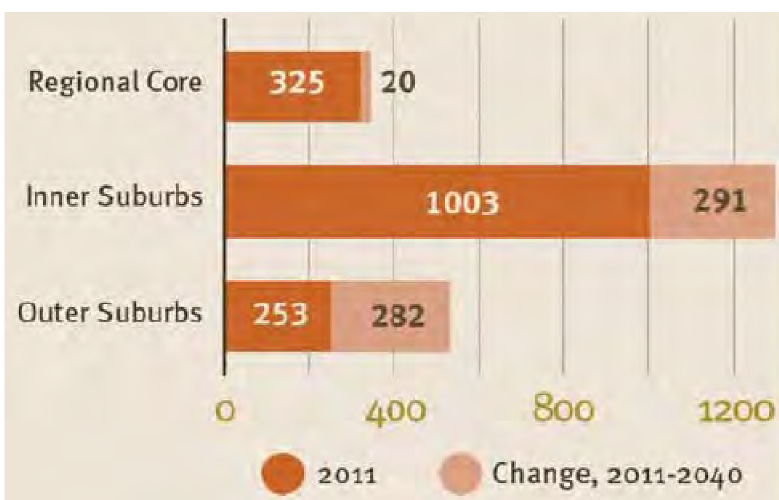
[74] The Financially Constrained Long-Range Transportation Plan (2010), November 2010. http://www.mwcog.org/store/item.asp?PUBLICATION_ID=412

Figure 52: Changes in Travel Pattern and Traffic Conditions between 2011 and 2040



The road network will also experience a gap between forecast demand and additional capacity. Given funding constraints, lane-miles are only expected to increase 11%, while VMT is expected to rise 22%, resulting in a 38% increase in the number of lane-miles of congestion (Figure 53). Nearly all of this congestion will occur in the suburbs, with inner suburban jurisdictions experiencing the worst congestion. The outer suburban jurisdictions, however, will experience the most dramatic increase in congestion, with a 111% increase in lane-miles of congestion by 2040.

Figure 53: Lane Miles of Congestion (AM Rush Hour), 2011-2040

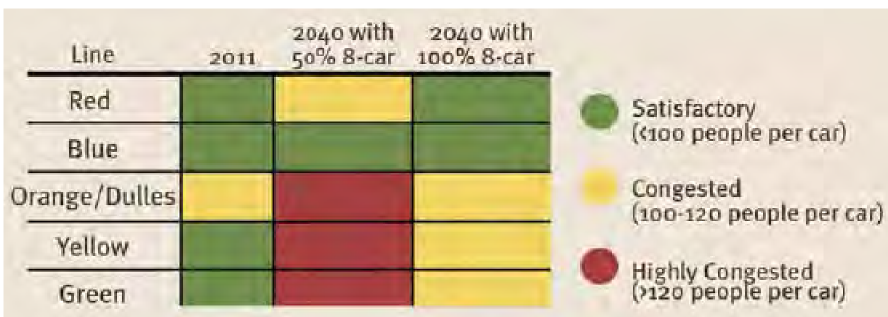


Severe stop-and-go congestion is expected to be prevalent throughout the entire region in 2040, not just in isolated areas. In 2040, there are some areas of forecasted improvement, such as I-95 and I-495 in Virginia, which will benefit from HOT lane projects included in the 2010 CLRP.

Outer suburban jurisdictions in the region will experience the greatest increase in congestion, while the already congested inner suburban jurisdictions will experience the worst overall congestion. Making matters worse, congestion will increasingly not be limited to rush-hour periods, but will also affect off-peak weekday periods and weekends.

Due to a lack of funding for capacity enhancement projects to accommodate all of the projected transit ridership growth in the region, the Metrorail system will likely reach capacity on trips to and through the regional core. According to a WMATA study (Figure 54), without additional railcars beyond those currently funded, all lines entering the core will become congested by 2040, and the Orange/Dulles, Yellow and Green lines are forecast to be highly congested.

Figure 54: Metrorail AM Congestion at Maximum Load Points, 2011-2040



Another way to measure the performance of the plan is by residents' accessibility to jobs by transit and auto, as shown in Figure 55 and Figure 56. The average accessibility to jobs by auto is expected to increase slightly between 2011 and 2040, and accessibility by transit is forecast to increase more significantly. However, overall accessibility by transit will still remain less than by auto (Figure 57).

Figure 55: Job Accessibility by Transit, 2011-2040

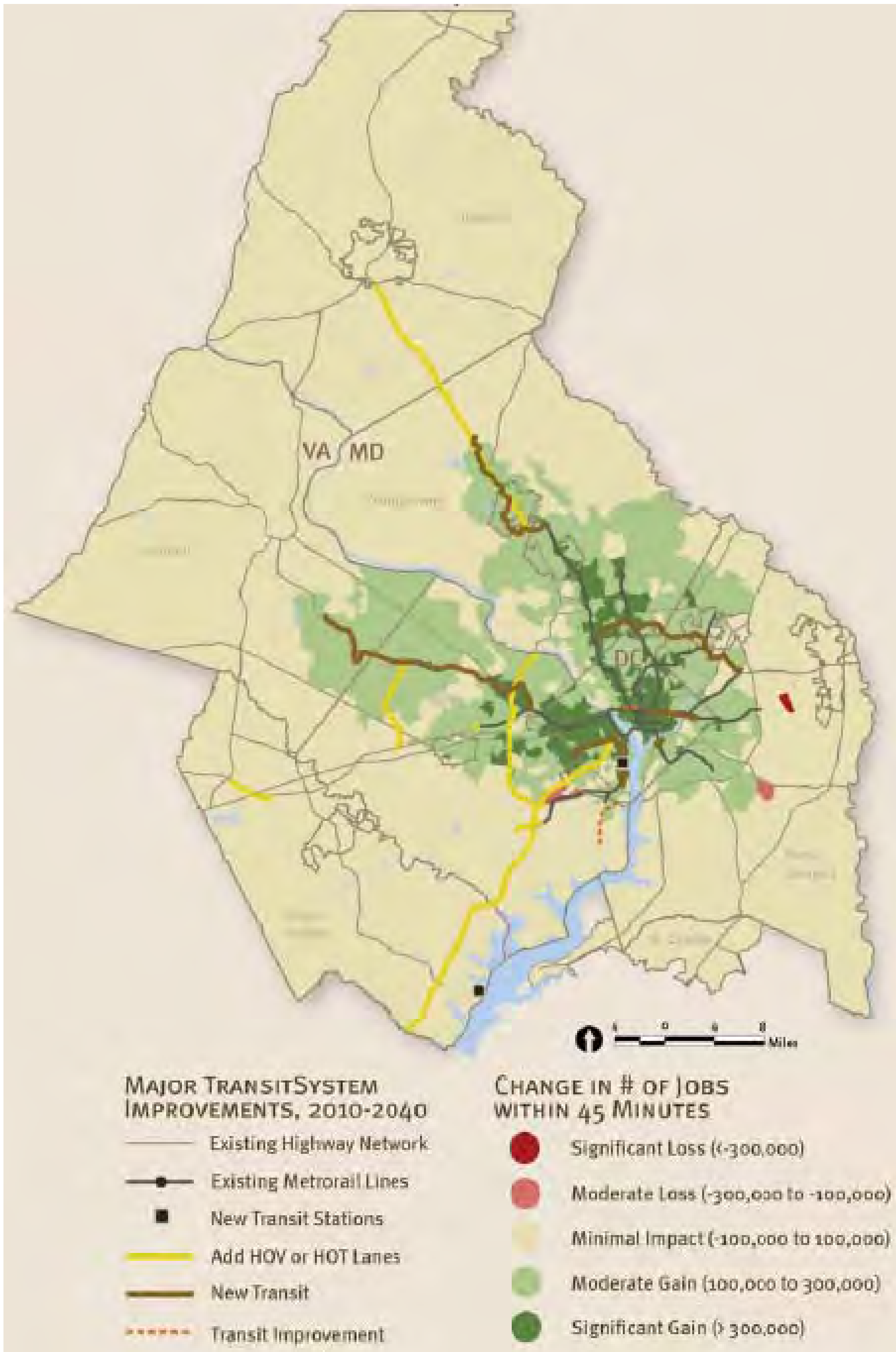


Figure 56: Job Accessibility by Auto, 2011-2040

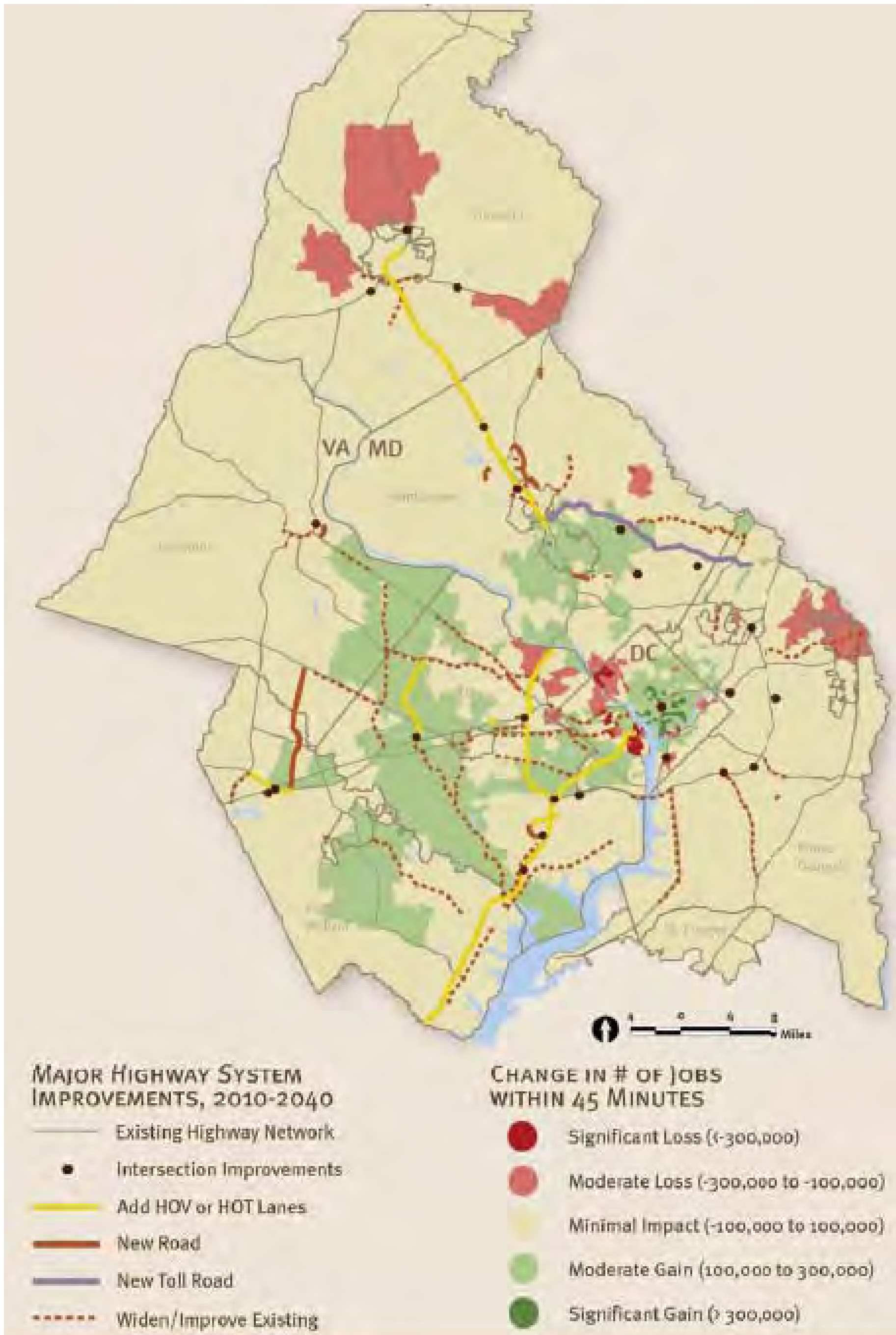
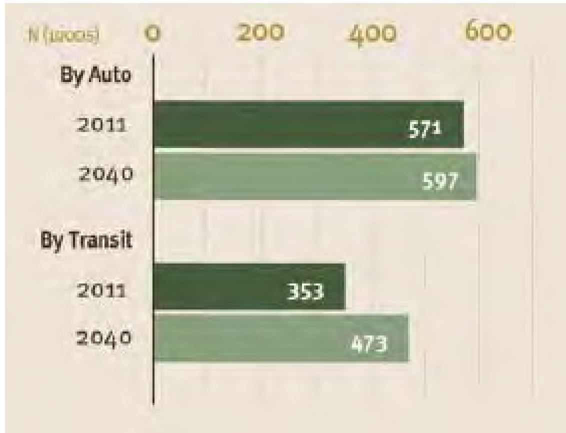


Figure 57: Average Number of Jobs Accessible within 45 Minutes, 2011-2040

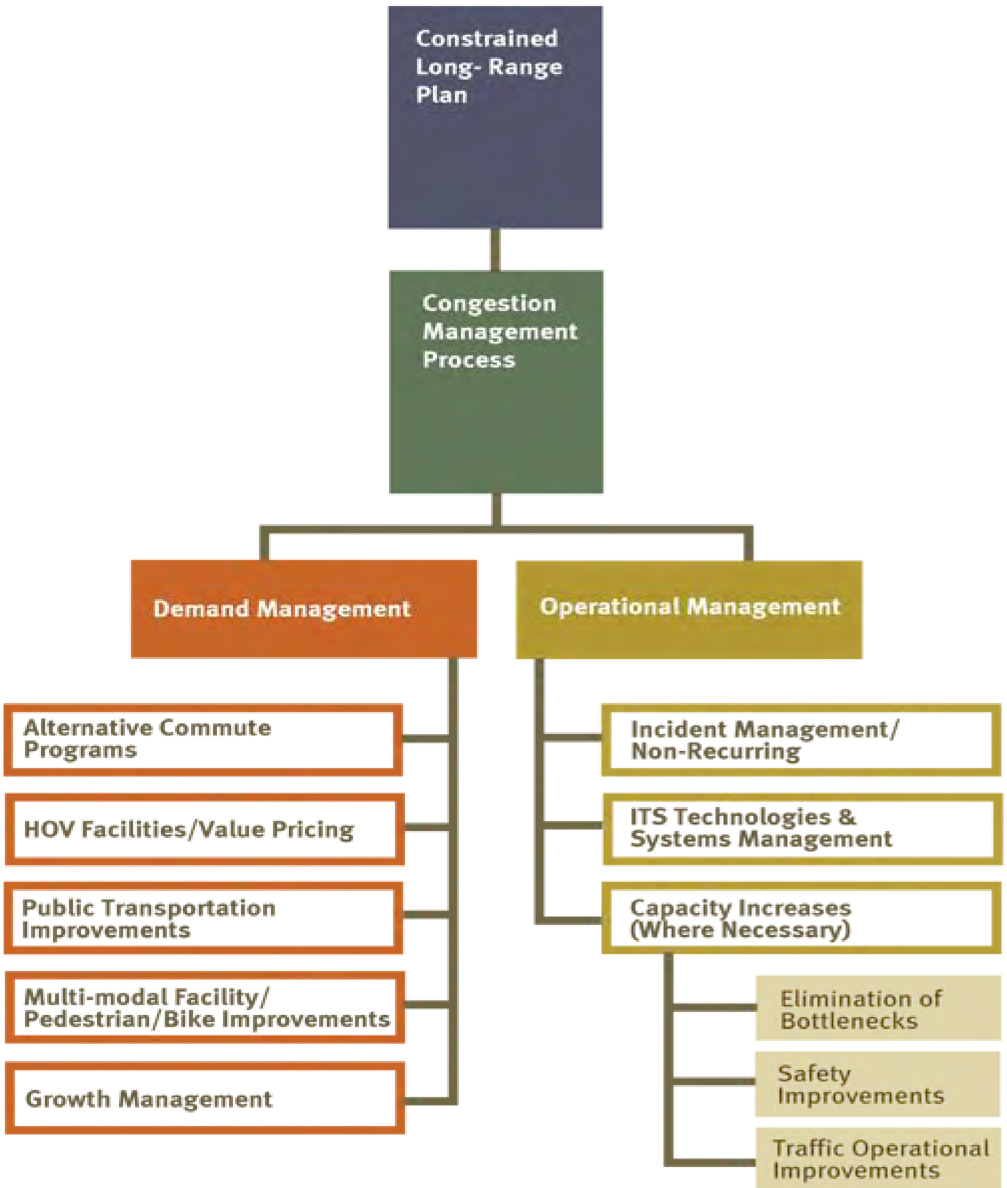


3. CONSIDERATION AND IMPLEMENTATION OF CONGESTION MANAGEMENT STRATEGIES

3.1 Overview of Demand Management and Supply Management

Congestion Management Strategies generally can be divided into two types – Demand Management strategies and Operational, or Supply Management strategies, as shown in Figure 58.

Figure 58: Major CMP Strategies



Note: There are synergies between demand management and operational management strategies, such real-time traveler information on ridesharing opportunities responsive to a real-time traffic incident or situation.

Demand Management is aimed at reducing the demand for travel and influencing travelers behavior; either overall or by targeted modes. Demand Management strategies can include carpooling, vanpooling, telework programs that allow people to work from home to reduce the amount of cars on the road, and living near your work as a means of reducing commute travel.

Supply management, on t he other hand, is managing and making better use of existing transportation modes in order to meet the region's transportation goals and ultimately improve congestion. Example supply management strategies are High-Occupancy Vehicle (HOV) lanes, variably priced lanes, transit systems, and nontraditional modes.

These strategies, and how they are implemented throughout the Washington region, are explained in further detail below. It should be noted that although strategies are divided into two categories, many times demand management and operational management strategies work together and are not stand-alone strategies.

3.2 Demand Management Strategies

3.2.1 Commuter Connections Program

Commuter Connections is a regional network, coordinated by COG/TPB, which provides commuter information and commuting assistance services to those living and working in the Washington, DC region. This program has been in existence since the 1970's under different names and has implemented a number of demand management strategies in the region. The Commuter Connections program is designed to inform commuters of the availability and benefits of alternatives to driving alone, and to assist them in finding alternatives to fit their commuting needs. The program is funded by the District of Columbia, Maryland, and Virginia Departments of Transportation, as well as the U.S. Department of Transportation, and all services are provided free to the public and employers. Continuing the Commuter Connections Program is one of the key recommendations of the 2012 CMP Technical Report.

Commuter Connections evaluates the impacts of their programs through the Commuter Connections Transportation Demand Management Evaluation Project.[75] The evaluation process allows for both on-going estimation of program effectiveness and for annual and triennial evaluations.

Both qualitative and quantitative types of performance measures are included in the evaluation process to assess effectiveness. First, measures reflecting commuters' and users' awareness, participation, utilization, and satisfaction with the program, and their attitudes related to transportation options are used to track recognition, output, and service quality. Some of the important performance measures are:

- Vehicle trips reduced
- Vehicle miles of travel (VMT) reduced

[75] *Transportation Emission Reduction Measure (TERM) Analysis Report FY 2006-2008*, January 27, 2009.

- Emissions reduced: Nitrogen Oxides (NOx), Volatile Organic Compounds (VOC), Particulate Matter (PM2.5), PM 2.5 pre-cursor NOx, and CO_2 emissions (Greenhouse Gas Emissions - GHG)

Particularly of interest to congestion management is the impact on vehicle trips reduced, vehicle miles of travel (VMT) reduced, and cost effectiveness. Appendix E shows the summary of results for individual terms (i.e., how many daily vehicle trips were reduced and the daily VMT reduced compared to the goals set by Commuter Connections).

Commuter Connections also operates the Commuter Operations Center (COC), providing direct commute assistance services, such as carpool and vanpool matching through telephone and internet assistance to commuters. The Commuter Operations Center also provides transit, bicycling, park and ride lot, and telecommuting information to commuters in the region.

In addition, a variety of surveys (the following lists a subset of them) are conducted by Commuter Connections to follow-up with program applicants and assess user satisfaction on TERMs. These surveys provide data used to estimate program impacts. Some of the surveys, such as the Applicant Placement survey and Guaranteed Ride Home (GRH) Survey, also provide information used by Commuter Connections staff to fine tune program operations and policies.

- ***Commuter Connections Applicant Placement Rate Survey*** – Since May 1997 Commuter Connections has conducted commuter applicant placement surveys to assess the effectiveness of the Commuter Operations Center and other program components. The surveys assess users' perceptions of and satisfaction with the services provided.
- ***GRH Applicant Survey*** – Commuters who register with the GRH program or use a one-time exception trip will be surveyed to establish how the availability and use of GRH influenced their decision to use an alternative mode and to maintain that mode. Satisfaction with GRH services also will be polled.
- ***State of the Commute Survey (SOC)*** – The SOC survey, a random sample survey of employed adults in the Washington metropolitan region, serves several purposes. First, it establishes trends in commuting behavior, such as commute mode and distance, and awareness and attitudes about commuting, and awareness and use of transportation services, such as HOV lanes and public transportation, available to commuters in the region.
- ***Employee Commute Surveys*** – Some employers conduct baseline surveys of employees' commute patterns, before they develop commuter assistance programs and follow-up surveys after the programs are in place.
- ***Employer Telework Assistance Follow-up Survey*** – Sent to employers that received telework assistance from Commuter Connections to determine if and how they used the information they received.
- ***Bike-to-Work Day Participant Survey*** – A survey among registered participants in the Bike-to-Work Day event is undertaken to assess travel behavior before and after the Bike-to-Work Day, as well as commute distance and travel on non-bike days.

- ***Carshare Survey*** – A survey about the experiences of carshare users and the impact carsharing has on travel patterns in the region. The survey examines characteristics of carshare trips, travel changes made in response to carshare availability, and auto ownership and use changes in response to carshare availability.
- ***Vanpool Driver Survey*** – a survey that collects data on van ownership and operation, vanpool use and travel patterns, availability and use of vanpool assistance and support services, and issues of potential concern to vanpool drivers.

Transportation Emission Reduction Measures (TERMs) Evaluation

With the introduction of Clean Air Amendments in the 1990's reducing vehicle emissions became important in the region. Analysis showed that enhancing existing and introducing new demand management strategies will have a two-fold impact; reducing congestion and at the same time reducing emissions and clearing the air of ozone causing pollutants. These programs were called as Transportation Emissions Reduction Measures (TERMs) and the regional programs were implemented through the Commuter Connections Program, in concert with program partners to meet air quality conformity and federal clean air mandates. Commuter Connections sets goals on TERM programs that impact commute trips[76], and evaluates the TERMs to determine the impact they are having on reducing congestion and vehicle emissions. These TERMs include:

- ***Guaranteed Ride Home (GRH)*** – Eliminates a barrier to use of alternative modes by providing free rides home in the event of an unexpected personal emergency or unscheduled overtime to commuters who use alternative modes.

- ***Employer Outreach*** – Provides regional outreach services to encourage large, private-sector and non-profit employers voluntarily to implement commuter assistance strategies that will contribute to reducing vehicle trips to worksites, including the efforts of jurisdiction sales representatives to foster new and expanded trip reduction programs.

- ***Mass Marketing*** – Involves a large-scale, comprehensive media campaign to inform the region's commuters of services available from Commuter Connections as one way to address commuters' frustration about the commute. Projects associated with this program include a regional Bike to Work Day event, Car free day event, and the 'Pool Rewards rideshare incentive program.

- ***'Pool Rewards*** - 'Pool Rewards is a special incentive program available through Commuter Connections designed to encourage current drive alone commuters to start ridesharing in the Washington Metropolitan region. Commuters who currently drive alone to work may be eligible for a cash payment through 'Pool Rewards when they start or join a new carpool. If eligible, each carpool member can earn $2 per day ($1 each way) for each day they carpool to work over a consecutive 90-day period. The maximum

[76] The region has adopted and implemented TERMs other than those in the Commuter Connections program. Some other TERMs, such as for Signal Timing Optimization, may also impact congestion. Others, such as for emissions control equipment on heavy-duty diesel vehicles, impact only emissions.

incentive for the 90-day trial period is $130. Carpools may consist of two or more people. For commuters who drive alone to work and can get at least seven people together to form a vanpool, they may qualify for a $200 monthly 'Pool Rewards subsidy for the new vanpool.[77]

Both the TERM evaluation and associated surveys are keys to assessing the impact these programs have on congestion management and air quality. Following is a more detailed analysis on the above TERMs and other Commuter Connections demand management strategies in the region.

Telework

Teleworking, or telecommuting, can be described as a means of using telecommunications and information technology to replace work-related travel. This can be done by working at one's home, or at a designated telework center one or more days a week. There are designated telework centers throughout the region, in the District, Maryland, and Virginia. Phones, wireless communications, fax machines, and computers make teleworking an easy alternative to getting in a car and driving long distances to an office. Teleworking has shown to boost the quality of life, have economic benefits, reduce air pollution, and ease traffic congestion.

Telework is a TERM evaluated by Commuter Connections. Telework Outreach is a resource service to help employers, commuters, and program partners initiate telework programs. In evaluating teleworking, several travel changes need to be assessed, including: trip reduction due to teleworking, the mode on non-telework days, and mode and travel distance to telework centers.

Telework impacts are primarily estimated from the State of the Commute survey (SOC) and by surveys conducted of employers directly requesting information from Commuter Connections. The most recent SOC survey[78] concluded the following regarding teleworking:

- Teleworkers accounted for 25% of all regional commuters. That is, workers who travel to a main work location on non-telework days.[79]
- An additional 21% of commuters said they "would and could" telework, that is, they have job responsibilities that could be done while teleworking and would be interested in teleworking, if given the opportunity.
- Almost half of those surveyed (48%) said they teleworked at least one day a week.

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[77] http://www.mwcog.org/commuter2/commuter/ridesharing/PoolRewardsLandingpage.html

[78] *2010 Commuter Connections State of the Commute Survey*. Prepared for Metropolitan Washington Council of Governments. Prepared by: LDA Consulting, Washington, DC. In conjunction with: CIC Research, San Diego, CA. June 2008.
http://www.mwcog.org/commuter2/pdf/publication/2010-StateOftheCommute-Final.pdf

[79] Using this base of commuters excludes workers who are self-employed and for whom home is their only workplace.

The *TERM Analysis Report for FY 2009-2011* estimated the impacts of teleworking. The following are some noteworthy statistics from that report:

- In 2011, a pproximately 600,000 regional workers were telecommuting at least occasionally, about 23.5% of the total workforce and 25% of all workers who are not self-employed, working only at home. This number of teleworkers represented an increase of 31% over the 200 number of 456,000 teleworkers and several times the 1996 baseline of 150,900 teleworkers.
- The Maryland and Virginia Telework TERM reduced 12,499 da ily vehicle trips and 241,834 VMT. These numbers reflect growth after the most recent Travel Forecasting Model calibration.

Employer Outreach

Employer Outreach is aimed at increasing the number of private and non-profit employers implementing worksite commuter assistance programs, and is ultimately designed to encourage employees of client employers to shift from driving alone to alternative modes.

In this TERM, jurisdiction-based sales representatives contact employers, educate them about the benefits commuter assistance programs offer to employers, employees, and the region and assist them to develop, implement, and monitor worksite commuter assistance programs.

The *TERM Analysis Report for FY 2009-2011* estimated the impacts of employer outreach. The following are some noteworthy statistics from that report:

- Employers participating in Employer Outreach substantially exceeded the goal, with 1,119 participating employers compared to the goal of 581.

- Estimated trip reduction and VMT reduction as well as emission reductions for Employer Outreach met and exceeded the goals for this TERM.

Live Near Your Work

Population and growth can be considered a wonderful thing for a region, but with it comes side effects of congestion. The trend of employees living further from their job is worsening, creating longer commutes. 'Live Near Your Work' is a program to help bridge the gap between the workplace and home. The program is primarily geared towards employers in an attempt to improve their employees' work-life balance. In turn, the results of employees living closer to where they work can reduce the number of cars on t he road, which ultimately can ease congestion and have positive environmental impacts.

To promote the 'Live Near Your Work' initiative, Commuter Connections provides housing information in an online Employer's Resource Guide. The tool highlights various housing programs and resources available for the Washington area workforce and aims to assist employees with moving closer to where they work. This guide also provides a list of flexible commuter options available through Commuter Connections. Used in tandem, employers have a number of ways to provide the information workers need to make living near and getting to work a reality. Employers can work with their internal staff to find and execute the right fit for their employees, and ultimately help everyone feel "more connected." Employers can find that this can have a true impact on their bottom line.

Carpooling, Vanpooling, Ridesharing and other Commuter Resources

Commuter Connections provides information on carpooling, vanpooling, and Ridesharing. These alternative commute methods reduce the amount of single occupant vehicles (SOVs) on the road, which is important to congestion management.

- ***Carpooling*** is two or more people traveling together in one vehicle, on a continuing basis.

- ***Vanpooling*** is when a group of individuals (usually long-distance commuters) travel together by van, which is sometimes provided by employers. There are typically three kinds of vanpool arrangements:

    - *Owner-operated vans* — An individual leases or purchases a van and operates the van independently. Riders generally meet at a central location and pay the owner a set monthly fee.

    - *Third-party vans* — A vanpool "vendor" leases the vanpool vehicle for a monthly fee that includes the vehicle operating cost, insurance, and maintenance. The vendor can contract directly with one or more employees. The monthly lease fee is paid by the group of riders.

    - *Employer-provided vans* — The employer (or a group of employers) buys or leases vans for employees' commute use. The employer organizes the vanpool riders and insures and maintains the vehicles. The employer may charge a fee to ride in the van or subsidize the service.

- ***Ridematching Services*** enables commuters to find other individuals that share the same commute route and can carpool/vanpool together. This provides carpooling options for people who may not know of someone to carpool with, thus broadening the carpooling options

Bike To Work Day

Each May thousands of area commuters participate in Bike to Work Day (http://www.biketoworkmetrodc.org/), sponsored by Commuter Connections and the Washington Area Bicyclist Association.[80] The TPB has a Bike to Work Day Steering Committee which coordinates the event each year.

Bike to Work Day encourages commuters to try bicycling to work as an alternative to solo driving. The program has grown enormously attracting nearly 11,000 bicyclists in 2011.

Biking and other nontraditional modes are expanded upon in Section 3.2.4.

[80] http://www.mwcog.org/commuter2/commuter/bicycling/biketoworkday.html

3.2.2 Local and Other Transportation Demand Management and Traffic Management Activities

Local agencies and organizations, such as local governments and Transportation Management Areas (TMAs) are doing their part to promote alternative commute methods and other demand management strategies. Table 15 provides detailed information on s pecific ongoing demand management strategies in the Washington region.

Table 15: Ongoing State Local Jurisdictional Transportation Demand Management (TDM) Strategies

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
Region-w ide	Region-w ide	WMATA	Public Transportation Improvements	Demand	Metrobus transit	Public bus service available throughout the region. Connects to other modes: Metrorail, commuter rail, park-and-ride lots, etc.	http://w mata.com/bus/
Region-w ide	Region-w ide	WMATA	Public Transportation Improvements	Demand	Metrorail transit	Public rail services DC, MD, and VA. Connects to commuter rail, Metrobus and local bus systems.	http://w mata.com/rail/
Region-w ide	Region-w ide	WMATA	Park-and-ride lot improvements	Demand	Metrorail station park-and-ride lots	Parking offered at 42 Metrorail stations.	http://w mata.com/rail/parking/
State/Multi-jurisdictional	Maryland State-w ide	MDOT	Pedestrian, Bicycle, and Multimodal Improvements	Demand	Maryland Bicycle and Pedestrian Advisory Committee (MBPAC)	Provides information on biking, w alking. Master Plan guides bike/ped planning in the State.	http://w w w .mdot.state.md.us/Planning/Bicycle/BikePedPlanIndex
State/Multi-jurisdictional	Maryland State-w ide	MDOT	Telecommuting	Demand	MDOT's Telew ork Partnership w ith Employers/Telew orkBaltimore.com program	Offers free telew orking consulting services to Maryland employers. Promotes telew orking.	http://w w w .mdot.state.md.us/Planning/Telew ork%20Partnership%20Web%20Page/Telew ork%20Partnership%20w ith%20Employers
State/Multi-jurisdictional	Maryland State-w ide	MTA	Employer outreach / mass marketing	Demand	MDOT's Commuter Choice Maryland	Reaches out to Maryland employers and offers incentives to implement a commuter program.	http://w w w .commuterchoicemaryland.com/
State/Multi-jurisdictional	Maryland State-w ide	MTA	Public Transportation Improvements	Demand	MDOT's MARC train	Maryland MTA Public commuter rail serving Montgomery County, Prince William County, Frederick County, and into DC.	https://w w w .mtamaryland.com/services/marc/index.cfm

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
State/Multi-jurisdictional	Maryland State-w ide	MTA	Public Transportation Improvements	Demand	Local bus	Maryland MTA Public bus service throughout Maryland, primarily around the Baltimore-DC area.	https://w w w .mtamaryland.com/services/bus/routes/bus/
State/Multi-jurisdictional	Maryland State-w ide	MTA	Public Transportation Improvements	Demand	Commuter Bus	Maryland MTA Commuter bus service in Maryland and DC's inner-ring suburbs.	https://w w w .mtamaryland.com/services/commuterbus/
State/Multi-jurisdictional	District-w ide	DDOT	Pedestrian, Bicycle and Multimodal Improvements	Demand	Bicycle and Pedestrian Programs	Committed to providing safe and convenient bicycle and pedestrian access throughout the City.	http://ddot.dc.gov/DC/DDOT/On+Your+Street/Bicycles+and+Pedestrians
State/Multi-jurisdictional	District-w ide	Partnership of DDOT and Arlington, VA	Bicycle Programs	Demand	Capital Bikeshare	A bikesharing program to encourge the use of bicyles.	http://capitalbikeshare.com/
State/Multi-jurisdictional	District-w ide	DDOT	Carsharing Programs	Demand	DDOT Carsharing Initiative	A netw ork of vehicles offered for rent to the public. Allow s mobility of a car w ithout ow ning one.	http://ddot.dc.gov/DC/DDOT/On+Your+Street/Car+Sharing?nav=1&vgnextrefresh=1
State/Multi-jurisdictional	District-w ide	DDOT	Public Transportation Improvements	Demand	DDOT Mass transit	DDOT helps coordinate mass transit w ith agencies and WMATA.	http://ddot.dc.gov/ddot/cw p/view ,a,1250,q,638123,ddotNav_GID,1586,ddotNav,%7C32399%7C.asp
State/Multi-jurisdictional	Takoma Park and Takoma Park, MD	DDOT	Grow th Management	Demand	DDOT's Takoma Transportation Study	A study done for Takoma area of DC and adjacent Takoma Park, MD. Study recommends pedestrian, bicycle, transit, and road improvements.	http://ddot.w ashingtondc.gov/ddot/cw p/view ,a,1249,q,561963.asp
State/Multi-jurisdictional	District-w ide	DDOT	District TDM Program	Demand	goDCgo	goDCgo is an initiative of DDOT that is designed to help reduce congestion and improve air quality in the District through the promotion of sustainable	http://godcgo.com/

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
State/Multi-jurisdictional	Dow ntow n DC	Partnership of DDOT, WMATA, and DC Surface Transit	Public Transportation Improvements	Demand	DC Circulator	A public bus system serving the District.	http://w w w .dccirculator.com/DCCirculator.html#home
State/Multi-jurisdictional	Virginia-statew ide	VDRPT	Telecommuting	Demand	Telew ork!VA	Primary resource for Virginia's employers to start a telew ork program in VA, promotes telew orking.	http://w w w .telew orkva.org/
State/Multi-jurisdictional	Northern Virginia	VDOT	Variably Priced HOT Lanes	Demand/Operational	I-495/Capital Beltw ay HOT Lanes	Construction of high occupancy toll (HOT) lanes that use congestion pricing to manage contgestion on the Beltw ay in Virginia	http://www.vamegaprojects.com
State/Multi-jurisdictional	Virginia-statew ide	Virginia TAX and VDRPT	Telecommuting	Demand	Virginia Telew ork Tax Credit	Qualifying businesses in Virginia can claim a tax credit up to $50,000 to offset expenses for equipment for new telew orkers and a telew ork assessment.	http://w w w .telew orkva.org/
State/Multi-jurisdictional	Northern Virginia	VDOT and VDRPT	Transportation Management Program	Demand/ operational	Virginia Megaprojects Regional, Dulles Rail, and Beltw ay HOT lanes TMP's	Various targeted TDM and Transit improvements to mitigate impacts and delays caused by construction of large scale projects in Northern Virginia	http://w w w .vamegaprojects.com
State/Multi-jurisdictional	Northern Virginia	VDOT and VDRPT	Employer Outreach	Demand	Virginia Megaprojects Employer Solutions Team	The Employer Solutions helps employers create new approaches or enhance existing TDM services to keep employees moving during construction of the I-495 HOT lanes and Phase I of the Dulles Metrorail project.	http://w w w .vamegaprojects.com/employer-solutions/

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
State/Multi-jurisdictional	Northern Virginia	VDOT, VDRPT, Loudoun County, and PRTC	Public Transportation Improvements	Demand	Tysons Express Bus Service	Regional bus services to Tysons Corner that removes auto trips from the construction zones for the Megaprojects projects.	http://www.drpt.virginia.gov/news/details.aspx?id=452
State/Multi-jurisdictional	Northern Virginia	NVRC	Laws and Safety Tips Booklet	Demand	Safety/Outreach	Pocket Booklet	www.bikewalkvirginia.org
State/Multi-jurisdictional	Fairfax and Loudoun Co. VA	VDRPT and MWAA	Public Transportation Improvements	Demand	Dulles Corridor Metrorail Project	In cooperation with WMATA and local governments. Construct an extension of Metrorail to Dulles Airport.	http://www.dullesmetro.com
State/Multi-jurisdictional	I-66, I-95/395 HOV lanes	VDOT/NOVA	HOV Lanes	Demand	I-66 HOV Lanes, Shirley Highway HOV	Lanes available to ridesharers, those carpooling and vanpooling, and transit vehicles	www.VDOT.Virginia.gov
State/Multi-jurisdictional	Virginia Statewide	VDRPT and AMTRAK	Public Outreach	Demand	AMTRAK Virginia	Promotes AMTRAK passenger rail service in Virginia	http://www.amtrakvirginia.com
State/Multi-jurisdictional	Virginia Statewide	VDOT	Traffic Management	Operational	I-66 ATM	Promote safety and congestion management	none
State/Multi-jurisdictional	Virginia Statewide	VDOT	TDM and Traffic management	Operational	I-95 ICM	Promote safety and congestion management	none
State/Multi-jurisdictional	Loudoun, Fairfax, Arlington, and Prince William Counties	Northern Virginia Transportation Authority	Public Transportation Improvements	Demand	NVTA's TransAction 2030 Regional Transportation Plan	Identifies a number of public transit improvements, including new park-and-ride lots throughtout Northern VA.	http://www.thenovaauthority.org/projects.html

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
State/Multi-jurisdictional	Loudoun, Fairfax, Arlington, and Prince William Counties	Northern Virginia Transportation Authority	Alternative Commute Programs	Demand	NVTA's Mission of the Authority	Responsibilities include a general oversight of regional congestion mitigation, including carpooling, vanpooling, and other commute programs	http://w w w .thenovaauthority.org/mission.html
State/Multi-jurisdictional	Northern VA and the District of Columbia	VRE	Public Transportation Improvements	Demand	VRE	Commuter rail serving Northern VA and tw o stations in the District. Connects to local transit.	http://w w w .vre.org/index.html
State/Multi-jurisdictional	Prince William Co., Manassas, and several locations in VA & DC	PRTC	Public Transportation Improvements	Demand	PRTC's OmniRide	Commuter bus service along I-95 and I-66 corridor in Prince William Co., Manassas, and to several locations in VA & DC, including Metrorail stations.	http://w w w .prtctransit.org/omniride/index.php
State/Multi-jurisdictional	Eastern Prince William Co. and Manassas	PRTC	Public Transportation Improvements	Demand	PRTC's OmniLink	A local bus service in Eastern Prince William Co. and Manassas	http://w w w .prtctransit.org/omnilink/index.php
State/Multi-jurisdictional	Prince William Co. and Manassas	PRTC	Ridematching Services	Demand	PRTC's OmniMatch	A free ridematching service for carpooler and vanpoolers originating in Prince William Co and Manassas.	http://w w w .prtctransit.org/omnimatch/index.php
State/Multi-jurisdictional	I-66, I-95/395 HOV lanes	VDOT/NOVA	HOV Lanes	Demand	I-66 HOV Lanes, Shirley Highw ay HOV	Lanes available to ridesharers, those carpooling and vanpooling, and transit vehicles	http://w w w .VDOT.Virginia.gov
State/Multi-jurisdictional	Fairfax, Loudoun, and Prince William Counties	VDOT/NOVA	Park-and-Ride Lots	Demand/ operational	Commuter Park-and-Ride lots	Provides and maintains numerous park-and-ride lots	w w w .virginiadot.org/travel/pnrlots.asp

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
State/Multi-jurisdictional	Fairfax, Loudoun, and Prince William Counties	VDOT/NOVA	Bicycle Lockers	Demand/ operational	Bicycle Locker Rental Program	Provides reserved bicycle lockers at several Park-and-Ride lots for an annual rental fee	http://w w w .virginiadot.org/travel/nova-mainBicycle.asp
State/Multi-jurisdictional	Northern Virginia	MWAA	HOV Lanes	Demand	Dulles Toll Road HOV Lanes	Lanes available to rideshares, Those carpooling and vanpooling, And transit vehicles	w w w .mw aa.com
State/Multi-jurisdictional	District of Columbia, Arlington County, and City of Alexandria	Local	Bike Rental	Demand	Capital Bikeshare	Short-term bicycles for rent	www.capitalbikeshare.com
State/Multi-jurisdictional	NOVA	DRPT	Transit and TDM	Demand	SuperNOVA Transit and TDM	Transit/TDM vision planning	none
State/Local	NOVA	VDOT/Local	Bike Lanes	Demand	Road Diet	Improve safety and mobility	none
County	Throughout Montgomery County	Montgomery County, MD	Park-&-Ride lots: Provision, maintenance & improvements	Demand	Montgomery County Park-and-Ride Lots	Provide park-and-ride lots information in the County.	http://w w w .montgomerycountymd.gov/tsvtmpl.asp?url=/content/DOT/transit/routesandschedules/brochures/parklots.asp
County	Throughout Montgomery County MD	MCDOT/Commuter Services Section	Alternative Commute Programs	Demand	MCDOT TDM Programs & Services - available throughout the	Provides information on alternative commute options: carpooling, biking, employer incentives, all other TDM services & strategies	http://w w w .montgomerycountymd.gov/commute
County	Throughout Montgomery County MD	MCDOT/Commuter Services Section & other offices w ithin MCDOT; M-NCPPC	Grow th Management	Demand	TDM for Development Review	Coordinates TDM strategies required in new developments	http://w w w .montgomerycountymd.gov/commute

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
County	Throughout Montgomery County MD	MCDOT/Commuter Services Section & Traffic Engineering	Alternative Commute Programs – Bicycling	Demand	Bicycling Resources	Bike/transit maps for County and individual service areas. Bike resources	http://www.montgomerycountymd.gov/commute http://www2.montgomerycountymd.gov/DOT-DTE/BikeWays/BWHome.aspx
County	Throughout Montgomery County MD	MCDOT/Commuter Services Section	Telework Incentive Program	Demand	Telework Resources	Laptops and consulting services available to employers exploring or adopting telework	http://www.montgomerycountymd.gov/commute
County	Throughout Prince George's County	Prince George's County Dept. of Public Works and Transportation	Alternative Commute Programs	Demand	Prince George's County Ride Smart Commuter Solutions	Provides information on commuter services available in Prince George's County.	http://www.ridesmartsolutions.com/
County	Throughout Prince George's County	Prince George's County Dept. of Public Works and Transportation	Park-and-ride lot improvements	Demand	Prince George's County Park-and-Ride Lots	There are 15 free park-and-ride lots available in Prince George's County.	http://www.goprincegeorgescounty.com/Government/AgencyIndex/DPW&T/Transit/park_ride.asp?nivel=foldmenu(2)
County	Throughout Prince George's County	Prince George's County Dept. of Public Works and Transportation	Improving accessibility to multimodal options	Demand	Prince George's County Call-A-Bus	Bus service available to all residents of Prince George's County who are not served by existing bus or rail.	http://www.goprincegeorgescounty.com/Government/AgencyIndex/DPW&T/Transit/bus.asp?nivel=foldmenu(2)
County	Throughout Frederick County	Frederick County, MD	Public Transportation Improvements	Demand	Frederick County TransIt	Public bus and paratransit services.	http://frederickcountymd.gov/index.aspx?nid=105
County	Throughout Frederick County	Frederick County, MD	Alternative Commute Programs	Demand	Frederick County TransIt	TransIt also offers information on alternative commute programs.	http://www.co.frederick.md.us/index.asp?NID=208
County	Throughout Frederick County	Frederick County, MD	Alternative Commute Programs	Demand	TransIT Services of Frederick County	Help business and employees find best transportation solutions	http://www.frederickcountymd.gov/index.aspx?NID=4609
County	Throughout Fairfax County	Fairfax County, VA	Public Transportation Improvements	Demand	Fairfax Connector	Public bus system in Fairfax County. Connects to Metrorail and bus.	http://www.fairfaxcounty.gov/connector/

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
County	Throughout Fairfax County	Fairfax County, VA	Alternative Commute Programs	Demand	Fairfax County RideSources Program	Provides information on alternative commute programs.	http://w w w .fairfaxcounty.gov/fcdot/sources.htm
County	Throughout Fairfax County	Fairfax County, VA	Alternative Commute Programs	Demand	Fairfax County Employer Services Program	Help business and employees find best transportation solutions	http://w w w .fairfaxcounty.gov/fcdot/employer.htm
County	Throughout Fairfax County	Fairfax County, VA	Alternative Commute Programs	Demand	Fairfax County Bike Program	A comprehensive bicycle initiative and program committed to making Fairfax County bicycle friendly	http://w w w .fairfaxcounty.gov/fcdot/bike/
County	Throughout Fairfax County	Fairfax County, VA	Alternative Commute Programs	Demand	Fairfax County Pedestrian Program	A comprehensive Pedestrian Program to provide dedicated resources to meet specific goals	http://w w w .fairfaxcounty.gov/fcdot/pedestrian/
County	Throughout Fairfax County	Fairfax County, VA	Transit	Demand	Fairfax Transit	Study countyw ide transit needs	http://www.fairfaxcounty.gov/FCDOT/2050Transit Study
County	Throughout Arlington County	Arlington County, VA	Public Transportation Improvements	Demand	Arlington Transit (ART)	Public bus service in Arlington. Connects to Metrorail and bus.	http://w w w .commuterpage.com/art/
County	Throughout Arlington County	Arlington County, VA	Alternative Commute Programs	Demand	Getting Around Arlingon	Provides information on alternative commute programs, and public transit.	http://w w w .commuterpage.com/art/villages/arl_tran.htm
County	Throughout Arlington County	Arlington County, VA	Pedestrian, Bicycle and Multimodal Improvements	Demand	Arlington's BikeArlington	Initiative to encourage more people to bike often.	http://w w w .bikearlington.com/about.cfm
County	Throughout Arlington County	Arlington County, VA	Alternative Commute Programs	Demand	Arlington's Car-Free Diet	Promotes alternative commute methods.	http://w w w .carfreediet.com/
County	Throughout Arlington County	Arlington County, VA	Promote Alternate Modes	Demand	WALKArlington	Promotes w alking as an alternative mode.	http://w w w .w alkarlington.com/about/index.html

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
County	Throughout Arlington County	Arlington County, VA	Alternative Commute Programs	Demand	Arlington County's CommuterPage.com	Provides information on transportation options in Arlington and the DC area.	http://www.commuterpage.com/
County	Throughout Arlington County	Arlington County, VA	Growth Management	Demand	Arlington County's TDM Management for Site Plan Developmetn	Coordinates site plan development (proposed land use) with commuter and transit services.	http://www.commuterpage.com/TDM/
County	Throughout Loudoun and from Loudoun to DC	Loudoun County, VA	Public Transportation Improvements	Demand	Loudoun County Transit	Commuter bus service from Loudoun Co. to area park-and-ride lots and downtown DC.	http://inter4.loudoun.gov/Default.aspx?tabid=969
County	Throughout Loudoun County	Loudoun County, VA	Park-and-ride lot improvements	Demand	Loudoun's Free Park-and-Ride lots	Several free park-and-ride lots are available throughout the County.	http://inter4.loudoun.gov/Default.aspx?tabid=959
County	Throughout Loudoun County	Loudoun County, VA	Alternative Commute Programs	Demand	Loudoun's Commuting options	Provides information on alternative commute programs and transit options.	http://inter4.loudoun.gov/Default.aspx?tabid=789
County	Throughout Loudound County	Loudoun County, VA		Demand	Loudoun's Employer Services	Helps businesses identify commuting solutions for employees in Loudound County	http://inter4.loudoun.gov/Default.aspx?tabid=984
County	Throughout Southern Loudoun and in Northern Loudoun to Purcellville	Virginia Regional Transit (in cooperation with Loudoun Co.)	Public Transportation Improvements	Demand	Virginia Regional Transit	Public bus service within Loudoun County.	http://inter4.loudoun.gov/Default.aspx?tabid=898
County	Throughout Prince William County	Prince William County, VA	Park-and-ride lot improvements	Demand	Prince William County Commuter Parking Lots	Goal is to work with VDOT and provide convenient sites to encourage residents to use transit or carpool.	http://www.pwcgov.org//default.aspx?topic=010017001530000797

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
City	The length of College Park, MD	City of College Park, MD	Pedestrian, Bicycle and Multimodal Improvements	Demand	College Park Trolley Trail	Trail is to run the length of the City of College Park, in the old trolley right-of-w ay.	http://w w w .thew ashcycle.com/college_park_trolley_trail/
City	Throughout Greenbelt	City of Greenbelt, MD	Public Transportation Improvements	Demand	Greenbelt Connection	A local bus in Greenbelt; runs upon request.	http://w w w .greenbeltmd.gov/public_w orks/connection.htm
City	Throughout City of Frederick	City of Frederick, MD	Pedestrian, Bicycle and Multimodal Improvements	Demand	Frederick Shared use paths	Promotes the use of, and creates new shared use paths.	http://w w w .cityoffrederick.com/cms/files/maps/shared-use-path.pdf
City	Throughout Falls Church and to the Metro stations	City of Falls Church, VA	Public Transportation Improvements	Demand	Falls Church GEORGE	Local bus system providing service to East and West Falls Church Metrorail stations and throughout the City of Falls Church.	http://w w w .fallschurchva.gov/Content/CultureRecreation/GEORGEmain.aspx
City	Throughout Alexandria	City of Alexandria, VA	Alternative Commute Programs	Demand	Alexandria Rideshare / Local Motion	Promotes use of alternative modes.	http://w w w .alexride.org/
City	Throughout Alexandria	City of Alexandria, VA	Public Transportation Improvements	Demand	Alexandria DASH	Local bus system. Connects to Metrobus and Metrorail, VRE, and other local bus systems.	http://w w w .dashbus.com/
City	Throughout City of Fairfax	City of Fairfax, VA	Public Transportation Improvements	Demand	City of Fairfax's CUE	Public bus service w ithin City of Fairfax. Also connects to Vienna Metrorail station.	http://w w w .fairfaxva.gov/CUEBus/CUEBus.asp
Local / Corridor-based	Along the corridor betw een Baltimore and DC	BWI Business Partnership	Alternative Commute Programs	Demand	BWI Business Partnership Commuter Resources	Provides information on commuter programs available to the BWI area.	http://w w w .bw ipartner.org/index.php?option=com_content&task=view &id=21&Itemid=59
Local / Corridor-based	Dow ntow n Bethesda Transportation Management District (TMD)	MCDOT/Commuter Services Section w ith contractor: Bethesda Transportation Solutions (BTS)	Alternative Commute Programs	Demand	Bethesda TMD	Provides information on alternative commute options: carpooling, biking, employer incentives	http://w w w .bethesdatransit.org/

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
Local / Corridor-based	Downtown Bethesda Transportation Management District (TMD)	MCDOT with contractor: Bethesda Urban Partnership (BUP)	Public Transportation Improvements	Demand	Bethesda Circulator	Downtown Bethesda Circulator Bus	http://www.bethesda.org/parking/circulatorinfo.htm
Local / Corridor-based	North BethesdaTransportation Management District (TMD)	MCDOT/Commuter Services Section with contractor: North Bethesda Transportation Center (NBTC)	Alternative Commute Programs	Demand	N. Bethesda TMD	Provides information on alternative commute options: carpooling, biking, employer incentives	http://www.nbtc.org
Local / Corridor-based	Friendship Heights Transportation Management District (TMD)	MCDOT/Commuter Services Section (CSS)	Alternative Commute Programs	Demand	Friendship Heights TMD	Provides information on alternative commute options: carpooling, biking, employer incentives	http://www.montgomerycountymd.gov/commute
Local / Corridor-based	Silver Spring Transportation Management District (TMD)	MCDOT/Commuter Services Section (CSS)	Alternative Commute Programs	Demand	Silver Spring TMD	Provides information on alternative commute options: carpooling, biking, employer incentives	http://www.montgomerycountymd.gov/commute
Local / Corridor-based	Greater Shady Grove Transportation Management District (TMD)	MCDOT/Commuter Services Section (CSS)	Alternative Commute Programs	Demand	Greater Shady Grove TMD	Provides information on alternative commute options: carpooling, biking, employer incentives	http://www.montgomerycountymd.gov/commute
Local / Corridor-based	Loudoun, Fairfax, and Prince William Counties	Dulles Area Transportation Association (DATA)	Alternative Commute Programs	Demand	DATA Commuter Resources	Advocates for alternative commute programs, transit needs, and transit-oriented development.	http://www.datatrans.org/about.html

Geography	Location	Local Jurisdiction / Organization	Strategy Name	Operational or Demand Mngt. Strategy	Project/Program Name	Description	Website
Local / Corridor-based	Reston	LINK	Alternative Commute Programs	Demand	Reston's LINK Commuter Resources	Provides information on carpooling, vanpooling, and regional bus schedules.	http://www.linkinfo.org/index.cfm
Local / Corridor-based	Tyson's Corner area	Tyson's Transportation Association (TYTRAN)	Alternative Commute Programs	Demand	TYTRAN's Commuter Resources	Provides information on carpooling, vanpooling, park-and-ride lots, and telework locations.	http://www.tytran.org/index.htm
Local / Corridor-based	Northern VA - Loudoun, Fairfax, Prince William	Northern Virginia Transportation Commission (NVTC)	Public Transportation Improvements	Demand	NVTC Research on public transit and HOV performance	NVTC compiles data on regional transit systems and HOV performance.	http://www.thinkoutsidethecar.org/transit.asp
Local / Corridor-based	Northern VA - Loudoun, Fairfax, Prince William	Northern Virginia Transportation Commission (NVTC)	Alternative Commute Programs	Demand	NVTC Commuter Info	Provides information on how to use the region's transit system, bicycle and pedestrian options, HOV schedules, and park-and-ride lots.	http://www.thinkoutsidethecar.org/info.asp
Local / Corridor-based	Eastern Arlington's Potomac Yard neighborhood	Full Access Solutions in Transportation (FAST) for Potomac Yard	Growth Management	Demand	Non-profit, developer-initiated FAST	Aims at reducing single-occupant trips to the growing Potomac Yard area. Promotes transit, biking, walking. Offers discounted Metrobus shuttle.	http://fastpotomacyard.com/index.html

3.2.3 Transit Systems

Transit systems can improve the operation of existing roadways and systems by carrying more passengers than a single-occupant vehicle. They can also be considered demand management strategies in that they can influence a person's traveling behavior and convince them to leave their car at home. Many of the transit systems in the region are operated by transit agencies or local government agencies, including:

- *Alexandria DASH*, a local bus service in Alexandria, Virginia
- *Arlington Transit (ART)*, a bus service in Arlington County, Virginia
- *Bethesda Circulator*, a downtown Bethesda bus service
- *Central Maryland Regional Transit*, a bus service for the City of Laurel and a portion of Prince George's County, with additional services in Anne Arundel and Howard Counties.
- *CUE in City of Fairfax*, a bus service in City of Fairfax, Virginia
- *DC Circulator* bus, serving downtown District of Columbia
- *Fairfax Connector*, a bus service in Fairfax County, Virginia
- *Frederick County TransIT*, a bus service in Frederick County, Maryland
- *GEORGE*, a bus serving Falls Church, Virginia
- *Greenbelt Connection*, bus serving Greenbelt upon request
- *Loudoun County Transit* operates commuter bus services from Loudoun to destinations that include West Falls Church Metro, Rosslyn, the Pentagon, and Washington, D.C., as well as providing services from West Falls Church Metro to and among employment sites in Loudoun County.
- *Maryland Transit Administration (MTA) MARC* train commuter rail, serving District of Columbia and Maryland
- *Montgomery County Ride-On*, a local bus service in Montgomery County, Maryland
- *MTA Local Bus* service throughout Maryland
- *Potomac and Rappahannock Transportation Commission (PRTC)*, providing *OmniLink*, a local bus service in Eastern Prince William County and Manassas, and *OmniRide*, commuter bus services offering service from locations throughout Prince William County and the Manassas and Gainesville areas to destinations that include the Vienna, West Falls Church and Franconia/Springfield Metrorail Stations, the Pentagon, Crystal City, Rosslyn/Ballston, downtown Washington, D.C., Capitol Hill, and the Washington Navy Yard.
- *Prince George's County Call-A-Bus*, serving those in Prince George's County not served by existing bus or rail
- *Prince George's County TheBus*, serving Prince George's County
- *Virginia Railway Express (VRE)* commuter rail serving Virginia and District of Columbia
- *Virginia Regional Transit* (in cooperation with Loudoun County Transit), a bus service in Loudoun County, Virginia
- *Washington Metropolitan Area Transit Authority (WMATA) Metrobus*, serving the entire Washington metropolitan area
- *Washington Metropolitan Area Transit Authority (WMATA) Metrorail*, serving the entire Washington metropolitan area
- *TIGER Grant Supported Priority Bus Network* (anticipated completion: 2016)

While these transit systems are individually very important strategies, it is important to note that they work together to form an entire transit network important to our congestion management system. They work well with other strategies as well, such as VPLs and HOV lanes. In addition, with the help of Intelligent Transportation System (ITS) technologies, Advanced Traveler Information Systems and providing buses with bicycle racks, transit can be even more appealing to travelers.

The latest (2007/2008) regional household travel survey revealed that commuting transit modal share increased from 15.1% in 1994 to 17.7%, and daily transit modal share increased from 5.5% in 1994 to 6.1%[81]. These increases reflect the positive effect of the region's longstanding efforts to promote transit usage.

In 2011, the TPB in, cooperation with WMATA and the State DOTs, began the *Multimodal Coordination for Bus Priority Hot Spots study which* represents further advancement of the implementation of key bus priority improvements on the roadway network in the Washington, DC Metropolitan Area. The study uses bus route frequency and travel speeds in corridors to provide an initial list of "hot spot" locations throughout the region. Through coordination with State DOT's and TPB subcommittees, the locations in the list will be prioritized six locations will move forward to the final phase of the study. The study will conclude with the advancement of design development for bus priority treatments at a subset of locations on the refined "hot spot" list. This design would represent approximately a 15% design, and identify the scope of the infrastructure improvements, but will reflect more of a plan and typical section layouts without detailed assessment of storm water or utility impacts. This study is expected to be completed in June 2012.[82]

University Transit Systems

Many area universities have their own transit systems for students, faculty, staff, and in some cases, visitors. These shuttle systems increase transit options for the university community and help reduce congestion on campus roads. Two examples of university transit systems are Shuttle-UM system at the University of Maryland, College Park and Masons Shuttles at George Mason University. The Shuttle-UM system is one of the nation's largest University transit services with a fleet of over 60 vehicles[83] and a ridership of 2,967,164 during FY 2011.[84] Mason Shuttles has routes that include Vienna Metro Station to/from the Fairfax campus a shuttle between its Fairfax and Prince William campuses, and campus circulators. These routes supplement CUE and Fairfax Connector service. The George Mason shuttle system had an annual ridership of 519,519 in 2009.[85]

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[81] A presentation of the 2007/2008 Household Travel Survey, May 19, 2009. http://www.mwcog.org/uploads/committee-documents/YV5cV1ZX20090520110217.pdf

[82] Multimodal Coordination for Bus Priority Hot Spots Task 2 Technical Memorandum: Development of Regional Hot Spots List

[83] http://www.transportation.umd.edu/shuttle.html

[84] http://www.transportation.umd.edu/images/about/pdfs/DOTS%20ANNUAL%20REPORT%20FY%2011%20FINAL.pdf

[85] http://transportation.gmu.edu/pdf/GMU_FairfaxCampus_TransMgmtPlan_Final.pdf

3.2.4 Pedestrian and Bicycle Transportation

Walking and bicycling is gaining more attention as having positive environmental and health benefits. As a part of the region's transportation network, these activities impact congestion management as well. There are a number of things the Washington region is doing to enhance the area of bicycle and pedestrian transportation to encourage non-motorized transportation.

- Most of the area's local governments have adopted bicycle, pedestrian, trail plans, and/or policies. Bicycle or pedestrian coordinators and trail planners are now found at most levels of government.
- On May 16, 2012, the TPB approved the "Complete Streets Policy for the National Capital Region" which is a directive to all of the TPB member jurisdictions to ensure safe and adequate accommodation, in all phases of project planning, development, and operations, of all users of the transportation network in a manner appropriate to the function and context of the relevant facility.[86]
- Most of the region's transit agencies, including WMATA, have bike racks on their buses. WMATA allows bikes on rail outside rush hour and on week-ends.
- Secure, covered bicycle parking facilities including Bikestation Washington DC[87] adjacent to Union Station and WMATA's newly opened Bike and Ride facility at the College Park Metro Station[88] provide more convenience for multi-mode travelers.
- Local governments are starting to require bicycle parking, as well as provide free on-street racks. DC requires bike parking in all buildings that offer car parking.
- In accordance with federal guidance and new state policies, pedestrian and bicycle facilities are increasingly being provided as part of larger transportation projects. A number of local jurisdictions have implemented transit oriented developments (TODs) and other walkable communities.
- VDOT has altered its secondary street acceptance requirements to mandate that streets built by private developers connect with adjacent streets and future developments in a manner that enhances pedestrian and bicycle access, and that adds to the capacity of the transportation system. Residential streets may be narrower and incorporate traffic calming features.
- Employers are investing in bike facilities at work sites, and developers are including paths in new construction.
- Specific bicycle/pedestrian campaigns are developing to encourage biking/walking, such as WALKArlington, Localmotion, and GoDCGo.[89]
- The Safe Routes to School program, which is administered through the States, provides funding for both hard and soft improvements and programs to encourage children to walk or bicycle to school, improve safety, and reduce congestion and air pollution near schools.
- More and better on line bike and walk routing resources have become available from the private sector. Google Maps offers both walk and bike routing features. Another excellent bike routing resources for the Washington region is RidetheCity.com/dc, which allows users to choose a preferred safety level.

[86] http://www.mwcog.org/uploads/committee-documents/mV1dXl9e20120510092939.pdf
[87] http://home.bikestation.com/washingtondc
[88] http://www.wmata.com/about_metro/news/PressReleaseDetail.cfm?ReleaseID=5225
[89] http://www.walkarlington.com/

Bicycle and pedestrian plans and projects are widespread throughout the Washington region. For example, in the District of Columbia, two major bicycle facilities, the southern portion of the Metropolitan Branch Trail, bike lanes on Pennsylvania Avenue and a cycle track on 15th Street have opened in the last few years. Bicycling and walking have an even greater potential to grow as modes of transportation. Many trips taken by automobile could potentially be taken by bicycle. This is especially true in areas such as Activity Centers and Activity Clusters, where a number of trips are more easily switched from motorized transportation to walking. Many people who live far from their jobs, but closer to transit or a carpool location could walk or bike to transit or the carpool instead of driving. When considering the following statistics, switching from a motor vehicle or bicycling or walking is feasible[90]:

- The median work trip length for all modes in the Washington Metropolitan Statistical Area is 9.3 miles.
- Twenty-five percent of commute trips are less than 4.3 miles, a distance most people can cover by bicycle.
- The median auto driver trip (for all purposes) is only 4 miles, and 25% of all auto driver trips are less than 1.5 miles.
- Auto passenger trips, often children being taken to school, are even shorter, with a median trip distance of 2.8 miles, and 25% of trips less than 1.2 miles.

WMATA released its Metrorail Bicycle and Pedestrian Access Improvements Study in October 2010. The study provides recommendations for WMATA as well as for partnerships beween WMATA and local governments and/or surrounding property owners for cost-effective improvements with goals of improving safety, increasing the mode share or Metro riders walking and biking to stations, and improving the customer satisfaction of those accessing Metro stations by walking or bicycling. Some of the "early action" recommendations include developing guidelines for the design and placement of bicycle parking facilities, developing and implementing a formal station-specific pedestrian and bicycle focused assessment process, and requiring multimodal circulation and access studies as part of adjacent/joint development. Longer-term recommendations include providing direct access to stations along pedestrian and bicycle desire lines, ensuring that funding for pedestrian and bicycle facility maintenance is included in the budgeting process, and coordinating with jurisdictions to provide consistently designed wayfinding directing travelers to off-site destinations such as trails, parks, and schools.[91]

Supporting bicycle and pedestrian planning is important to congestion management. Each additional person walking or biking for a trip is one less person on the road, thus easing congestion. Pedestrian and bicycle facility planning is something that will continue to be considered in the realm of congestion management, not only as a stand-alone area, but in conjunction with transit projects and land use planning.

[90] *Bicycle and Pedestrian Plan for the National Capital Region*. July, 2006 http://www.mwcog.org/uploads/committee-documents/v1ZfWl020070726155118.pdf
[91] http://planitmetro.com/wp-content/uploads/2010/12/Metrorail-Bicycle-Pedestrian-Access-Improvements-Study-_Final.pdf

Bikesharing

In 2008, the District of Columbia became the first city in North America to launch a bike sharing program, Smartbike D.C., which had 120 bikes at 10 stations in the downtown area. That program ended in January 2010.[92] The more expansive, destined to be regional system, Capital Bikeshare, opened in September 2010 with 1100 bikes at 110 stations. The public-private partnership has since expanded to Arlington County and boasts over 1,200 bikes at 140 stations.[93] In Virginia, Capital Bikeshare will expand to the City of Alexandria in Spring 2012.

In Maryland, there are plans to expand Capital Bikeshare to Montgomery County in the Rockville and Shady Grove as part of a JARC grant in 2012, lower Montgomery County and College Park/UMD in Prince George's County in 2013 as part of a Maryland Bikesharing grant. Feasibility studies that are also part of the Maryland Bikesharing grant are planned in Frederick and Greenbelt.[94]

3.2.5 Car Sharing

Carsharing is a model of car rental where people rent cars for short periods of time, often by the hour. This supports residents, especially in densely populated urban environments, who make only occasional use of a vehicle, as well as others who would like occasional access to a vehicle of a different type than they use day-to-day. Urban car sharing is often promoted as an alternative to owning a car in dense, walkable, mixed-use development communities, where public transit, walking, and cycling can be used most of the time and a car is only necessary for out-of-town trips, moving large items, or special occasions. It can also be an alternative to owning multiple cars for households with more than one driver.[95]

Car sharing has taken off in the Washington region, with over 800 shared Zipcar® cars in the District of Columbia alone with plans for that number to continue growing. The District of Columbia provides on-street spaces, at a cost, for car share vehicles, and encourages developers to provide off-street car share spaces in conjunction with new development. Zipcar® also has vehicles outside the District of Columbia, mostly near Metro stations.

Based on polls of Zipcar® members who say they either sold a vehicle or cancelled a planned purchase after joining, The company estimates that each Zipcar® takes 16 personally owned vehicles off the road.

In addition to Zipcar®, Car2Go and Hertz On Demand have moved into the Washington region car sharing market.

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[92] http://en.wikipedia.org/wiki/Capital_Bikeshare
[93] http://www.capitalbikeshare.com/about
[94] http://www.mdot.maryland.gov/News/2012/May%202012/GOVERNOR_OMALLEY_ANNOUNCES_BIKESHARE_GRANTS.html
[95] Adapted from Wikipedia, "Carsharing", http://en.wikipedia.org/wiki/Carsharing.

3.2.6 LAND USE STRATEGIES IN THE WASHINGTON REGION

The relationship of land use and transportation often have an important influence on a person's willingness to commute by transit, ridesharing, bicycling, or walking; modes other than driving alone. The TPB is undertaking projects that consider the relationship of land use and transportation, all of which are important components of the CMP. Concentrating activities near transportation facilities helps reduce the number and length of vehicle trips necessary by residents and workers. More trips can be made by walking. Densities can be sufficient to make provision of transit services cost effective.

Cooperative Forecasting

TPB coordinates with the regional Cooperative Forecasting process at COG.

Cooperative forecasting is a regional process that provides forecasts for demographic information that considers the potential impacts of future transportation facilities. The forecasts are based on national economic trends, local demographic factors, and are closely coordinated with regional travel forecasts.

Local jurisdictions develop independent projections of population, households, and employment based on pipeline development, market conditions, land use plans and zoning, and planned transportation improvements. These local forecasts are also compared and coordinated at the regional level to ensure compatibility. If there is a major change in planned transportation facilities (such as an addition or removal of a planned major facility) the cooperative forecasts are updated to reflect this change. Overall, Metropolitan Washington has strong, well-established processes to ensure transportation planning and land use planning are well-coordinated.

Regional Activity Centers and Regional Activity Clusters

The most recent round of cooperative forecasting projects increases in employment, population, and households by 2030, the end of the forecast period. Employment growth, population, and household growth is expected to increase more in the inner and outer suburbs than in the central jurisdictions. Much of this increase in employment and households is going to mean the development of new infrastructure and the expanding of already existing Regional Activity Centers and Regional Activity Clusters.

Regional Activity Centers and Regional Activity Clusters help coordinate transportation and land use planning in specific areas in the Washington region experiencing and anticipating growth. Focusing growth in Centers and Clusters is important to congestion management, where transportation options for those who live and work there can be provided. The concentration of activities and location near transportation facilities help reduce vehicle trips, as more trips can be made by walking. Transit services also become more cost effective.

The first map of Regional Activity Centers was created in 1999, and since that time it has been updated several times, based upon current local comprehensive plans and zoning. In 2007, COG released a report of Metropolitan Washington Regional Activity Centers and Clusters, which is based on Cooperative Forecasting Round 7.0.[96]

The report concluded that approximately 54 percent of the region's current employment and 55 percent of future jobs were located in the Activity Centers. In addition, the Activity Centers capture 58 percent of all new jobs between now and 2030. The Centers contain 13 percent of the region's existing households and nearly 16 percent of future households, a significant increase from the previous forecast. Although this number may not seem high, it is clear that Activity Centers are growing in many respects. It is important that transportation options continue to be considered for these Centers to accommodate the needs of people who live and work there. Work is underway to update the definitions of the Activity Centers and Clusters to better coordinate local and regional planning. It is expected that work will be complete by the end of 2012.

Transportation-Land Use Connection (TLC) Program

The Transportation-Land Use Connection (TLC) program provides support and assistance to local governments in the Washington region as they implement their own strategies to improve coordination between transportation and land use.

The program does this in two ways. First, it provides information via the Regional TLC Clearinghouse, which is a web-based source of information and transportation/land use coordination, experiences with transit-oriented development, and key strategies. Secondly, the TLC Technical Assistance Program provides consultant services to local jurisdictions working on projects land use and transportation projects.

Eight projects were approved as part of the FY 2012 TLC program:

- District of Columbia: Pedestrian Safety and Accessibility Study in the Farragut Square Area
- Montgomery County, MD: Glenmont Community Visioning Workshop Plan
- Prince George's County, MD: Transitway Systems Study
- City of Rockville, MD: Bikeway Master Plan Update
- City of Takoma Park, MD: New Hampshire Avenue Streetscape Design Standards
- Arlington County, VA: Arlington ADA Evaluation
- Fairfax County, VA: Development and Implementation of Multimodal Transportation Hubs in Tysons Corner
- Multi-Jurisdiction - Prince George's County, District of Columbia, City of Alexandria: Transit-Oriented Development Housing Needs Analysis

The TLC program allows for flexibility to study a wide variety of transportation – land use issues. Some projects are more demand management focused, focusing on pe destrian

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[96] *Metropolitan Washington Regional Activity Centers and Clusters report*, June, 2007. http://www.mwcog.org/store/item.asp?PUBLICATION_ID=299

improvements, growth management, and transit oriented development. Other projects address operational issues, including pedestrian safety improvements and roadway design. The goals among each may be different, but each project is applicable to congestion management.

Household Travel Surveys

In-depth surveys of household travel behavior conducted by the Transportation Planning Board in ten strategically-chosen areas around the Washington region will help planners and local officials better understand neighborhood-level travel patterns in ways that no other existing survey can. All of the focused survey areas were chosen for a variety of reasons by officials from the local jurisdictions in which the surveys took place. The results will inform efforts by local jurisdictions to plan for future growth and to identify strategies for meeting future transportation needs. The results of the TPB's first phase of Geographically-Focused Household Travel Surveys, which were conducted in spring 2010 and fall 2011, will supplement the findings of a similar but less concentrated survey of the entire region conducted by the TPB in 2007 and 2008. The study looked at three high-density developments (14th St NW/Logan Circle, Crystal City, and Shirlington), a planned high-density development area (White Flint in Montgomery County), two areas with emerging transportation options (Woodbridge, VA, and Frederick, MD), and four study areas with recent or planned rail transit options (Columbia Pike Corridor in Arlington County; Reston, VA; the University Boulevard corridor in Maryland; and the area around the Largo Metrorail Station in Prince George's County.[97] Additional phases of focused surveys are currently underway and more are planned for the future. Initial results for the first ten locations were presented to the TPB at its May 2012 meeting.[98]

Region Forward

Region Forward is a vision for a more accessible, sustainable, prosperous, and livable National Capital Region. It was developed by the Greater Washington 2050 Coalition, a group of public, private, and civic leaders created by the Metropolitan Washington Council of Governments in 2008 to help the region meet future challenges like accommodating two million more people by 2050, maintaining aging infrastructure, growing more sustainably, and including all residents in future prosperity.

The Coalition spent a year-and-a-half reviewing regional plans, studying efforts in other parts of the country, and asking for input. A workshop of bold scenarios, survey of area residents, and comments from the public revealed support for a comprehensive vision that would combine physical development goals with social and economic ones.

In June 2011, the Region Forward Coalition (RFC), which is now the group charged with supporting Region Forward held its inaugural meeting. RFC members will use Region Forward to measure progress, prioritize needs, and jumpstart projects that will help us meet our goals. Like the 2050 Coalition that preceded it, the RFC has a broad membership of local, state and federal government officials, business and nonprofit leaders, and advocates.

[97] http://www.mwcog.org/transportation/weeklyreport/2012/05-29.asp
[98] http://www.mwcog.org/uploads/committee-documents/k11dXlle20120517145044.pdf

The Region Forward Compact seeks effective coordination of land use and transportation planning resulting in an integration of land use, transportation, environmental, and energy decisions. Specifically in the transportation sector, Region Forward:

- Seeks a broad range of public and private transportation choices for our Region which maximizes accessibility and affordability to everyone and minimizes reliance upon single occupancy use of the automobile.
- Seeks a transportation system that maximizes community connectivity and walkability, and minimizes ecological harm to the Region and world beyond.[99]

Local Jurisdictional Land Use Planning Activities

There are also a number of activities going on at the local level that are important to congestion management. Activities range from having a strong comprehensive plan that guides local development, to the implementation of projects that include transportation options and pedestrian and bicycle facilities. Examples of local jurisdictional planning activities (note: not a comprehensive list) include:

- The *City of Alexandria* works to make sure its development proposals are consistent with the Master Plan and Zoning Ordinance. Planning and Zoning works closely with the community in each area of the City to carry out City Council's 2004-2015 Strategic Plan and Community Vision for vibrant, walkable neighborhoods, protected natural resources, and vital Main Street business districts. Recently, the Planning Commission of the city voted to adopt a resolution to recommend approval to include the North Potomac Yard Small Area Plan in the City's Master Plan. The North Potomac Yard Plan creates a balance among office, residential and retail uses.

- In 2010, the Arlington County Board adopted the "Crystal City Sector Plan." The 2005 Base Realignment and Closures (BRAC) had a significant impact on the Crystal City area creating 4.2 million square feet of vacant office space. The plan for Crystal City's future is outlined by seven major goals which include enhancing multi-modal access and connectivity, and providing a mix of uses including residential, commercial, retail, cultural and civic uses[100].

- *Fairfax County's* Comprehensive Plan encourages Transit-Oriented Development (TOD) with focused growth near planned and existing rail transit stations to create opportunities for compact pedestrian- and bicycle-friendly neighborhood centers accessible to transit. The implementation guidelines include the promotion of a mix of uses to maximize internal trips, ensure the efficient use of transit, and other measures to limit single occupant vehicle trips. In addition to active promotion of transportation demand management (TDM) strategies, Fairfax County also negotiates trip reduction targets coupled with developer-funded monitoring programs and imposes penalties for non-attainment. *Fairfax County* is planning to leverage the Silver line in Tysons Corner

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[99] http://www.regionforward.org/compact
[100] http://www.arlingtonva.us/departments/CPHD/planning/docs/CRYSTAL%20CITY%20SECTOR%20PLAN.pdf

through greatly increased density, by adding many more residential units, and retrofitting a street grid[101].

- The *Montgomery County* Council recently approved the "Great Seneca Science Corridor" Master Plan[102]. The long-term plan—formerly known as the Gaithersburg West Master Plan—will allow the area near Shady Grove Road and Darnestown Road to develop into one of the nation's premier areas for scientific research and development. According to the approved plan, the Great Seneca Science Corridor would allow a maximum of 9,000 dwelling units and approximately 52,500 jobs.

- The District of Columbia is planning significant development for the East Campus of St. Elizabeth's. This development will positively impact air quality because it will connect the campus's walkable campus with the Anacostia metro station. This development is intended to be complementary to the Federal development on St. Elizabeth's west Campus. The district envisions evasions extending some type of rail service directly though the campus in the future providing additional value for air quality[103].

- Frederick County is planning a large, mixed-use development near the I-70/I-270 junction where it intends to build upon its emerging technology sector. The 173-acre site will have a mix of residential units, commercial development, retail, and open space[104].

- The City of College Park is planning to leverage its Purple line stop to generate better transit oriented development near the College Park Metrorail station.

- The City of Falls Church is in the process of approving a new master plan that will add street grid, mixed use, bus circulation. This plan also intends to make stronger connections with the W&OD Trail[105].

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[101] http://www.fairfaxcounty.gov/tysons/design/

[102] Montgomery County Council News. *Montgomery County Council Approves 'Great Seneca Science Corridor' Master Plan* http://www.montgomerycountymd.gov/Apps/Council/PressRelease/PR_details.asp?PrID=6559

[103] http://planning.dc.gov/DC/Planning/In+Your+Neighborhood/Wards/Ward+8/Saint+Elizabeths+East+Redevelopment+Framework+Plan

[104] http://www.rodgers.com/portfolioDetail.php?recID=19

[105] http://www.fallschurchva.gov/content/government/departments/developmentservices/2012docs/draftplan_mar12.pdf

3.3 Operational Management Strategies

3.3.1 High-Occupancy Vehicle (HOV) Facilities

Overview

High Occupancy Vehicle (HOV) lanes are defined as roadways or roadway segments that are restricted to use by vehicles (cars, buses, vanpools) carrying the driver and one or more additional passengers.

HOV facilities offer several advantages over conventional lanes and roads. They increase the number of persons per motor vehicle using a highway over conventional (non-HOV) roadways, they preserve the person-moving capacity of a lane or roadway as demands for transportation capacity increase, and enhance bus transit operations. All of these advantages are important to effectively managing the operations of existing and new capacity on roadways.

However, HOV facilities can also be considered demand management strategies as well, providing predictable travel times even during peak periods of high demand for highway capacity. HOV lanes can help influence travelers' behavior and provide them with additional choices of how, or if, to travel a certain route.

Currently there are five HOV facilities in the Washington region on highways functionally classified as freeways:

- I-66 in the Northern 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);
- Virginia Route 267 (Dulles Toll Road), where operation of concurrent-flow HOV lanes began in December 1998, connecting to I-66 via the Dulles Connector; and,
- I-95/I-395 (Shirley Highway) in the Northern Virginia counties of Prince William, Fairfax, and Arlington, and the City of Alexandria,
- I-270 and the I-270 spur in Montgomery County, Maryland;
- U.S. 50 (John Hanson Highway) in Prince George's County, Maryland.

COG/TPB staff typically studies the performance of HOV facilities every three or four years during the AM and PM peak periods. The most recent data collected and analyzed along these five HOV corridors was in Spring, 2010 and the results can be found in the *2010 Performance of Regional High Occupancy Vehicle Facilities on Freeways in the Washington Region*[106]. The next round of data collection and analysis is tentatively scheduled for 2014. The 2010 report concluded the following trends on the entire network of HOV facilities in the region:

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[106] *2010 Performance of Regional High Occupancy Vehicle Facilities on Freeways in the Washington Region*, September 7, 2011. http://www.mwcog.org/uploads/committee-documents/ll1fXl1b20110908082403.pdf

- During Spring 2010, all of the HOV lanes required fewer cars to carry more persons per lane during the HOV restricted periods than adjacent non-HOV lanes making the HOV lanes more efficient at moving people to their destinations

- 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.

- Average auto occupancy in 2010 was little-changed from 2004 and 2007, even though the HOV lanes in Northern Virginia continue to exempt vehicles with "Clean Special Fuel Vehicle" registration plates from the HOV requirement

Following is a breakdown of each HOV facility in detail with statistics provided from the aforementioned HOV performance report.

I-66 (Custis Memorial Parkway)

Interstate-66 was opened to traffic between the Capital Beltway (I-495) and Rosslyn, in Arlington County, in 1982. Initially the facility was restricted to HOV-4 traffic, meaning four occupants per vehicle. This was lowered to HOV-3 in late 1983 and to HOV-2 in March 1995. During the 1990s, I-66 outside the Beltway was expanded to include a concurrent-flow HOV lane to Virginia Route 234 (Business) in Prince William County just north of Manassas.

Currently the I-66 HOV corridor consists of two distinct sections. One section is between the Capitol Beltway (I-495) and Rosslyn. This segment of I-66 is restricted to HOV use only during the peak commute period of the peak direction, due to the large amount of traffic traveling inbound from Northern Virginia in the morning, and outbound from the District of Columbia in the evening. The other section, between Virginia Route 234 (Business) near Manassas and the Capitol Beltway, is a concurrent-flow lane HOV facility. The entire HOV corridor is about 27 miles in length, about 9 miles inside the Beltway and 18 miles outside the Beltway.

I-66 is a key commuting corridor, as it connects the District of Columbia with the suburbs of Virginia and beyond. Direct access to employment centers in Washington, D.C. is provided via the Theodore Roosevelt Bridge over the Potomac River. Along the I-66 corridor there are also several Metrorail stations that many commuters drive to everyday. Some of these stations contain Park-and-Ride facilities that allow commuters to drive and connect to other modes, such as rail or bus.

I-95/I-395 (Shirley Highway)

The Shirley Highway Corridor is one of the two corridors that provide direct access to the employment centers (the other is I-66). Therefore, understanding congestion on these corridors is crucial.

The HOV lanes in this corridor are entirely barrier-separated, and reversible, so they accommodate heavy AM peak period northbound traffic and operate southbound in the P.M. peak period. The HOV roadway is about 27 miles long, extending from Virginia Route 234

(Dumfries Road) near Dumfries, Prince William County to South Eads Street near the Pentagon in Arlington County. Several HOV-only ramps provide direct access to the HOV lanes from park-and-ride facilities in Prince William County.

The corridor is also served by the Virginia Railway Express (VRE) Fredericksburg Line. The Metrorail Blue Line terminates in the corridor at Franconia-Springfield. Numerous bus lines serve the corridor, including Metrobus, the City of Alexandria's DASH, Fairfax Connector, PRTC OmniRide and private motor coach companies serving communities in Stafford and Spotsylvania Counties and the City of Fredericksburg.

VA 267 (Dulles Toll Road)

Concurrent flow HOV lanes operate along this corridor from a point between Sully Road (VA 28) and Centreville Road (VA 657) to just west of Leesburg Pike (VA 7). There are noHOV lanes through the interchanges at VA 7, the main toll plaza, Spring Hill Road (VA684), I-495 and VA 123. HOV restrictions apply to all lanes of the Dulles Connector road from east of VA 123 to I-66. Fairfax Connector provides most transit bus service in the corridor, with the Loudoun County Commuter Express providing commuter bus service from Loudoun County to the Metro Core area (including stops in Rosslyn, Arlington County and downtown Washington, D.C.).WMATA operates the route 5A Metrobus service between Washington Dulles International Airport and the L'Enfant Plaza Metrorail station, with intermediate stops at the Herndon/Monroe Park and Ride, the Tysons-Westpark Transit Station, and the Rosslyn Metrorail station.

The HOV lanes require at least two persons per vehicle and the requirement is from 6:30A.M. to 9:00 A.M. and from 4:00 P.M. to 6:30 P. M.

I-270 HOV Facilities

In the southbound (A.M. peak) direction, the HOV concurrent-flow lane runs from I-370 near Gaithersburg south to the Rockville Pike/Capital Beltway interchange. There is also a concurrent flow HOV lane along the southbound lanes of the I-270 Spur. Together, the A.M. peak-flow direction lanes total about 11 miles in length. The Spur is just less than 2 miles long. In the northbound (P.M. peak) direction, concurrent-flow HOV lanes exist along the entire northbound I-270 Spur, and along I-270 from its southern terminus at I-495/Md. 355 to I-370 (the same sections of the corridor having HOV lanes southbound). Additionally, there are about 7.5 miles of HOV lane between I-370 and Maryland 121 near Clarksburg.

The Metro Red Line serves the I-270 corridor from Shady Grove (I-370), continues south to Bethesda, and onto the downtown area of the District of Columbia. The Mass Transit Administration's (MTA) MARC Brunswick Line also serves several stops in this corridor, and continues south to Silver Spring and onto Union Station in the District of Columbia. Montgomery County Ride-On serves areas in the corridor north of I-370, and MTA coach service (between Hagerstown, Frederick and Shady Grove) use the HOV lanes. Express Metrobus service operates on the HOV lanes in the corridor between Bethesda and Gaithersburg.

US 50 HOV Facilities

Concurrent-flow HOV lanes operate in the U.S. 50 (John Hanson Highway) Corridor from just west of the Md. 704 Martin Luther King Highway interchange to east of the U.S. 301/Md. 3 interchange in Bowie. Unlike all other HOV lanes in the region, these lanes are HOV-2 restricted at all times (24 hours, 7 days) in both directions.

Buses operated the Washington Metropolitan Area Transit Authority (WMATA) and the Maryland Transit Administration (MTA) run on the U.S. 50 HOV lanes. To the east, the buses serve the City of Bowie in Prince George's County, and the Annapolis and Crofton areas of Anne Arundel County. All WMATA buses terminate at the New Carrollton rail station. Some MTA buses serve the downtown area of the District of Columbia, others terminate at New Carrollton.

2010 Performance of HOV Facilities on Freeways study

Most comparisons are made with results obtained from the previous Regional HOV Facilities Monitoring reports for 1997, 1998, and 1999, 2004, and 2007. Trends and changes are emphasized for the HOV restricted periods inbound and outbound.

One of the ways to assess the performance of HOV facilities, and to compare these facilities, is to measure the travel time for HOV facilities versus non-HOV, and to determine the time savings. The results for the 2010 study are shown in Appendix D.

Generally, the results showed that in all corridors, HOV routes saved time and operated at higher than average speeds than parallel non-HOV routes. The time savings during the AM restricted periods in 2010 are greater than those observed in 2007 for the I-66 and Dulles Toll Road corridors and have declined slightly in the I-95/I-395 and the I-270 corridors. The travel time advantage of HOV over non-HOV in the U.S. 50 corridor is negligible. In 2010, the areas with the greatest time savings are I-395 and I-66 inside the Beltway. All other segments save less than a minute per mile, but on I-395 inside the Beltway time savings are 2.9 minutes per mile and I-66 sees 2.4 minutes per mile time savings. The PM restricted period showed similar results: improved travel time advantages for HOV in the I-95/I-395 and I-66 corridors, some rebound travel time savings in the Dulles Toll Road and U.S. 50 corridors over 2007, and I-270 held steady on the west side of the spur while experiencing a three minute increase in travel time savings from the east spur.

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.

3.3.2 Variably Priced Lanes/Systems

Variably Priced Lanes (VPLs), a demand management strategy, is one type of managed lanes where the pricing of roadways to helps reduce congestion and generates revenue for transportation projects. VPLs are an effective way to provide alternatives to travelers willing to pay for travel time reliability. There are several examples of managed lanes in the United States including SR-91 in Orange, California; I-95 in Miami, FL; and I-394 and I-35W in Minneapolis.

There is currently one VPL facility in operation in the region and one under construction, and one in the planning phase.

- *The Intercounty Connector* – an 18-mile east-west highway in Montgomery County and Prince George's County Maryland that will run between I-270/I-370 and I-95/US 1. The majority of the facility, from I-270/I-370 to I-95 opened in November 2011. The facility has six VPLs and with express bus service connecting to Metrorail, BWI Airport and Fort Meade. Toll rates vary by time of day. The toll rate in the peak period is $0.25 per mile, off-peak is $0.20 per mile, and overnight is $0.10 per mile.

- *The I-495 Express Lanes* – Fourteen miles of new high-occupancy toll (HOT) lanes (two in each direction) are being built on I-495 between the Springfield Interchange and just north of the Dulles Toll Road. These HOT lanes will offer HOV-3 connections with I-95/395, I-66 and the Dulles Toll Road for the first time. Buses, carpools and vanpools with three or more people, and motorcycles can ride in the new lanes for free. Vehicles carrying two or less people can ride them if they pay a toll. The project was added to the CLRP in 2005, and completion is expected by 2013.

- *I-95/ Express Lane project in Northern Virginia* – This new project will create approximately 29 miles of Express Lanes on I-95. This project will add capacity to the existing HOV Lanes from the Prince William Parkway to the vicinity of Edsall Road; improve the existing two HOV lanes for six miles from Route 234 to the Prince William Parkway. A nine-mile reversible two-lane extension of the existing HOV lanes from Dumfries to Garrisonville Road in Stafford County will help to alleviate the worst traffic bottleneck in the region.[107] Vehicles carrying two people would have a choice to ride in the HOT lanes for a toll or travel in the regular lanes for free. Completion is expected in 2015.

The TPB has had active interest in VPLs since June 2003 when the TPB, together with the Federal Highway Administration and the Maryland, Virginia, and District Department of Transportation, sponsored a successful one day conference on value pricing in the Washington region. After the conference, in Fall 2003, the TPB created a Task Force on Value Pricing to further examine and consider the subject. Over the past several years, under a grant from the Federal Highway Administration's Value Pricing Program, the TPB Value Pricing Task Force has been evaluating a regional network of variably priced lanes in the region. The Value Pricing Pilot Program allowed extensive analysis of this large network, as well as the creation of other scenarios that apply variable pricing to some existing freeway and arterial lanes. A final report, essentially a "vision document" for the future of VPLs, was produced in February, 2008, which outlines the study of a regional network of variably priced lanes.[108]

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[107] http://www.vamegaprojects.com/about-megaprojects/i-95-hov-hot-lanes/
[108] *Evaluating a Network of Variably Priced Lanes for the Washington Metropolitan Region*, National Capital Region Transportation Planning Board, February 2008.

The study involved the development and evaluation of the following VPL scenarios. These scenarios outline ways that VPLs could be used in the future:

- A "Maximum Capacity" network in which two VPLs were added to each direction of the region's freeways; one VPL was added to each direction of major arterials outside the Capital Beltway; existing High-Occupancy vehicle (HOV) lanes were converted to VPLs, and direct access/egress ramps were added at key interchanges in the VPL network.

- A "DC Restrained" scenario in which the new capacity from the "Maximum Capacity" scenario was removed from all of the bridges and other facilities in the District of Columbia, and replaced by variable pricing applied to existing freeway and selected arterial lanes.

- A "DC and Parkways Restrained" scenario in which the "DC Restrained" scenario was further restrained by applying variable pricing to the existing capacity on the region's parkways (Baltimore Washington, George Washington Memorial, Rock Creek, Clara Barton, and Suitland).

Comparison of scenarios, cost estimates, evaluation of potential land use impacts, and impacts of pricing scenarios on di fferent populations were examined among the various scenarios. The results of the VPL study were used in the CLRP Aspirations Scenario Study which is discussed more in Chapter 4.

3.3.3 Traffic Management

The topic of Traffic Management, including Incident Management and Intelligent Transportation Systems (ITS) is considered under the Management, Operations, and Intelligent Transportation Systems (MOITS) Policy Task Force and MOITS Technical Subcommittee. MOITS advises the TPB on traffic management matters and provides a regional forum for coordination among TPB member agencies and other stakeholders on these topics.

Investments in operations-oriented strategies have time and again shown good benefit-cost ratios and best enable transportation agencies (for both highways and transit) to provide effective incident management and good customer service, through operations centers and staffs, motorist/safety service patrols, traffic signal optimization, and supporting technologies. Particularly, intersection improvements (signalization timing / g eometrics) can provide cost efficient congestion reduction.

In addition, the Metropolitan Transportation Operations Coordination (MATOC) program, comprising DDOT, MDOT, VDOT, and WMATA, is a regional program to enhance the availability of real-time transportation information and strengthen coordination among transportation agencies.

Incident Management

According to the Federal Highway Administration, an estimated 50% of congestion is associated with incidents such as crashes, disabled vehicles, and traffic associated with special events. If an incident disrupts traffic, it is important for congestion that normal flow resumes quickly.

Many successful incident management activities are part of the robust activities undertaken by the Washington region's transportation agencies. The region's state DOTs all pursue strategies for managing their transportation systems, including operation of 24/7 traffic management centers, roadway surveillance, service patrols, and communications interconnections among personnel and systems. All three focus on getting timely word out to the media and public on incidents. Local-level agencies also play an important role in transportation management, particular on local roads and traffic signal optimization.

Specific state-wide and regional incident management strategies include:

- ***Imaging / video for surveillance and detection*** – help detect incidents and allow emergency vehicles to arrive quickly. Also helps travelers negotiate around incidents.
    - Montgomery County operates an Advanced Transportation Management System (ATMS), with 200 surveillance cameras across the County;
    - Arlington County and City of Fairfax in Virginia also deployed many cameras.
    - The three state DOTs implement cameras for surveillance and detection.

- ***Service patrols*** – These specially equipped motor vehicles and trained staff help in clearing incidents off a roadway and navigating traffic safely around an incident.
    - MDOT and VDOT have deployed service patrols for a number of years. DDOT began deploying patrols in 2003.
    - Montgomery County became the region's first local jurisdiction to deploy patrols in 2006, concentrating on major arterials rather than freeways.

- ***Road Weather Management*** – Can take the forms of information dissemination, response and treatment, surveillance and monitoring, prediction, and traffic control.
    - All three state DOTs implement road weather management systems that disseminate information, treat roadways, and monitor conditions, especially during winter snow and ice events

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- ***Traffic Management Centers (TMCs)*** – These centers collect and analyze traffic data, then disseminate data to the public. Data collection includes CCTVs, cameras, and detectors.
    - All three state DOTs have TMCs:
        - *VDOT's McConnell Public Safety Transportation Operation Center (MPSTOC)* operates Northern Region Transportation Operations Center (TOC) and Signal System. The TOC monitors traffic and incidents by using cameras and other information-gathering mechanisms to better manage day-to-day traffic flow and large incidents.

  - *DDOT's Transportation Management Center* gathers and disseminates information to the public using a network of cameras and other devices.
  - *MDOT's Coordinated Highway Action Response Team (CHART)* collects traffic data, disseminates information to the public, and provides emergency motorist assistance.

- ***Curve Speed Warning Systems*** - use roadside detectors and electronic warning signs to warn drivers, typically those in commercial trucks and other heavy vehicles, of potentially dangerous speeds in approach to curves on highways, with the intention of preventing incidents.
  - Curve speed warning systems have been used on the Capital Beltway.

- ***Work zone management*** - uses traffic workers, signs, and temporary road blockers to direct and control traffic during construction activities.
  - All three state DOTs have work zone management programs to temporary implement traffic management and direct traffic. The goal is to reduce incidents by controlling the flow, speed, and direction of traffic.

- ***Automated truck rollover systems*** - detectors deployed on ramps to warn truck drivers if they are about to exceed their rollover threshold, thus helping to reduce incidents.
  - Automated truck rollover systems, similar to the curve speed warning systems, were implemented at the same locations on the Capital Beltway in Virginia and Maryland. This was in response to a high number of truck rollovers on the Beltway in the 1980's.

- ***Active Traffic Signal Management*** – Coordinate management of traffic signals across a signal network, adjusting the lengths of signal phases based on prevailing traffic conditions automatically in response to traffic detected at a large number of detectors.
  - Arlington County's successful Adaptive Signal System allows traffic signals to be coordinated based on prevailing traffic conditions, which can be impacted by incidents.
  - VDOT's signal/arterial management program: VDOT actively optimizes traffic signal timing plans and launched a signal/arterial traffic management control center located adjacent to the MPSTOC operating floor to proactively manage the arterial traffic.

Studies have shown the impact incident management activities have on reducing congestion, in particular reducing duration of incidents and reducing chances for secondary incidents. An example of this type of study is the yearly analysis of impacts of the Coordinated Highway Action Response Team (CHART) on incident management in Maryland. The focus of the report is to gauge effectiveness of CHART's availability to detect and manage incidents on major freeways and highways.

Highlights of the 2010 CHART performance evaluation report includes[109]:

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[109] Chang, G.L & S.M. Rochon. Performance Evaluation and Benefit Analysis for CHART in Year 2010 (final report). http://chartinput.umd.edu/reports/CHART_2010_final_final.pdf

- Distribution of incidents an disabled vehicles
    - By day and time
    - By road and location
    - By lane blockage type
    - By blockage duration
    - By nature of incident (accident, disabled vehicle, etc.)
- Comparison of current year's data with that of previous years
- Benefits from CHART's incident management
    - Assistance to drivers
    - Potential reduction in secondary incidents
    - Estimated benefits due to efficient removal of stationary vehicles
    - Direct benefits to highway users

The CHART report includes specific statistics on the impact of Maryland State Highway Administration (SHA) patrol[110], including:

- Response time to incidents blocking three or more lanes was shortened with SHA patrol:
    -
    - For incidents blocking only the shoulder, response time averaged 8 minutes with SHA patrol, compared to 5 without SHA patrol.
    - For incidents blocking 1 lane or 2 lanes, response time averaged 7 minutes with SHA patrol, compared to 4 minutes without SHA patrol.
    - For incidents blocking 3 lanes, response time averaged 8 minutes with SHA patrol, compared to 4 minutes without SHA patrol.

- Clearance time was shortened with SHA patrol:
    - .
    - For incidents blocking only the shoulder, clearance time averaged 20 minutes with SHA patrol, compared to 27 without SHA patrol.
    - For incidents blocking 1 lane, clearance time averaged 23 minutes with SHA patrol, compared to 38 minutes without SHA patrol.
    - For incidents blocking 2 lanes, clearance time averaged 39 minutes with SHA patrol, compared to 39 minutes without SHA patrol.
    - For incidents blocking 3 lanes, clearance time averaged 58 minutes with SHA patrol, compared to 48 minutes without SHA patrol.

- Incident duration also decreased with SHA patrol:
    - Duration averaged 28 minutes with SHA patrol, compared to 48 minutes without.
    - For incidents blocking shoulder only, duration averaged 21 minutes with SHA patrol, compared to 26 minutes without.

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[110] Chang, G.L & S.M. Rochon. CHART 2007 Evaluation, Module 4: The Performance Evaluation for Year 2010, http://chartinput.umd.edu/module4_2010.htm

- For incidents blocking one lane, duration averaged 26 minutes with SHA patrol, compared to 54 minutes without.
- For incidents blocking two lanes, duration averaged 43 minutes with SHA patrol, compared to 39 minutes without.
- For incidents blocking three lanes, duration averaged 63 minutes with SHA patrol, compared to 49 minutes without.

Analysis and studies such as those conducted by CHART indicate that incident management activities do have a positive impact on congestion. Each minute of reduced duration of incidents, for example, reduces the chances of secondary incidents and has a concomitant reduction in the severity and duration of non-recurring congestion. It was estimated in 2010 495 secondary incidents were eliminated due to the CHART program. The total estimated delay reduction amounted to 41.2 million vehicle hours. Even a relatively simple activity such as a service patrol assisting a motorist with a flat tire, or who is out of gas, might prevent a congestion-inducing crash. Continuing enhancement and investment of incident management activities will support congestion management.

Intelligent Transportation Systems

The TPB works with the region's jurisdictions and local transportation agencies to implement various ITS technologies, from which the TPB compiles and analyzes operational management data.

ITS strategies can be defined as electronic technologies and communication devices aimed at monitoring traffic flow, detecting incidents, and providing information to the public and emergency systems on what is happening on our roadways and transit communities. Much of what is done with ITS helps in reducing non-recurring and incident-related congestion.

- ***Advanced Traveler Information Systems (ATIS)*** – A technology-based means of compiling and disseminating transportation systems information on a real-time or near-real-time basis prior to or during tripmaking.
  - Virginia operates under a statewide 511 system via telephone and the Internet.
  - The District of Columbia makes traffic information, including live traffic cameras, traffic alerts, and street closures, available on the DDOT website.
  - Maryland provides live traffic information on traffic and incidents via the CHART website and a phone-based 511 system.
  - Both Virginia and Maryland deployed Dynamic Message Signs (DMSs) for mainly the freeway system.
  - WMATA provides real-time transit information on the web and on informational screens in the Metrorail stations.
  - The newly launched MATOC website has links to all three state's traffic information. In addition, there is a link provided to the Traffic View website (www.trafficview.org) which aggregates traveler information including incidents, traffic camera feeds, construction activity and schedules, and variable message sign information for Maryland, the District of Columbia and five other states. Currently, data are not available Virginia, but that information should be forthcoming.

    - Capital Region Updates (CapitalRegionUpdates.gov) was established to be a "one-stop-shop" where residents can get information during emergencies including real-time news and traffic and transit information[111]

- ***Advanced Traffic Signal Systems*** - The coordination of traffic signal operation in a jurisdiction, or between jurisdictions. This is important to congestion, as it reduces delay and improves travel times.
    - Arlington County has successfully deployed an adaptive signal system for a portion of its signal system.
    - VDOT actively optimizes traffic signal timing plans and launched a signal/arterial traffic management control center located adjacent to the MPSTOC operating floor to proactively manage the arterial traffic.

- ***Electronic Payment Systems* -** These systems can make transit use more convenient by allowing a user to pay for bus, rail, park-and-ride lots, and other transit services with one card. Convenience an appealing factor, and helps increase transit ridership and transfers among different transit modes.
    - SmarTrip cards are used for rail and bus fares (both WMATA and local buses) and for WMATA parking facilities.
    - The region's roadway toll agencies are part of the E-ZPass consortium electronic payment system. The newly-opened ICC is Maryland's first all-electronic toll road.

- ***Freeway Ramp Metering* -** Traffic signals on freeway ramps that alternate between red and green to control the flow of vehicles entering the freeway. This prevents incidents that may occur from vehicles entering the freeway too quickly, and also prevents a backup of traffic on the on-ramp.
    - Ramp meters are used inside the Capital Beltway (I-495) in Virginia.

- ***Bus Priority Systems*** - Bus priority systems are sensors used to detect approaching transit vehicles an alter signal timings to improve transit performance. For example, some systems extend the duration of green signals for public transportation vehicles when necessary. This is important because improved transit performance, including a more precisely predicted time for bus arrivals, makes public transit a more appealing option for travelers.
    - There have been three pilot deployments in the region: U.S. 1 (Fairfax County), Columbia Pike (Arlington County), and Georgia Avenue (DC). These are pilot projects intended to provide lessons learned for wider deployments.
    - Montgomery County has co-located traffic management and transit dispatch which enables adjustment of signals (by the centralized signal operations center) if deemed necessary for transit.
    - The region, led by TPB, was awarded $58 million federal Transportation Investment Generating Economic Recovery (TIGER) grant for developing a priority bus corridors network. A total of 13 priority bus corridors are funded in

[111] http://www.mwcog.org/news/press/detail.asp?NEWS_ID=555

DC, Maryland and Virginia. Bus priority improvements include running buses on freeway HOV lanes, adding queue jump lanes for buses, implementing transit signal priority, building super stops and improving bus stops. This regional priority bus network is anticipated to be complete by 2016.

- ***Automated Enforcement (e.g. red light cameras)* -** Still or video cameras that monitor things such as speed, ramp metering, and the running of red lights, to name a few. They are important to preventing non-recurring and incident related congestion.
  - In the Washington region, the legal ability to deploy these systems is in place in the District of Columbia and Maryland, and pending in Virginia.

- ***Traffic Signal Timing* -** Traffic signal timing plans adjust traffic signals during an incident, during inclement weather, or to improve transit performance. The overall objective is to reduce backups at traffic signals and to increase the level of service.

- ***Reversible Lanes* -** Traffic sensors and lane control signs reverse the flow of traffic and allow travel in the peak direction during rush hours. This is important to alleviating congestion that may occur in one direction during a peak hour.

- ***Dynamic Routing/Scheduling* -** Public transportation routing and scheduling can automatically detect a v ehicle's location, and dispatching and reservation technologies can facilitate the flexibility of routing/scheduling. This is can help increase the timeliness of public transportation, keep transit on schedule, which in turn increases ridership.

- ***Service Coordination and Fleet Management. (e.g. buses and trains sharing real-time information* -** Monitoring and communication technologies in a vehicle that facilitate the coordination of passenger transfers between vehicles or transit systems. This is important and appealing to passengers that use more than one type of transit.

- ***Probe Traffic Monitoring* -** Using individual vehicles in the traffic stream to measure the time it takes them to travel between two points and also to report abnormal traffic flow caused by incidents. Tracking could be done with the use of cellular phones, and in the future with the installation of a system in the vehicle which would send information to transportation operators. This is important to monitoring recurring and non-recurring congested locations, and travel time.
  - Probe traffic monitoring has been tested in the Baltimore region under the Maryland State Highway Administration and private sector partners.

- ***Active Traffic Management (ATM) (e.g. Lane Control, Queue Warning, Variable Speed Limits)*** – VDOT has been operating the shoulder lane on I-66 between I-495 and US-50 for many years. VDOT now is upgrading the ATM system on I-66, one of the most congested corridors not only in Virginia, but in the nation. Specific ATM strategies and technologies that fit the needs of the I-66 corridor have been identified and are being readied for roadway deployment. These include lane control signal systems, shoulder lane management systems, adaptive ramp metering, enhanced detection and camera systems, queue warning systems, and others. The I-66 ATM system will emphasize rapidly identifying and responding to incidents, using the shoulder lanes whenever conditions merit, and providing detailed traffic information to travelers. The section of roadway to be outfitted with ATM is 34 miles in length, extending from the District of Columbia to Haymarket in Prince William County. The 34 miles of roadway is divided into five segments, with different combinations of ATM treatments planned for each segment. Operation of the system will be managed by the VDOT Public Safety Transportation Operations Center (PSTOC).[112]

- ***Regional ITS Architecture*** – the TPB has developed a regional ITS architecture, the Metropolitan Washington Regional Intelligent Transportation Systems Architecture (MWRITSA)[113]. The Regional Architecture is intended to provide a regional ITS framework for the foreseeable future, to define and validate ITS operations of regional significance, and to address national and statewide conformity in accordance with federal law and guidance. The architecture aims to ensure knowledge of ITS operations across the region, encouraging appropriate systems integration and enhanced technical systems interoperability. In addition to describing the interrelationships among existing transportation technology systems, the MWRITSA can provide a starting point for identifying responsibility for ITS Projects and applicable standards. It can inform business cases for state and federal ITS investment in transportation improvement programs as well as other plans, programs, and projects. The three DOTs have worked collaboratively to bring consistency among their regional ITS architectures.

- ***Integrated Corridor Management (ICM)*** – VDOT is looking at new technologies and concepts that have been tested nationally or internationally to integrate operations to manage total corridor capacity including freeways, arterials, bus, rail, and parking systems. The purposes of the initiative include identifying innovative technologies to facilitate multi-modal local, regional, and national corridor travel, and indentifying tools to provide information to travelers related to travel times and parking. VDOT's current ICM project development focuses on I-95 and US-1 corridor from the DC line to Fredericksburg. By the time this CMP report is released, VDOT would have finalized the strawman ICM, concept of operations, deployment strategy, and a deployment plan.

Regional Operations Coordination

Metropolitan Area Transportation Operations Coordination (MATOC)

The Metropolitan Area Transportation Operations Coordination (MATOC) Program is a coordinated partnership between transportation agencies in D.C., Maryland, and Virginia that aims to improve safety and mobility in the region through information sharing, planning, and coordination. While this list is constantly growing, current agencies include the District of Columbia, Maryland, and Virginia Departments of Transportation along with County and City transportation departments and transit providers like WMATA and other local providers. For example, a recent review of the MATOC program showed that coordination between the

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112 VDOT I-66 ATM Fact Sheet (July 2011)
113 The Metropolitan Washington Regional Intelligent Transportation Systems Architecture. http://www.mwcog.org/itsarch/Home.htm

MATOC family of agencies during a bus crash on I-66 resulted in a savings of over $382,000 for area commuters**.** This savings was a result of decreased emissions, fuel consumption and lost time. [114]

A benefit-cost study of the MATOC program was undertaken and the results were based on three incidents that were handled by MATOC. The benefit-cost study looked at travelers "modified trips" - trips made at a later time, on another route, by another mode, or not made due to regionally significant incidents. Benefits were estimated from reduced delay, fuel consumption, emissions (including greenhouse gases), and secondary incidents. Three case studies were conducted, two for freeway incidents and one for arterial incident. The study found an overall benefit/cost ratio conservatively estimated at 10 to 1. A summary report of this study called the MATOC Benefit Cost Analysis dated June 2010 is available. MATOC also maintains a public use website called Traffic View which can be accessed at www.trafficview.org which uses the RITIS traffic information to inform the public about regional incidents.

Regional Incident Coordination (RIC)

The formation of a Steering Committee on Incident Management and Response (IMR) was approved by the COG board of Directors in March 2011 in response to the snow and ice storm of January 26, 2011, that triggered widespread and many hours-long traffic gridlock and causing power outages that impacted thousands of residents. The product of the IMR was a Major Regional Incident Response Action Plan. One of the major recommendations in the plan is the creation of a Regional Incident Coordination (RIC) Program that would be responsible for using the established traffic and incident management programs throughout the region (such as MATOC) to distribute relevant information to appropriate officials, creating a picture of the regional situation, and sharing this information with decision-makers on the Regional Incident Communication and Coordination System (RICCS) calls to provide better information for officials to make operational decisions. [115]

Defense Base Closure and Realignment Commission (BRAC)

Walter Reed

The Walter Reed National Military Medical Center (WRNMMC) is located at 8901 Rockville Pike in Bethesda, Montgomery County. The facility occupies most of the east side of Rockville Pike (MD 355) between Jones Bridge Road and Cedar Lane. Under the BRAC action, this facility represents the absorption of the former Walter Reed Army Medical Center, an Army facility located at 6900 Georgia Avenue, NW in the District of Columbia (now closed), into the Bethesda site previously called the National Naval Medical Center. The Uniformed Services University of Health Sciences (USUHS) is located on the WRNMMC site.

Employment at the site has increased from about 8,000 in 2008 to about 10,200 in 2012. According to the Walter Reed Web site, about 23% of employees "utilize environmentally-friendly transportation modes to come to work each day." A new pedestrian tunnel under

[114] www.matoc.org
[115] http://www.mwcog.org/uploads/committee-documents/al1fWFhb20111110130828.pdf

Rockville Pike linking the site to the Medical Center stop on the Metrorail Red Line and new elevators from near the hospital entrance to the Metro platform are scheduled for completion by 2013. Additionally, the Maryland State Highway Administration and Montgomery County Department of Transportation are completing major intersection improvements at the intersections of Rockville Pike and Cedar Lane / West Cedar Lane, Rockville Pike and Jones Bridge Road, and Connecticut Avenue (MD 185) at Jones Bridge Road. For years, these three intersections have consistently been among the most congested in the County. Smaller scale improvements are also being / have been implemented at other intersections along the roads adjacent to the site.

Mark Center

The Mark Center (also known as BRAC-133) is located at the southwest quadrant of the interchange of I-395 and Seminary Road in the City of Alexandria. Access to the site is via Mark Center Avenue, which intersects Seminary Road, and Mark Center Drive, which intersects North Beauregard Street. The Mark Center was built to house about 6,400 employees of the Department of Defense (of which roughly 50% have moved in as of May 2012). Adjacent is the Institute for Defense Analysis, which houses about 600 employees.

A new transit bus station with five bus bays, which accommodates service from WMATA Metrobus, Alexandria DASH and private providers was built a short walk from the Mark Center. The Beauregard corridor is one of three under study by the City for high-capacity transit service. The Virginia Department of Transportation (VDOT) is planning to build a new reversible ramp from the I-395 High Occupancy Vehicle (HOV) lanes to enable direct access from those lanes to Seminary Road during the morning peak commute period, and from Seminary Road to the HOV lanes in the afternoon commute period. These lanes are limited to HOV-3 (three-person car-pools, van-pools, buses and motorcycles) while in northbound operation from 6:00 AM to 9:00 AM and southbound from 3:30 PM to 6:00 PM. This project is currently being reviewed under the National Environmental Policy Act (NEPA) process.

Fort Belvoir

Fort Belvoir is located along Richmond Highway (US 1) and I-95 in Fairfax County. It consists of two separate sites, the larger main post (located on the east and west sides of U.S. 1 south of Mount Vernon Highway (VA 235) and the smaller Fort Belvoir North area (the former Engineer Proving Ground), generally bounded by I-95, the Fairfax County Parkway (VA 7100) and the neighborhoods just south of the Franconia-Springfield Parkway (VA 7900).[116] The National Geospatial Agency (NGA) is the primary tenant at Fort Belvoir North, while the main post hosts a number of Army functions.

In 2006, there were about 23,300 jobs at Fort Belvoir and Fort Belvoir North. As of 2011, there are about 36,400 jobs on the two sites (there will be additional off-base jobs which are not included in this total).

Recent transportation improvements in the area include:

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[116] Both of these facilities will soon be renumbered as part of their placement onto the VDOT primary road network as a result of Commonwealth Transportation Board (CTB) action earlier this year.

- Completion of the final section of VA 7100 between Newington and VA 7900, including a new interchange on the west side of Fort Belvoir North at Barta Road
- A new ramp from the I-95 Express Lanes (HOV-3 restricted during peak commute times) to Heller Road on Fort Belvoir North

In addition, the Federal Highway Administration (FHWA) and VDOT are studying improvements to US 1, which may include widening of the highway from four to six lanes through the Fort Belvoir area, and improvements to ease turning movements along US 1 between VA 7100 and Pohick Road, which provides access to Tulley Gate for the main post.

3.4 Additional System Capacity

3.4.1 Documentation of Congestion Management for Additional System Capacity

Federal regulations state that any project proposing an increase in Single-Occupant Vehicle Capacity should show that congestion management strategies have been considered. The specific language from the Federal Rule states that Transportation Management Areas (TMAs) shall provide for:

"*an appropriate analysis of reasonable (including multimodal) travel demand reduction and operational management strategies for the corridor in which a project that will result in a significant increase in SOVs is proposed to be advanced with Federal Funds. If the analysis demonstrates that travel demand reduction and operational management strategies cannot fully satisfy the need for additional capacity in the corridor, and additional SOV capacity is warranted, then the congestion management process shall identify all reasonable strategies to managed the SOV facility safely and effectively.*"

In the Washington region, the TPB is ensuring that all proposed SOV capacity increasing projects (except those which are exempt) show that congestion management strategies have been considered to effectively manage the additional capacity. This is being done with agencies completing a "CMP Documentation Form" when submitting a proposal for projects in the long-range plan and Transportation Improvement Program (TIP).

A sample CMP documentation form was developed to provide guidance to agencies completing these forms (Appendix F). Agencies completing these forms are able to cite various ongoing strategies in the region, local jurisdiction, and corridor in the vicinity of their project.

3.4.2 Where Additional System Capacity Is Needed and How the Additional System Capacity Will be Managed Efficiently

The CLRP, updated regularly, identifies where major roadway capacity expansions are planned. The TPB, through the CLRP, asks that congestion management strategies be considered for these capacity increases. In the Washington region, all proposed SOV capacity increasing projects (except those which are exempt), show that congestion management strategies have been considered to effectively manage the additional capacity. These types of strategies could be of demand or operational management, or both, as outlined in this report. Many of these strategies are considered before any capacity-increasing project is adopted.

The CLRP, through the CMP, strongly encourages consideration and implementation of strategies such as the following to manage both existing and future additional roadway capacity:

- Transportation Demand Management (TDM) strategies, such as Commuter Connections programs.
- Traffic Operational Improvements
- Public Transportation Improvements
- Intelligent Transportation Systems technologies
- Combinations of the above strategies.

Roadway capacity increases may be needed in specific locations for a number of reasons including bottleneck removal, safety improvements, economic development, and other reasons. Managing this capacity through the CMP is key.

3.5 Project-Related Congestion Management

In recent years, the Washington region has successfully implemented project-related congestion management for major construction projects. Strategies include providing incentives for commuters to give up driving alone and try transit, carpooling, vanpooling, and other alternatives, disseminating more information about construction projects and congestion, improving alternative routes, providing fire and rescue equipment and staff for emergency services along with additional police services, adding additional spaces to park-and-ride lots, providing additional shuttle bus services, etc.

Some successful examples of implementing project-related congestion management include during construction of the recently completed Woodrow Wilson Bridge project, the I-95/I-495 Springfield Interchange project and the South Capitol Street project.

Ongoing major construction projects continue the practice of implementing project-related congestion management. Examples are DDOT 11th Street Bridges project and Northern Virginia Megaprojects.

11th Street Bridges Project

During the construction phases of the DDOT 11th Street Bridges project, several congestion management approaches were considered and the following will be implemented to mitigate congestion and keep traffic moving:

- Maintain three lanes of traffic in each direction across the river;
- Provide additional transit enhancements during peak traffic periods;
- Provide traveler information systems, including low power highway advisory radio, and Intelligent Transportation Systems, including real-time message signs with alternate route suggestions;

- Provide updated freeway guide signing within the immediate project area that reflects temporary access routes during the various phases of construction. Also provide way-finding signage for freeway access points on local roads in the project study area; and event management systems, such as roving tow services.

Northern Virginia Megaprojects

Northern Virginia Megaprojects[117] are a series of large-scale and simultaneous transportation improvements aimed to ease congestion and provide alternatives to travelers. The projects include I-495 HOT lanes, I-95 Express Lanes and Dulles Corridor Metrorail construction.

In 2007, the Virginia Department of Transportation (VDOT) began a new program of congestion management during the construction of megaprojects. The megaproject-related congestion management provides both "Commuter Solutions" and "Employer Solutions".

"Commuter Solutions" include new bus services (Tysons Express Bus Service) to Tysons Corner during construction of the I-495 HOT lanes and the Dulles Metrorail, Carpooling/Vanpooling/NuRide through the region's Commuter Connections Program, Telework, and so on. "Employer Solutions" are essentially several incentives to employers to help them create new approaches or enhance existing services to keep their employees moving during construction.

[117] http://www.vamegaprojects.com/

4. STUDIES OF CONGESTION MANAGEMENT STRATEGIES

Defining, analyzing and assessing congestion management strategies are important components of the CMP. This chapter reviews performance measures adopted by the TPB and its subcommittees and the effectiveness of demand and operational management strategies. Several important studies of strategies are also documented in this chapter as examples.

4.1 Review of Performance Measures

4.1.1 Introduction to Performance Measures

A performance measure, or indicator, is a means to gauge and understand the usage of a transportation facility, or the characteristics of particular travelers and their trips. The performance measure/indicator may refer to a particular location or "link" of the transportation system.

Performance measures can be either quantitative or qualitative. It may refer to the experience of a traveler on a trip between a particular origin and a particular destination. It may summarize all trips or trip makers between a particular origin and destination pair. Or, it may describe the operation of one mode of transportation versus another.

Federal regulations state that the CMP should include:

"Definition of congestion management objectives and performance measures to assess the extent of congestion and support the evaluation of the effectiveness of congestion reduction and mobility enhancement strategies for the movement of people and goods."

The fields of transportation planning have typically used mode-specific performance measures/indicators to gauge conditions on the system. These include motor-vehicle specific performance measures such as traffic volumes, capacities, and level-of-service.

4.1.2 How Performance Measures/Indicators Were Selected

Level of Service has generally been the most widely used performance measure in the Washington region, as can be seen in the Freeway Monitoring Program and Arterial Monitoring Program. However, there are other performance measures that are used, such as Volume/Capacity (V/C) ratio.

In 1993, the CMS Task Force undertook discussion of performance measures/indicators because of the emphasis in federal CMS guidance on this issue, culminating in the publication of performance measures in the 1994 CMS Work Plan[118]. The efforts at the beginning of the process involved a literature search and brainstorming process. An array of possible performance measures were developed based on materials from an FHWA instructional course on CMP. The CMP Task Force worked with these draft lists, adding, deleting, and changing the performance

[118] *CMS Work Plan for the Washington Region*, approved by the TPB on September 21, 1994.

measures to suit the needs of the Washington region. The result was a stratified list of CMP performance measures.

Early in the process, the CMS Task Force was already aware of the gap between the intermodal, locally focused performance measures/indicators available and the multi-modal, wide-area scope desired for congestion management. Other issues were raised, as well, which set the tone of the discussion. The following were taken into consideration:

- Can the particular performance measure/indicator (or the data needed to feed it) be forecast by known tools and capabilities?

- Traditional congestion indicators tended to be precise in scale, addressing a particular link or intersection on the transportation system, yet modeling or forecasting capabilities tended to be rough in scale, forecasting at best, a regional or sub-regional scale. Post processing forecast data would improve the precision at a corridor level. The choice of performance measures may lead or bias the investigator toward only certain kinds of solutions, and eliminate others that may actually be worthy. This was a particular concern expressed by elected officials on the TPB.

- The CMP tries to have a layman's term, "congestion" apply to a technical process. Congestion could be characterized by crowdedness, by delay, or by decreases in traffic speeds. Conversely, crowdedness, delay, and slowing are not all the same phenomenon not always experienced, and not always tantamount to congestion.

- Level of Service appeared to be the most promising alternative to using delay. It has been used frequently in the past, and there is a level of understanding and buy-in from regional decision makers and the public. Level-of service does have some drawbacks, including not being multi-modal. Even though LOS E and F are considered as congested, in urban areas some levels of congestion is considered accetable. In addition, it is difficult to distinguish from the varying severities of Level of Service "F."

The solution proposed and adopted instead was to choose a whole list of indicators, and apply them where and when relevant. The CMS Task Force reviewed over 100 different performance measures in use or suggested for use by States and localities around the country. This list was then narrowed to a manageable few. Some of the major criteria used to rate the utility of prospective performance measures were the following:

- Had to be clear and understandable.
- Had to be sensitive to modes.
- Had to be sensitive to time.
- Based on readily available data.
- Can be forecast.
- Able to gauge the impact of one or more congestion management strategies.
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4.1.3 Selected CMP Performance Measures from the 1994 CMS Work Plan

Summary List

Following is a list of performance measures selected:[119]

- *Data for Direct Assessment of Current (or future background) Conditions:*
  - Traffic volumes
  - Facility capacity
  - Speed
  - Vehicle density
  - Vehicle classification
  - Vehicle occupancy
  - Transit ridership
  - Accident/Incident data ?

- *Calculated performance measures/indicators for congestion assessment:*
  - Volume-to-capacity (V/C) ratio
  - Level of Service
  - Person miles of travel/vehicle miles of travel
  - Truck hours of travel
  - Person hours of delay/vehicle hours of delay
  - Modal shares
  - Safety considerations
  - Vehicle trips
  - Emissions reduction benefits

Descriptions of the Performance Measures

Direct Assessment

- *Traffic volumes* – number of vehicles crossing a certain point, usually expressed for an average weekday. This indicator would be applicable in corridors or spot locations, and of interest in the assessment of most CMP strategies.
- *Facility capacity* – Typically for highways, and expressed in terms of the number of passenger car equivalents that can pass over a certain point in an hour, given the geometric characteristics and environment of the highway.
- *Speed* – Defined as the average running speed of motor vehicles traversing a section of roadway. Speed as an indicator is applicable in corridors or spot locations, and is of interest in the assessment of most CMP strategies.
- *Vehicle density* – Described as passenger-car-equivalents per lane per mile. It is of interest for highway-oriented CMP strategies such as traffic operations and HOV facilities.
- *Vehicle classification* – Entails determining the proportion of vehicle traffic type passing a given point. Can be passenger cars, trucks, buses, or other vehicle types. It is applicable to spot locations, and is of interest in the assessment of most CMP strategies.

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[119] As originally identified in the 1994 *CMS Work Plan for the Washington Region*.

- *Vehicle occupancy* – average number of persons per motor vehicle for a given location. It is applicable region-wide, or on a corridor or spot basis. Can be used in the comparison of corridors.
- *Transit ridership* – average daily volume of passengers on given transit lines or facilities. It is of interest in the assessment of the following CMP strategies: Transportation Demand Management (TDM), transit, congestion pricing, and growth management.
- *Accident/Incident data* – average number of accidents per million vehicle miles of travel by different facility types. Higher accident rates is an indirect indication of congestion.

Calculated

- *Volume-to-Capacity (V/C) Ratio* – ratio of demand flow rate at a given level of vehicle capacity for a roadway. Calculated from available highway data according to national standards in the Highway Capacity Manual. V/C Ratio was analyzed in the 2008-2030 Plan Performance evaluation.
- *Level of Service* – rating of the quality of service provided by a roadway under a given set of operating conditions. A roadway is classified with a letter "A" through "F" with "A" being the least congestion and "F" being the most congested. For LOS F conditions density/speed is used as an indication of the severity of the F. This performance measure is currently used in the Freeway Monitoring Program.
- *Person Miles of Travel/Vehicle Miles of Travel* – sum of all miles of travel by all vehicles for a given area or facility for a given period of time, factored by the vehicle occupancy to gauge person movement.
- *Modal Shares* – indicate the apportioning of person trips among possible transportation modes: single-occupant vehicle (SOV), high-occupancy vehicle (HOV), transit, non-motorized, or other modes of transportation.
- *Safety Considerations* – include empirical or sketch planning evaluation of safety or hazard issues in a given congestion situation or in consideration of potential congestion management strategies.
- *Vehicle Trips* – number of motor vehicle trips from a given origin to a given destination, which may be stratified by mode purpose, time period, vehicle type, or other classifications.
- *Emissions Reductions Benefits* – reductions in criteria pollutant emissions based on reductions in vehicle miles of travel or vehicle trips. Currently, this performance measure is used when analyzing the TERMs for the region.

Other Performance Measures for Consideration

There are a number of performance measures that would be beneficial to congestion management, but require more research before use in the CMP. Some of these include:

- *Bicycle usage and pedestrian counts*
  - Very little data on these have been collected in the region, but would be beneficial in areas such as bicycle and pedestrian planning and growth management.
- *Number of congested intersections*

  - Will give an indication of the extent and severity of congestion. Possible sources include traffic volumes, Data Clearinghouse information, and traffic operations models.
- *Hours per day of congestion*
  - Will directly address the need to gauge the extent of congestion on the transportation system. This indicator is dependent upon having travel volumes by time of day.
- *Percent person miles of travel by congestion level*
  - Will allow comparison of the extent of congestion among CMP locations.
- *Percent delay*
  - The total delay (in minutes) divided by the designated threshold (meaning expected, ideal, or free-flow) travel time. For example, a percent delay of 25% would mean that travel time on a certain segment of the transportation system is taking 25% longer than it would be expected to under non-congested conditions.
- *Average duration of incidents*
  - Could be incidents, special events, infrastructure or equipment failures, or other unusual circumstances that lead to a one-time-only or occasional increase in traveler delay.
- *Truck and freight movement involvement with congestion*
  - Impact of truck and freight movement on congestion. Currently the region does not have much data on hand in this area.
- *Percent of person miles of travel by transit load factor*
  - This is the transit analog of highway congestion as described by Level of Service. Load factor indicates the crowdedness of the transit vehicles, thus providing an overall indication of crowdedness on the portion of the transportation system.
- *Person volume-to-person capacity ratio*
  - Used to develop a Level of Service for transportation corridors by taking the sum of automobile and transit capacities. Levels of service are then determined with reference to volume-to-capacity standards.

4.1.4 Additional CMP Performance Measures

Since the TPB development of the above CMP performance measures in 1994, there has been an evolution towards more traveler-oriented metrics in conveying congestion and related information to the general public. Some of the measures are leveraged by emerging highway performance monitoring activities such as the I-95 Corridor Coalition's Vehicle Probe Project that provides probe-based continuous monitoring. Earlier in this report, the following four measures were used, with the first two quantifying congestion and the latter two travel time reliability. The newly developed Strategic Plan for the Management, Operations and Intelligent Transportation Systems (MOITS) Program adopted travel time index, buffer time index and planning time index as three regional indices of travel conditions and traveler's experience.

- *Travel time index*
  - Travel time index is the ratio of actual travel time over free flow travel time obtained for a roadway segment during a specific time period. The travel time index expresses the average amount of extra time it takes to travel in a predefined time period relative to free-flow travel.

- *Planning time index*
    - Planning time index is 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 if the free flow travel time is 40 minutes and the 95th percentile travel time is 50 minutes. The planning time index is 1.25 which is 50 divided by 40.

4.2 Review of Congestion Management Strategies

4.2.1 Introduction

Federal regulations state that the CMP should include:

> *"Identification and evaluation of the anticipated performance and expected benefits of appropriate congestion management strategies that will contribute to the more effective use and improved safety of existing and future transportation systems based on the established performance measures. The following categories of strategies, or combinations of strategies, are some examples of what should be appropriately considered for each area:*
>
> *(i) Demand Management measures, including growth management and congestion pricing;*
> *(ii) Traffic operational improvements;*
> *(iii) Public transportation improvements;*
> *(iv) ITS technologies as related to the regional ITS architecture; and*
> *(v) Where, necessary, additional system capacity."*[120]

To address this point, strategy lists have been developed as a way of categorizing congestion management strategies and characterizing the current impact, or potential impact, these strategies have throughout our region.

These lists are modeled after the longstanding Transportation Emission Reduction Measure (TERM) process for air quality in the region. The TERM list was formed as a way of developing additional plan and program elements which could be utilized to mitigate emission increases.

Similarly, lists have been developed for strategies under consideration for Congestion Management. At this time the effort is proposed to be qualitative, as the congestion information is not tied to one specific location. In addition, some strategies are regional while others are local , and a qualitative effort better characterizes the impact they have on the region as a whole.

[120] §450.320(c), Metropolitan Transportation Planning, Final Rule, Federal Register, February 14, 2007 – emphasis added.

The following section contains background and summary information of how the Strategy Lists were developed.

4.2.2 Descriptions of Strategies

The general characteristics of strategies are provided in Table 16 and Table 17; one for operational management strategies (those strategies contributing to a more effective use of existing systems) and one for demand management strategies (those that influence travel behavior). The qualitative criteria across the top of the lists, and the methodology used to categorize each strategy as "some impact (x)", "significant impact (xx)", and "high impact (xxx)" are the same for both tables. The separate tables are simply for the purpose of distinguishing the two types of strategies. A more detailed review of the strategies is provided in Appendix G.

Table 16: Congestion Management Process (CMP) Demand Management Strategies Criteria

1. Some Impact (x)
2. Significant Impact (xx)
3. High Impact (xxx)

		QUALITATIVE CRITERIA									
		Impacts on Congestion									
STRATEGY		Reduces Overall Congestion	Reduces Incident-related Congestion	Supports/Promotes Multi-modal Transportation	Regional Applicability	Local Applicability	Existing Level of Deployment	Ease of Implementation	Cost	Cost Effectiveness	Enhance Existing Programs
C.5.0	***Alternative Commute Programs***										
C.5.1	Carpooling	xxx	x	x	xxx	xxx	xxx	xx	x	xxx	xxx
C.5.2	Ridematching Services	xxx	x	x	xxx	xxx	xxx	xx	x	xxx	xxx
C.5.3	Vanpooling	xxx	x	x	xxx	xx	xx	xx	x	xxx	xxx
C.5.4	Telecommuting	xx	x	x	xxx	xx	xx	xxx	x	xx	xxx
C.5.5	Promote Alternate Modes	xx	x	xxx	xxx	xxx	xxx	xxx	x	xx	xxx
C.5.6	Compressed/flexible w orkw eeks	xx	x	x	xxx	xxx	xxx	xxx	x	x	xx
C.5.7	Employer outreach/mass marketing	xx	x	xxx	xxx	xxx	xx	xx	xx	xx	xxx
C.5.8	Parking cash-out	xx	x	xxx	x	xxx	x	x	xx	xx	x
C.5.9	Alternative Commute Subsidy Program	xx	x	xxx	xxx	xx	xx	x	x	xxx	xxx
C.6.0	***Managed Facilities***										
C.6.1	HOV	xx	x	xxx	xxx	xx	xx	xx	xxx	xxx	xxx
C.6.2	Variably Priced Lanes (VPL)	xxx	x	xx	xxx	xx	x	x	xxx	xxx	xx
C.6.3	Cordon Pricing	xxx	x	xxx	xxx	x	x	x	xx	xxx	xx
C.6.4	Bridge Tolling	xxx	x	x	xx	xx	x	x	xxx	xx	x
C.7.0	***Public Transportation Improvements***										
C.7.1	Electronic Payment Systems	xx	x	xxx	xx	xx	xxx	xx	xx	xxx	xx
C.7.2	Improvements/added capacity to regional rail and bus transit	xx	xx	xxx	xx	xxx	xx	x	xxx	xxx	xx
C.7.3	Improving accessibility to multi-modal options	xx	x	xxx	xx	xxx	xx	xx	xx	xx	xxx
C.7.4	Park-and-ride lot improvements	xx	x	xx	xx	xx	xx	xx	xx	xx	xx
C.7.5	Carsharing Programs	xx	x	xxx	xxx	xxx	xx	xxx	xx	xx	xxx
C.8.0	***Pedestrian, bicycle, and multi-modal improvements***										
C.8.1	Improve pedestrian facilities	xx	x	xxx	xx	xxx	xx	xx	xx	xx	xxx
C.8.2	Creation of new bicycle and pedestrian lanes and facilities	xx	x	xxx	xxx	xxx	xx	xx	xx	xx	xxx
C.8.3	Addition of bicycle racks at public transit stations/stops	x	x	xx	xxx	xxx	xx	xxx	x	x	xxx
C.8.4	Bike sharing programs	xx	x	xxx	xxx	xxx	xx	xxx	xx	xx	xxx
C.9.0	***Growth Management***										
C.9.1	Coordination of Regional Activity Centers	xx	x	xxx	xxx	xxx	xx	x	xxx	xxx	xx
C.9.2	Implementation of TLC program (i.e. coordination of transportation and land use w ith local gov'ts)	xx	x	xxx	xxx	xxx	xx	xxx	x	xxx	xxx
C.9.3	"Live Near Your Work" program	xx	x	xx	xxx	xx	x	xx	x	x	xx

Table 17: Congestion Management Process (CMP) Operational Management Strategies Criteria

1. Some Impact (x)
2. Significant Impact (xx)
3. High Impact (xxx)

STRATEGY		QUALITATIVE CRITERIA: Impacts on Congestion – Reduces Overall Congestion	Reduces Incident-related Congestion	Supports/Promotes Multi-modal Transportation	Regional Applicability	Local Applicability	Existing Level of Deployment	Ease of Implementation	Cost	Cost Effectiveness	Enhance Existing Programs
C.1.0	***Incident Mngt./Non-recurring***										
C.1.1	Imaging/Video for surveillance and Detection	xx	xxx	xx	xxx	xxx	xx	xx	xx	xxx	xxx
C.1.2	Service patrols	xx	xxx	x	xxx	xxx	xx	xxx	xx	xxx	xxx
C.1.3	Emergency Mngt. Systems (EMS)	x	xx	x	xx	xxx	xxx	xx	xxx	xxx	xxx
C.1.4	Emergency Vehicle Preemption	x	xx	x	x	xxx	xx	xx	xx	x	xx
C.1.5	Road Weather Management	x	xxx	x	xxx	xxx	xx	xx	xx	xx	xx
C.1.6	Traffic Mngt. Centers (TMCs)	xx	xxx	xx	xxx	xx	xx	xx	xx	xxx	xxx
C.1.7	Curve Speed Warning System	xx	xx	x	x	xx	x	xx	xx	xx	x
C.1.8	Work Zone Management	xx	xxx	x	xx	xxx	xx	xx	xx	xx	xx
C.1.9	Automated truck rollover systems	x	xx	x	x	xx	xx	xx	xx	xx	xx
C.2.0	***ITS Technologies***										
C.2.1	Advanced Traffic Signal Systems	xxx	xx	xx	xxx	xxx	xx	xx	xxx	xxx	xxx
C.2.2	Electronic Payment Systems	xxx	x	xx	xxx	xx	xx	xx	xx	xxx	xx
C.2.3	Freew ay Ramp Metering	xx	x	x	xx	xx	x	xx	xx	xx	xx
C.2.4	Bus Priority Systems	x	x	xxx	xxx	xxx	x	xx	xxx	xx	xx
C.2.5	Lane Management (e.g. Variable Speed Limits)	xx	xx	x	xx	xxx	x	xx	xx	xx	xx
C.2.6	Automated Enforcement (e.g. red light cameras)	x	x	x	x	xxx	xx	xx	xx	xx	xx
C.2.7	Traffic signal timing	xxx	x	xx	xxx	xxx	xx	xxx	x	xxx	xxx
C.2.8	Reversible Lanes	xx	x	x	xx	xxx	x	x	xx	xx	xx
C.2.9	Parking Management Systems	xx	x	xx	xx	xxx	x	x	xxx	xx	xx
C.2.10	Dynamic Routing/Scheduling	xx	x	xx	xxx	xxx	x	x	xxx	xx	xx
C.2.11	Service Coordination and Fleet Mngt. (e.g. buses and trains sharing real-time information)	xx	x	xxx	xxx	xxx	x	x	xx	xx	xx
C.2.12	Probe Traffic Monitoring	xx	xxx	x	xx	xx	x	xx	xx	xxx	xx
C.3.0	***Advanced Traveler Information Systems***										
C.3.1	511	xx	xxx	xx	xxx	x	xx	xx	xxx	xx	xxx
C.3.2	Variable Message Signs (VMS)	xx	xxx	xx	xx	xxx	xx	xx	xx	xxx	xxx
C.3.3	Highw ay Advisory Radio (HAR)	x	xx	x	xx	xxx	xx	xxx	xx	x	xx
C.3.4	Transit Information Systems	xx	xx	xxx	xx	xxx	xx	x	xx	xx	xxx
C.4.0	***Traffic Engineering Improvements***										
C.4.1	Safety Improvements	x	xxx	x	x	xxx	xx	xxx	x	xxx	xxx
C.4.2	Turn Lanes	xx	x	x	x	xxx	xx	xx	xx	xx	x
C.4.3	Roundabouts	x	xx	x	x	xxx	x	x	x	xx	xx

4.3 Examples of Strategies Studies

4.3.1 Analysis of Transportation Emissions Reduction Measures (TERMs)

Overview

Transportation Emission Reduction Measures (TERMs) are strategies or actions employed to offset increases in nitrogen oxide (NOx) and volatile organic compound (VOC) emissions from mobile sources. The TPB has been adopting TERMs since FY 1995.

The Clean Air Act Amendments of 1990 (CAAA) and SAFETEA-LU requires metropolitan planning organizations and DOTs to perform air quality analyses, to ensure that the transportation plan and program conform to mobile emission budget established in the State Implementation Plans (SIP). Consequently MPOs and DOTs are required to identify TERMs that would provide emission-reduction benefits and other measures intended to modify motor vehicle use.

Selection of the TERMs requires quantitative as well as qualitative assessment. The quantitative assessment includes specific information on the benefits, costs, and expected air-quality benefits. Qualitative criteria includes ranking based on the subjective criteria's such as ease of implementation, how to implement, and synergy with other measures.

As greenhouse gas (GHG) emission becomes a global climate issue, the effects of TERMs on GHG reduction in the Washington region are analyzed in the "What Would It Take" Scenario Study (see Section 4.3.3).

Findings and Applications to Congestion Management

Most TERMs are intended to reduce either the number of vehicle trips (VT), vehicle miles traveled (VMT), or both. These strategies may include ridesharing and telecommuting programs, improved transit and bicycling facilities, clean fuel vehicle programs or other possible actions. These TERMs are not only important to offsetting increases in NOx and VOC, but many are important in congestion management by reducing trips and miles of travel.

The Washington region has adopted and implemented several TERMs with the sole aim of reducing emissions, such as the addition of clean diesel bus service, taxicabs with Compressed Natural Gas (CNG) cabs, and CNG buses. However, many TERMs also have an impact on congestion management. Examples of some of these congestion-mitigating TERMs that have been implemented include (the number after each TERM coincides with a number on the TERM tracking sheet):

- *Upgraded Signal Systems in Maryland*
    - MD 85 Executive Way to MD 355
    - MD 355, I-70 ramps to Grove Road
    - MD 410, 62nd Avenue to Riverdale Rd
- *Traffic Signal Optimization*

- *Alexandria Telecommuting Program*
- *Cherry Hill VRE access*
- *Bicycle facilities*
- *Additional park-and-ride lots*
    - Shady Grove West park-and-ride
    - White Oak park-and-ride
    - Tacketts Mill park-and-ride
    - Town of Leesburg park-and-ride
- *Pedestrian facilities to Metrorail*
- *Employer outreach/Guaranteed Ride Home*
- *District of Columbia Incident Response and Traffic Management System*
- *Carsharing program*

In addition, there are a number of potential TERMs that are being considered for the region that would impact congestion management. Some examples include:

- *Employer parking cash-out (M-07A)*
- *Improve pedestrian facilities near rail stations* (M-93)
- *Implement neighborhood circulator buses* (M -134)
- *Vanpool incentive program* (M-132)
- *WMATA bus information displays with maps* (M-148)
- *Enhanced commuter service (HOV facilities)* (M-150)
- *Parking impact fees* (M-144)

4.3.2 Scenario Planning

In 2007 the TPB Scenario Task Force was formed. Since then two new scenarios, "CLRP Aspirations" and "What Would It Take", were studied and the results presented to the TPB in 2010.

"CLRP Aspirations" Scenario

"CLRP Aspirations" scenario is an integrated land use and transportation scenario for 2030 building on the key results of previous TPB scenario studies. . It includes concentrated land use growth in Regional Activity Centers, a regional network of variably priced lanes, and a high quality bus rapid transit network operating on the VPL network. The TPB was briefed on the final results of the CLRP Aspirations Scenario and a land use only sensitivity test in September 2010. In response to TPB concerns about the cost and extent of the VPL network, a "streamlined" VPL network sensitivity test was developed and the results were presented in October 2011. Some of the major findings of the scenario study include:

- Relative to the 2008 CLRP baseline for 2030, the full CLRP Aspirations Scenario:
    - Shows an 11.9% decrease in regional vehicle hours of delay (VHD) while vehicle miles traveled (VMT) increase by 3.1%
    - Increases non-motorized trips by 16.3%, transit trips by 13.9%, and more than doubles HOV trips
- Relative to the 2008 CLRP baseline for 2030, the Land use Only Sensitivity Test

    - Shows a small increase in regional VHD (1%) and a small decrease in regional VMT (0.5%); however, VHD and VMT increase in the inner jurisdictions by 6.2 and 1.4 percent, respectively
    - Increases non-motorized trips by 16.5% and transit trips by 10.5%, while decreasing HOV trips by 2.4%
- Relative to the full CLRP Aspirations Scenario, the Streamlined VPL Network Sensitivity Test
    - Shows slightly lower reductions in VHD, but a slightly lower increase in VMT
    - Shows the same increased in non-motorized travel and slightly lover increase in HOV trips

"What Would It Take" Scenario

"What Would It Take?" scenario starts with the adopted COG non-sector specific goals for reducing mobile source greenhouse gas emissions for 2030 and beyond. It assesses how such goals might be achieved in the transportation sector through different combinations of interventions that include increasing fuel efficiency, reducing the carbon-intensity of fuel, and improving travel efficiency. The study was completed in May 2010. The study found that:

- Strategies analyzed to date do not achieve regional goals of reducing greenhouse gas emissions, and additional strategies can and should be analyzed.
- Goals are difficult to meet and will require emission reductions in all three categories: Vehicle efficiency (CAFÉ improvement), alternative fuel (cellulosic ethanol), and travel efficiency (strategies aimed at reducing VMT, congestion, and delays).
- While major reductions can come from federal energy policies, local governments can make significant reductions quickly.
- Some strategies may not have major greenhouse gas (GHG) reduction potential, but have multiple benefits worth exploring through benefit-cost analysis (e.g. the MATOC program).

The study also recommended nine potential local actions that can be implemented quickly to reduce GHG.

4.3.3 MATOC Benefit-Cost Analysis

The Metropolitan Area Transportation Operations Coordination (MATOC) Program is a joint program of VDOT, MDOT, DDOT, WMATA and TPB. It aims to provide real-time situational awareness of transportation operations in the National Capital Region (NCR), especially during emergencies and other incidents with significant impacts on travelers and on the transportation systems of the region.

A benefit-cost study has been carried out to quantify the effectiveness of this program as well as to better advise stakeholders in funding identification.

The benefit-cost study looked at traveler's "modified trips" - trips made at a later time, on another route, by another mode, or not made due to regionally significant incidents. Benefits were estimated from reduced delay, lower fuel consumption, lower emissions (including greenhouse gases), and avoidance of secondary incidents. Three case studies made up of two freeway incidents and one arterial incident was conducted. The study found an overall benefit/cost ratio conservatively estimated at 10 to 1. A summary report of this study will be released soon.

4.3.4 MOITS Strategic Plan

The Management, Operations, and Intelligent Transportation Systems (MOITS) program of the TPB has been developing a strategic plan for the program and a draft plan has been released.

This Strategic Plan defines and promotes potential regional projects or activities for the management, operations, and application of advanced technology for the region's transportation systems, as well as to advise member agencies on management, operations, and transportation technology deployments for meeting common regional goals and objectives.

The MOITS Strategic Plan builds upon the TPB Vision by identifying four key tactical actions toward achieving and building upon the goals, objectives, and strategies of the Vision. It identifies nine emphasis areas derived from the National ITS Architecture, seven proposed projects, three strategic efforts and a number of "best practices" for consideration by the member agencies and jurisdictions. The Plan also recommends use of a few key performance measures, including travel time index, buffer time index and planning time index, which are already used in this CMP Technical Report. The Strategic Plan concludes with seven key recommendations for the MOITS Technical Subcommittee and Program.

5. HOW RESULTS OF THE CMP ARE INTEGRATED INTO THE CLRP

According to federal regulations, the CMP should be an integrated process in the CLRP rather than a standalone product of the regional transportation planning process. This chapter clarifies this integration.

5.1 Components of the CMP Are Integrated in the CLRP

There are four major components of the CMP as described in the CLRP:

- Monitor and evaluate transportation system performance
- Define and analyze strategies
- Implement strategies and assess
- Compile project-specific congestion management information

In monitoring and evaluating transportation system performance, the TPB uses Skycomp aerial photography freeway monitoring and a number of other travel monitoring activities to support both the CMP and travel demand forecast model calibration, complementing operating agencies' own information, and illustrating locations of existing congestion. CLRP travel demand modeling forecasts, in turn, provide information on future congestion locations. This provides an overall picture of current and future congestion in the region, and helps set the stage for agencies to consider and implement CMP strategies, including those integrated into capacity-increasing roadway projects.

The CMP component of the CLRP defines and analyzes a wide range of potential demand management and operations management strategies for consideration. TPB, through its Technical Committee, Travel Management Subcommittee, Travel Forecasting Subcommittee, and other committees, reviews and considers both the locations of congestion and the potential strategies when developing the CLRP.

For planned (CLRP) or programmed (TIP) projects, cross-referencing the locations of planned or programmed improvements with the locations of congestion helps guide decision makers to prioritize areas for current and future projects and associated CMP strategies. Maps in the 2009 CLRP showed a high correlation between the locations of planned or programmed projects and locations where congestion is being experienced or is expected to occur.

Thus CLRP and TIP project selection is informed by the CMP, and implementation of CMP strategies is encouraged. The region relies particularly on non-capital congestion strategies in the Commuter Connections program of demand management activities, and the Management, Operations, and Intelligent Transportation Systems (MOITS) program of operations management strategies. Assessments of these programs are analyzed, along with regular updates of travel monitoring to look at trends and impacts, to feed back to future CLRP cycles.

The TPB also compiles information pertinent to specific projects in its CMP documentation process (form) within the annual CLRP Call for Projects. This further assures and documents that the planning of federally-funded SOV projects has included considerations of CMP strategy alternatives and integrated components.

5.2 Demand Management in the CLRP

Demand Management aims at influencing travelers' behavior for the purpose of redistributing or reducing travel demand. Existing demand management strategies contribute to a more effective use and improved safety of existing and future transportation systems. The long-range plan takes a number of demand management strategies into consideration when planning for the region's transportation infrastructure. Such strategies include alternative commute programs, managed facilities (such as HOV facilities and variably priced lanes), public transportation improvements, pedestrian and bicycle facility improvements, and growth management (implementing transportation and land use activities). These strategies are outlined in detail in Section 3.2

In "Call for Projects" for the CLRP and TIP, for any project providing a significant increase to SOV capacity, it must be documented that the implementing agency considered all appropriate systems and demand management alternatives to the SOV capacity. A Congestion Management Documentation Form is distributed along with the Call for Projects and a special set of SOV congestion management documentation questions must be answered for any project to be included in the Plan or TIP that significantly increases the single occupant vehicle carrying capacity of a highway.

A set of projects included in the CLRP and TIP are exclusively dedicated to (and titled as) transportation demand management (TDM), such as TDM for employer outreach, TDM media program, and implement a TDM program.

Some projects included in the CLRP and TIP are revised as needed to reflect pertinent TDM study results, e.g., the I-95/395 HOV-HOT-Bus Lanes project was revised to reflect the results of the Transit/Transportation Demand Management Study conducted by the Virginia Department of Rail and Public transportation (DRPT) and the Technical Advisory Committee in the 2008 CLRP.

Finally, the TPB certifies demand management of the CMP in the overall certification of the transportation planning process in the National Capital Region. The Board finds the transportation planning process is addressing the major issues in the region and is being conducted in accordance with all applicable requirements.

5.3 Operational Management in the CLRP

Part of the CMP effort focuses on defining the existing operational management strategies that contribute to the more effective use and improved safety of existing and future transportation systems. Such strategies include incident management programs, ITS Technologies, Advanced Traveler Information Systems, and traffic engineering improvements. These strategies are outlined in detail in Section 3.3.

Along with demand management strategies, operational management alternatives must also be considered when SOV capacity expanding projects are submitted to the Call for Projects of the CLRP and TIP. The considerations are documented in the Congestion Management Documentation Form.

The TPB also certifies operational management of the CMP in the overall certification of the transportation planning process in the National Capital Region.

5.4 Capacity Increases in the CLRP and Their CMP Components

Federal law and regulations list capacity increases as another possible component of operational management strategies, for consideration in cases of:

- *Elimination of bottlenecks*, where a modest increase of capacity at a critical chokepoint can relieve congestion affecting a facility or facilities well beyond the chokepoint location. Widening the ramp from I-495 Capital Beltway Outer Loop to westbound VA 267 (Dulles Toll Road) relieved miles of regularly occurring backups on the Beltway and across the American Legion Bridge.

- *Safety improvements*, where safety issues may be worsening congestion, such as at high-crash locations, mitigating the safety issues may help alleviate congestion associated with those locations.

- *Traffic operational improvements*, including adding or lengthening left turn, right turn, or merge lanes or reconfiguring the engineering design of intersections to aid traffic flow while maintaining safety.

These considerations should be included in the Congestion Management Documentation Form in the CLRP and TIP project submissions.

5.5 Regional Transportation Priorities Plan Facilitates CMP-CLRP Integration

The Regional Transportation Priorities Plan (RTPP)[121], which is a milestone of TPB's Performance-Based Planning approach, facilitates the integration of the CMP and the CLRP. The RTPP is expected to be completed in the first quarter of fiscal year 2014.

Building on previous regional transportation planning activities, the RTPP is to identify those transportation strategies that offer the greatest potential contributions to addressing continuing regional challenges, and to provide support for efforts to incorporate those strategies into future updates of the CLRP in the form of specific programs and projects. The plan will articulate regional priorities for enhancing the performance of the CLRP in advancing regional goals for economic opportunity, environmental stewardship, and quality of life. The RTPP will focus on identifying a limited number of regional priorities, perhaps 10 to 15 at any one time.

[121] Regional Transportation Priorities Plan, http://www.mwcog.org/transportation/priorities/

The development of the RTPP is taking place over a period of two years. An interim report on near-term regional priority strategies, programs and projects is expected to be complete by the summer of 2012, with a report on longer-term regional priorities due the following summer, in time to influence the projects and programs that will be a part of the next full CLRP update in 2014.

6. CONCLUSIONS

The 2012 CMP Technical Report hereby concludes with a summary of key findings and important recommendations from throughout the report to improve the Congestion Management Process in the Washington region.

6.1 Key Findings of the 2012 CMP Technical Report

1. Freeway travelers in the Washington region on average experienced decreasing delays from 2009 to 2011. The total hours of delay of a typical traveler who commuted on freeways was 133 hours (at a cost of $2,558) in 2011, decreased by 15% and 33% compared to 2010 and 2009, respectively. Consistent with the decease of delay, the intensity, spatial extent of freeway congestion during AM and PM peak periods, and the vehicle miles traveled (VMT) on freeways also decreased in the same time period; travel time reliability on freeways improved.

2. Congestion varies seasonally on freeways in the region: June usually experienced the longest delay in a year, while the winter months and August had only moderate delays, except when adverse weather conditions were in presence, such as the winter storms occurred in December 2009 and February 2010.

3. About 4,600 directional route miles of arterials were scanned for the first time in the region, thanks to the procurement of INRIX 2010 historical traffic data. Initial analysis revealed that there were always more than a quarter of the 4,600 route miles of arterials congested from 7:00 AM to 6:30 PM on a workday in 2010 (not necessarily the same set of arterials always congested).

4. Arterial congestion unevenly distributed in the region, with more congestion in dense urban areas where there is an emphasis on streets as accessibility in addition to mobility.

5. The TPB's Regional Transportation Priorities Plan (RTPP) has taken a performance-based transportation planning approach to identify those transportation strategies that offer the greatest potential contributions to addressing continuing regional challenges, and to provide support for efforts to incorporate those strategies into future updates of the CLRP in the form of specific programs and projects. The CMP supports the RTPP by monitoring congestion and providing strategies that could improve the mobility of the transportation systems.

6. The Commuter Connections program remains the centerpiece to assist and encourage people in the Washington region to use alternatives to the single-occupant automobile. The transit system in the Washington region serves as a major alternative to driving alone – transit mode share is among the highest several metropolitan areas in the country.

7. This region has enhanced efforts in regional transportation operations coordination. The Metropolitan Area Transportation Operations Coordination (MATOC) program was

recently enhanced with more staff covering longer time period, and a dedicated MATOC public website (www.matoc.org) providing real-time traffic and incidents information. A Regional Incident Coordination (RIC) program was newly created to facilitate regional coordination upon a variety of emergent incidents. A dedicated website (www.capitalregionaupdates.gov) was also launched to provide the general public one-stop shop for emergency alerts, weather, traffic, and utilities information.

8. Variably Priced Lanes (VPLs) provide options to travelers. Maryland Route 200 (Intercounty Connector (ICC)) was fully opened in November 2011 for the section between I-270 and I-95; some positive effects in reducing congestion and providing more options have already been observed. The 495 Express Lanes will be open on the Virginia side of the Capital Beltway in 2013.

9. Bike Sharing and Car Sharing programs are growing. The number of bicycle and pedestrian facilities in the region has increased in recent years. The Capital Bikeshare now covers Washington, D.C. and Arlington, VA, and will be expanded to Alexandria, VA and possibly Montgomery County, MD. Car sharing has taken off in the Washington region, with over 800 shared Zipcar® cars in the District of Columbia alone with plans for that number to continue growing. In addition to Zipcar®, Car2Go and Hertz On Demand have moved into the Washington region car sharing market.

10. Congestion management strategies of Management, Operations, and Intelligent Transportation Systems (MOITS) provide essential ways to make most of the existing transportation facilities.

6.2 Recommendations for the Congestion Management Process

The 2012 CMP Technical Report documents the updates of the Congestion Management Process in the Washington region from mid 2010 to mid 2012. Looking forward, the report leads to several important recommendations for future improvements.

The 2012 CMP Technical Report documents the updates of the Congestion Management Process in the Washington region from mid 2010 to mid 2012. Looking forward, the report leads to several important recommendations for future improvements.

1. **Continue to enhance the Congestion Management Process to help support the** Regional Transportation Priorities Plan (RTPP), and other performance-based planning and programming processes.

2. **Continue the Commuter Connections program.** The Commuter Connections program is a primary key strategy for demand management in the National Capital Region and it is beneficial to have a regional approach. Meanwhile, this program reduces transportation emissions and improves air quality, as identified by the TERMs evaluations.

3. **Continue and enhance the MATOC program and support agency/jurisdictional transportation management activities including the Regional Incident Coordination**

(RIC) Program. The MATOC program/activities are key strategies of operational management in the National Capital Region. Future enhancements of the MATOC program should be considered when appropriate to expand the function and participation of the program.

4. **Capacity increasing projects should consider variable pricing and other management strategies.** Variably priced lanes (VPLs) provide a new option to avoid congestion for travelers and an effective way to manage congestion for agencies.

5. **Encourage implementation of congestion management for major construction projects.** The construction project-related congestion management has been very successful in the past such as the Woodrow Wilson Bridge and Springfield Interchange projects.

6. **Continue 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. Local jurisdictions are encouraged to work closely with transit agencies to explore appropriate transit priority strategies that could have positive impacts on travelers by all modes.

7. **Continue to encourage access to non-auto travel modes**. The success of the Capital Bikeshare program and the decrease in automobile registrations in the District of Columbia indicate that there is a shift, at least in the urban areas, to non-automobile transportation.

8. **Continue to explore Integrated Corridor Management (ICM) systems and Active Traffic Management (ATM) strategies.** State DOTs are encouraged to explore ATM strategies along congested freeways and actively manage arterials along freeways. Transportation agencies (including transit agencies) and stakeholders are encouraged to work collaboratively along a congested corridor to explore the feasibility of an ICM system.

9. **Continue and enhance providing real-time, historical, and multimodal traveler information.** Providing travelers with information before and during their trips can help them to make decisions to avoid congestion and delays and better utilize the existing road and transit infrastructure. Website such as MATOC's www.trafficview.org, www.CapitalRegionUpdates.gov, state DOTs' 511 systems, and real-time transit information allow travelers to make more informed decisions for their trips. The value of real-time traveler information can be largely enriched by integrating historical travel information which can provide valuable travel time reliability measures. Agencies are encouraged to coordinate on providing multimodal information along a corridor (e.g., the outcome envisioned in the I-95/I-395 Integrated Corridor Management Initiative).

10. **Continue and enhance the arterial congestion monitoring program.** The TPB's traditional arterial floating car travel time studies ended in FY 2011 in view of that emergent private sector probe-based monitoring can provide unprecedented spatial and temporal coverage on arterials. There are needs to study the cost effectiveness and further verify the quality of data provided by different sources, and to formalize the arterial monitoring program for the future.

11. **Continue and enhance frequently updated congestion reporting with a standardized procedure in calculating performance measures and more trip-based assessments.** This CMP report and the National Capital Region Congestion Report established a hierarchical performance measurement structure for highway mobility/congestion assessments. T here are needs to standardize the performance measures calculation procedure since different variations in the calculation could yield to different results, and to provide more customized information with trip-based travel time analysis.

12. **Continue to conduct Geographically-focused Household Travel Surveys to collect mode choice information.** These studies can collect data to allow planners to see local level travel patterns and behaviors impacting mode shifts. In areas with major transportation improvements planned, these studies can provide a baseline for a before and after analysis.

APPENDICES

APPENDIX A – RESULTS OF FY 2010 AND FY 2011 ARTERIAL STUDIES

FY 2010 Study

During the FY 2010 survey[122] 145 centerline miles from the region were surveyed. This constitutes about 84 centerline miles from Virginia, 45 centerline miles from Maryland and 17 centerline miles from the District of Columbia. The FY 2010 s urvey includes two additional routes which were not surveyed during the FY 2001, FY 2007 and FY 2010 studies. These new routes include VA-28 from Compton Rd. to Goodwin Rd. in Virginia, MD-210 (Indian Head Hwy) from Southern Av. to Livingston Rd (Accokeek) in Maryland.

The routes and limits of this study are listed in Table A1 and a summary of LOS by time period and by direction is presented in Table A2. The LOS results are also mapped in Figures A1 through A9 for peak hour (5:00-6:00 PM), peak period (4:00-7:00 PM) and off-peak period (1:00-4:00 PM & 7:00-8:00 PM) respectively.

Table A1: Routes and Limits (FY 2010)

Jurisdiction	Route	Route Limits		Distance (miles)
		From	To	
MD	MD 4	Alabama	Old Crain	11.5
	MD 144	Waverly	Monocacy	4.2
	MD 450	Landover	Crain Hwy	12.8
	MD 586	1st St	University Blvd	5.4
	MD 210*	Southern Av	Livingston Rd	11.0
MD Total				**44.9**
VA	VA 7 (3 parts)	Menokin/Van Dorn	Cochran Mill	29.2
	VA 234 (2 parts)	Battleview Pkw	US 1	22.6
	VA 120	Mt Vernon	Chain Bridge	8.1
	VA 28 part 1	Compton	VA 7	17.1
	VA 28 part 2 *	Compton Rd.	Route 234 bypass	6.7
VA Total				**83.7**
DC	Canal/M St	30th St NW	Chain Bridge	3.7
	7th St./Georgia Ave	Independence Ave	New Hampshire Ave	3.4
	Georgia Ave	New Hampshire Ave	Eastern Av.	3.3
	Louisiana/Constitution Ave	North Capitol	21st St NE	2.4
	Pennsylvania/Branch Ave	Independence Ave	Southern Ave	3.7
DC Total				**16.5**
Regional Total				**145.1**

* New routes in FY 2010.

[122] http://www.mwcog.org/uploads/committee-documents/bl5XXF1d20101119160926.pdf

Table A2: LOS by Time Period and by Direction (FY 2010)

Juris-dicti-on	Route	LOS (Peak Hour)		LOS (Off-Peak Period)		LOS (Peak Period)	
		North/ Eastbound	South/ Westbound	North/ Eastbound	South/ Westbound	North/ Eastbound	South/ Westbound
MD	MD Route 4	C	B	B	B	C	B
	MD Route 144	D	C	D	C	D	C
	MD Route 450	C	C	C	C	C	C
	MD Route 586	D	D	C	C	C	D
	MD 210 (Indian Head Hwy)	C	D	B	B	C	D
VA	VA 7 - Segment 1	D	D	D	C	D	D
	VA 7 - Segment 2	E	B	C	B	D	B
	VA 7 - Segment 3	C	B	B	A	C	B
	VA 234 - Segment 1	B	C	C	C	B	C
	VA 234 - Segment 2	A	B	A	A	A	A
	VA Route 120	E	E	D	D	D	E
	VA Route 28 - Seg 1	C	C	A	A	B	C
	VA Route 28 - Seg 2	C	D	C	C	C	D
DC	Canal/M St	-	F	-	E	-	F
	7th St/Georgia Ave	D	E	D	D	D	E
	Georgia Ave	C	C	C	C	C	C
	Louisiana/Constitution Ave	D	D	C	D	D	D
	Pennsylvania/Branch Ave	E	D	E	D	E	D

Figure A1: PM Peak Hour LOS for Surveyed Arterials in DC (5:00-6:00 PM, FY 2010)

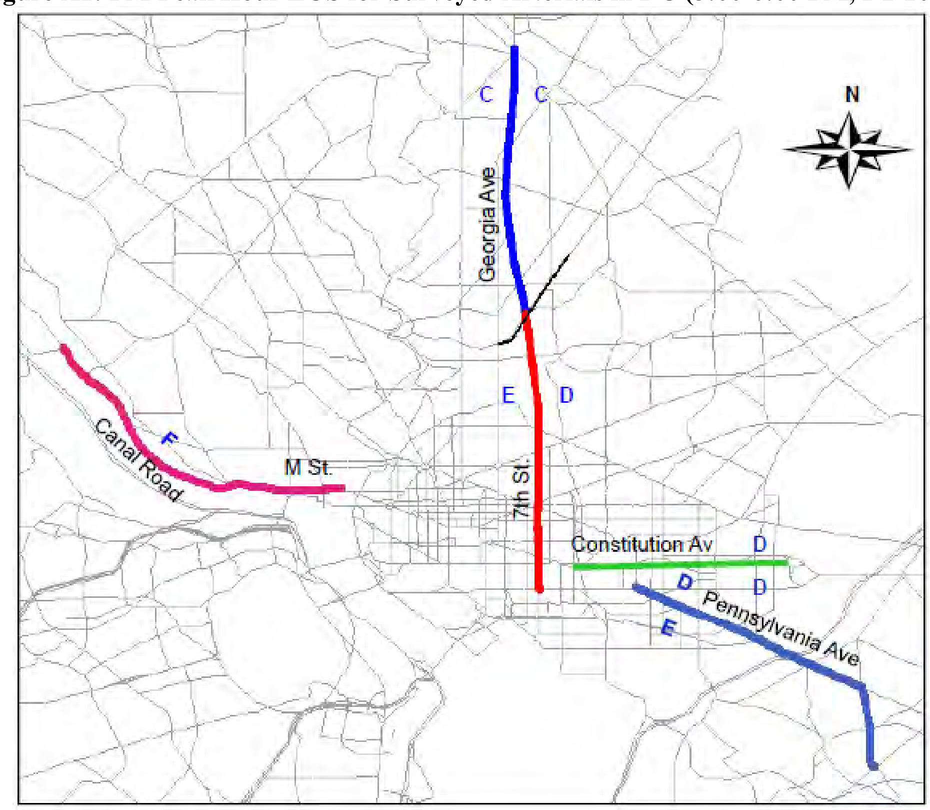


Figure A2: PM Peak Period LOS for Surveyed Arterials in DC (4:00-7:00 PM, FY 2010)

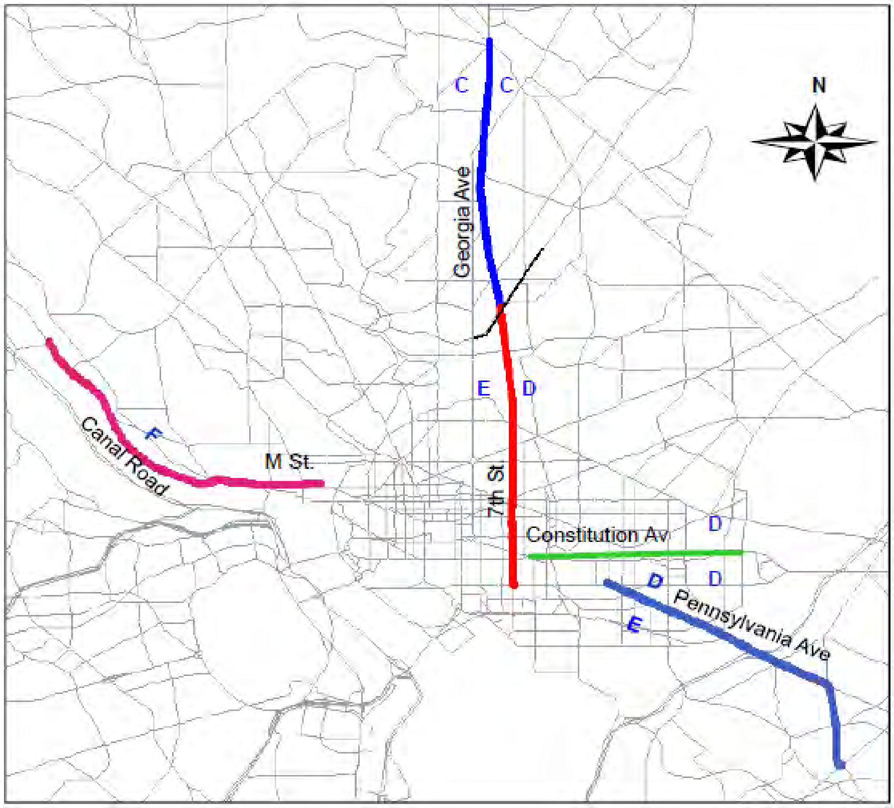


Figure A3: PM Off-Peak Period LOS for Surveyed Arterials in DC (1:00-4:00 PM & 7:00-8:00 PM, FY 2010)

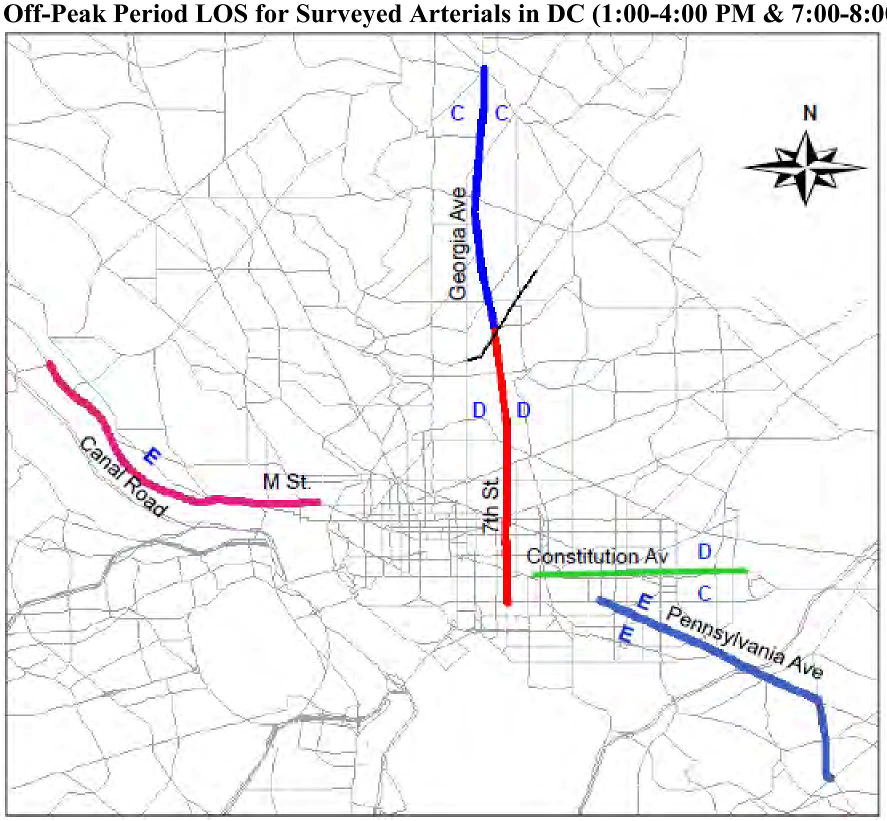


Figure A4: PM Peak Hour LOS for Surveyed Arterials in MD (5:00-6:00 PM, FY 2010)

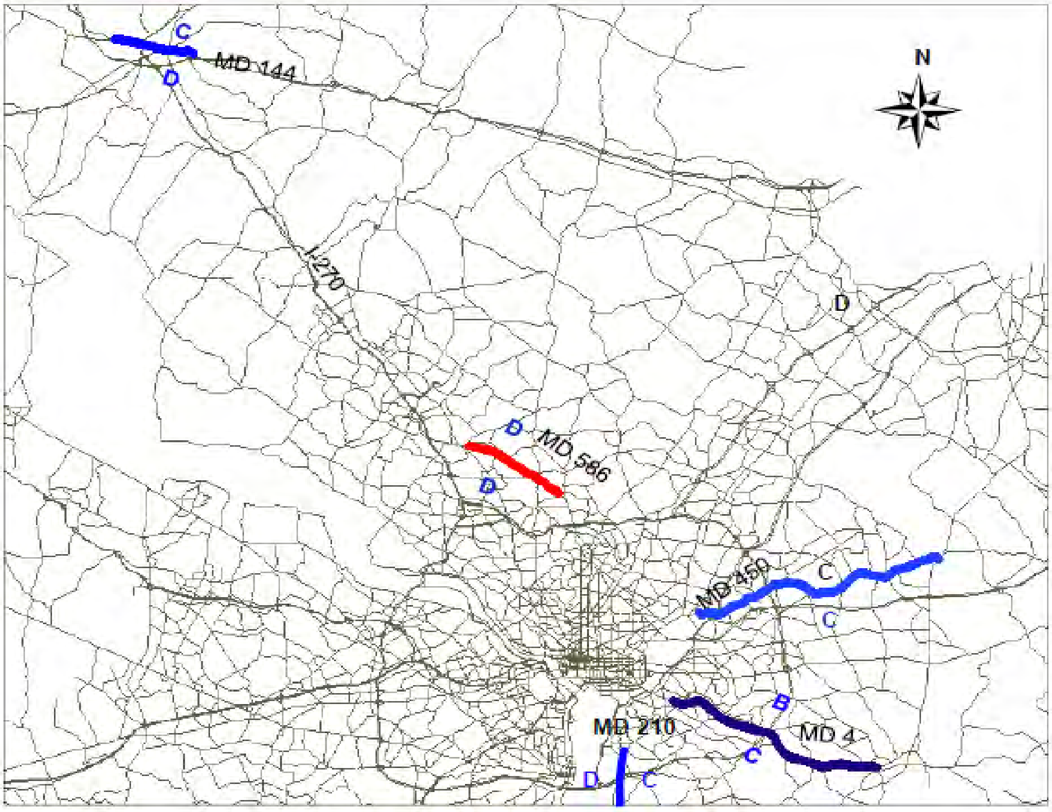


Figure A5: PM Peak Period LOS for Surveyed Arterials in MD (4:00-7:00 PM, FY 2010)

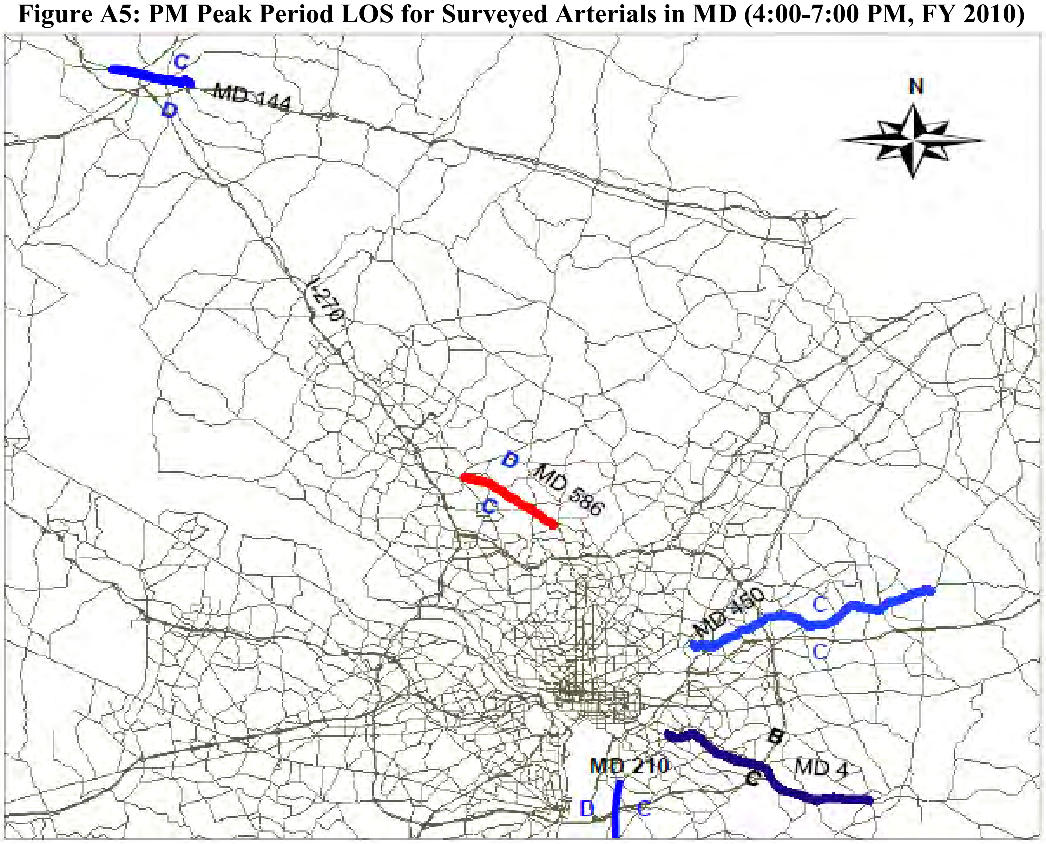


Figure A6: PM Off-Peak Period LOS for Surveyed Arterials in MD (1:00-4:00 PM & 7:00-8:00 PM, FY 2010)

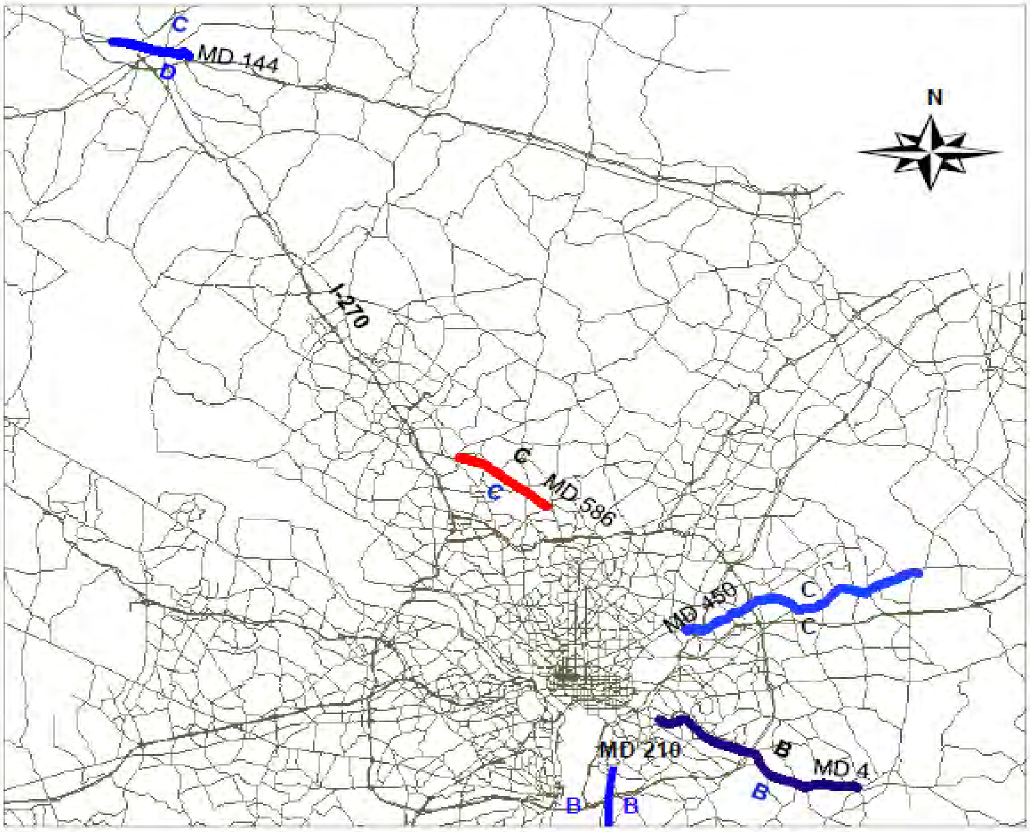


Figure A7: PM Peak Hour LOS for Surveyed Arterials in VA (5:00-6:00 PM, FY 2010)

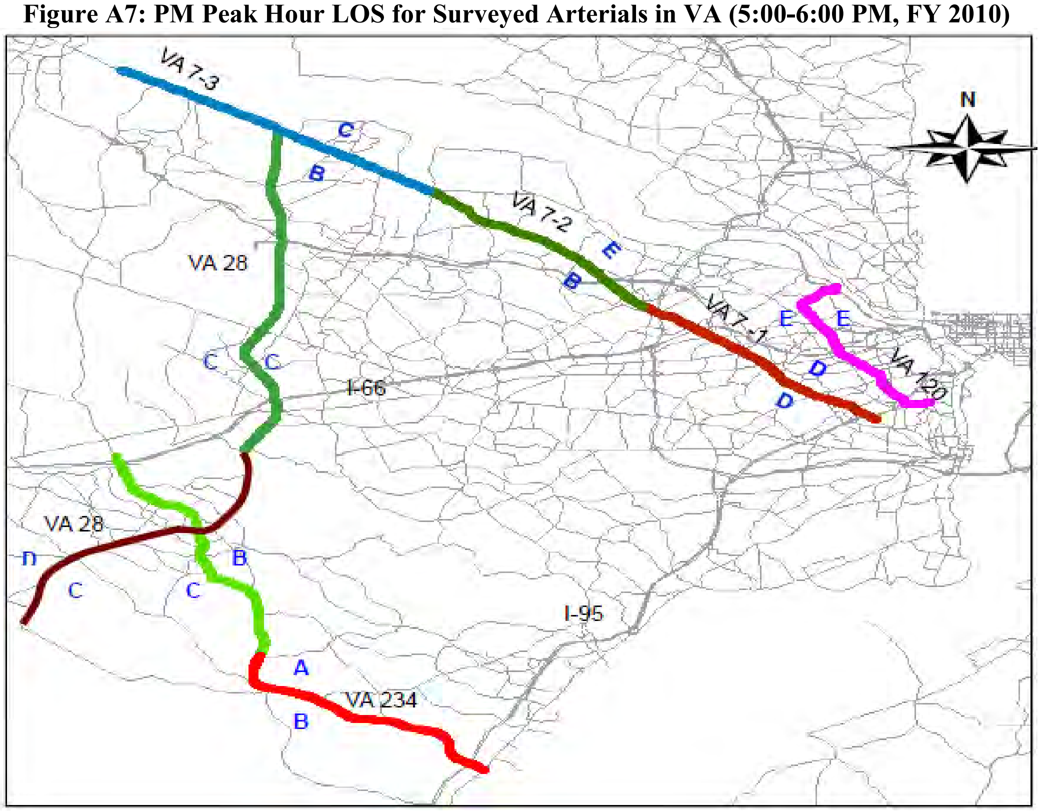


Figure A8: PM Peak Period LOS for Surveyed Arterials in VA (4:00-7:00 PM, FY 2010)

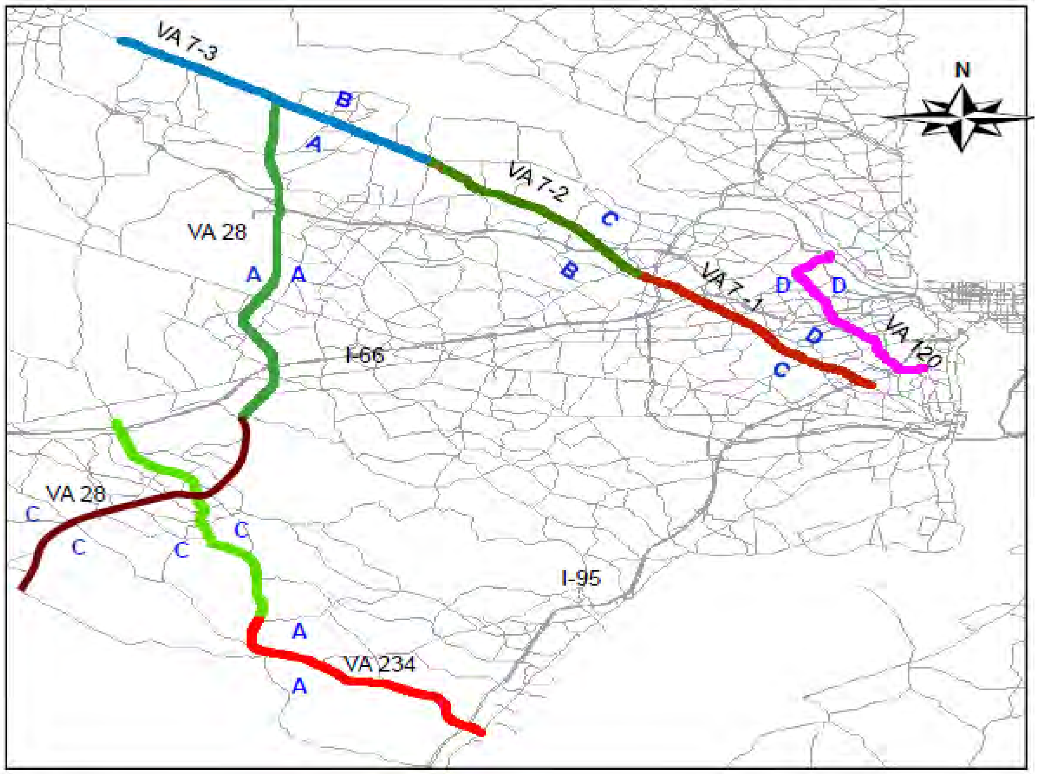
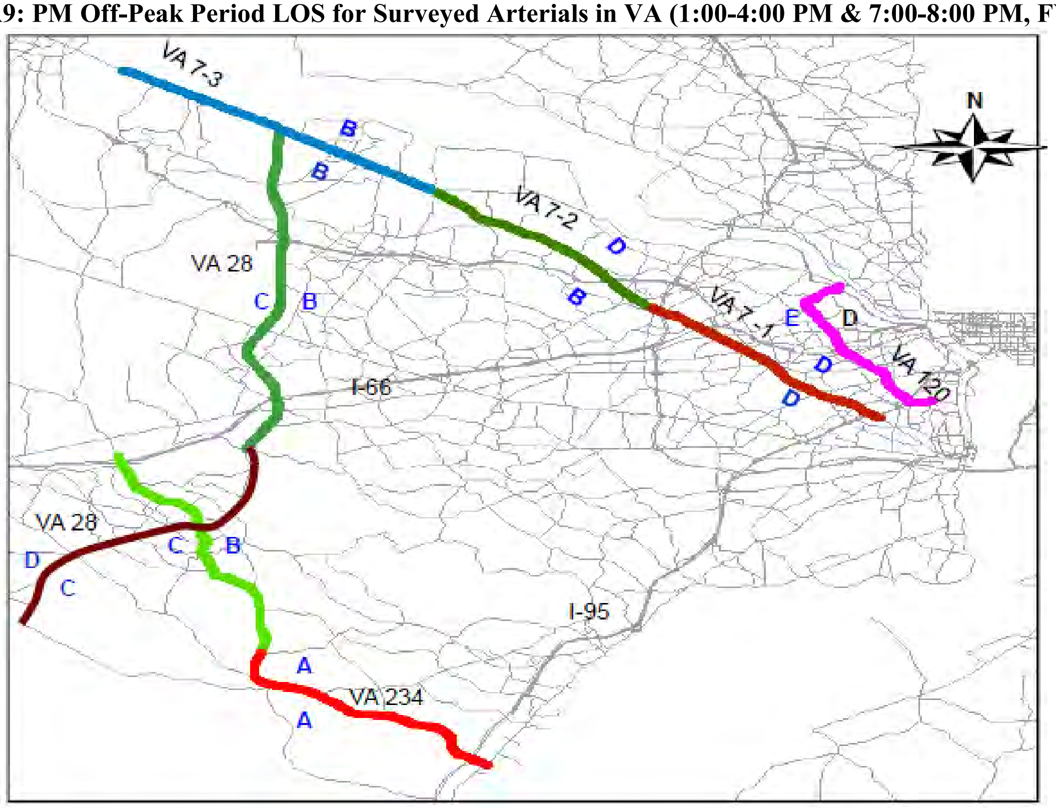


Figure A9: PM Off-Peak Period LOS for Surveyed Arterials in VA (1:00-4:00 PM & 7:00-8:00 PM, FY 2010)



FY 2011 Study

During the FY 2011 survey[123] 144 centerline miles from the region were surveyed. This constitutes about 71 centerline miles from Virginia, 51 centerline miles from Maryland and 22 centerline miles from the District of Columbia. The FY 2011 survey includes three additional routes which were not surveyed during previous studies. These new routes include US-29 from Bull Run Post Office Rd. to Buckland Mill Rd. in Virginia, US-29 from East-West Highway to Fairland Rd. in Maryland, and South Dakota Ave. from Bladensburg Rd. to Hamilton St. NE in DC. The surveyed routs in FY 2011 are shown in Figure A10 – A12.

The routes and limits of this study are listed in Table A3 and a summary of LOS by time period and by direction is presented in Table A4. The FY 2011 s urvey results were not mapped as previous surveys did.

Table A3: Routes and Limits (FY 2011)

Jurisdiction	Route	Route Limits		Distance (miles)
		From	To	
MD	Georgia Avenue – Segment 1	Eastern Ave	University Blvd	4.3
	Georgia Avenue – Segment 2	University Blvd	MD Route 28	5.2
	MD Route 5	Suitland Pkwy	Accokeek Rd	11.9
	MD Route 28	Viers Mill Rd	New Hampshire Ave	9.0
	MD 193 (University Blvd)	Connecticut Ave	US 29	4.2
	Randolph Rd	MD 355	Columbia Pike	9.1
	Colesville Rd / US29 *	East-West Highway	Fairland Road	7.1
MD Total				**50.8**
VA	Fairfax Co. Pkwy – Segment 1	Sunrise Valley Rd	Lee Hwy	7.2
	Fairfax Co. Pkwy – Segment 1	Lee Hwy	Rolling Rd	12.5
	US 1 – Segment 1	20th St	Boswell Ave	8.1
	US 1 – Segment 2	Boswell Ave	VA Route 123	10.7
	US 29 – Segment 1	M St NW	Park Rd	7.9
	US 29 – Segment 2	Park Rd	Village Dr	6.5
	US 29 – Segment 3	Village Dr	Bull Run PO	6.6
	US 29 * - Segment 4	Bull Run Post Office Road	Buckland Mill Road	11.1
VA Total				**70.6**
DC	14 Street NW	Independence Ave	K Street NW	1.0
	16th Street	K Street NW	Eastern Ave	6.1
	Connecticut Ave NW	K Street NW	Nebraska Ave	4.0
	K Street NW / New York Ave	21st Street NW	Bladensburg Rd	4.2
	Military Rd / Nebraska Ave	Connecticut Ave	Georgia Ave	2.5
	Pennsylvania Ave NW	Constitution Ave	15th Street NW	0.8
	L Street NW	Pennsylvania Ave	14th Street NW	1.1
	South Dakota Ave.*	Bladensburg Road	Hamilton Street NE	2.7
DC Total				**22.4**
Regional Total				**143.8**

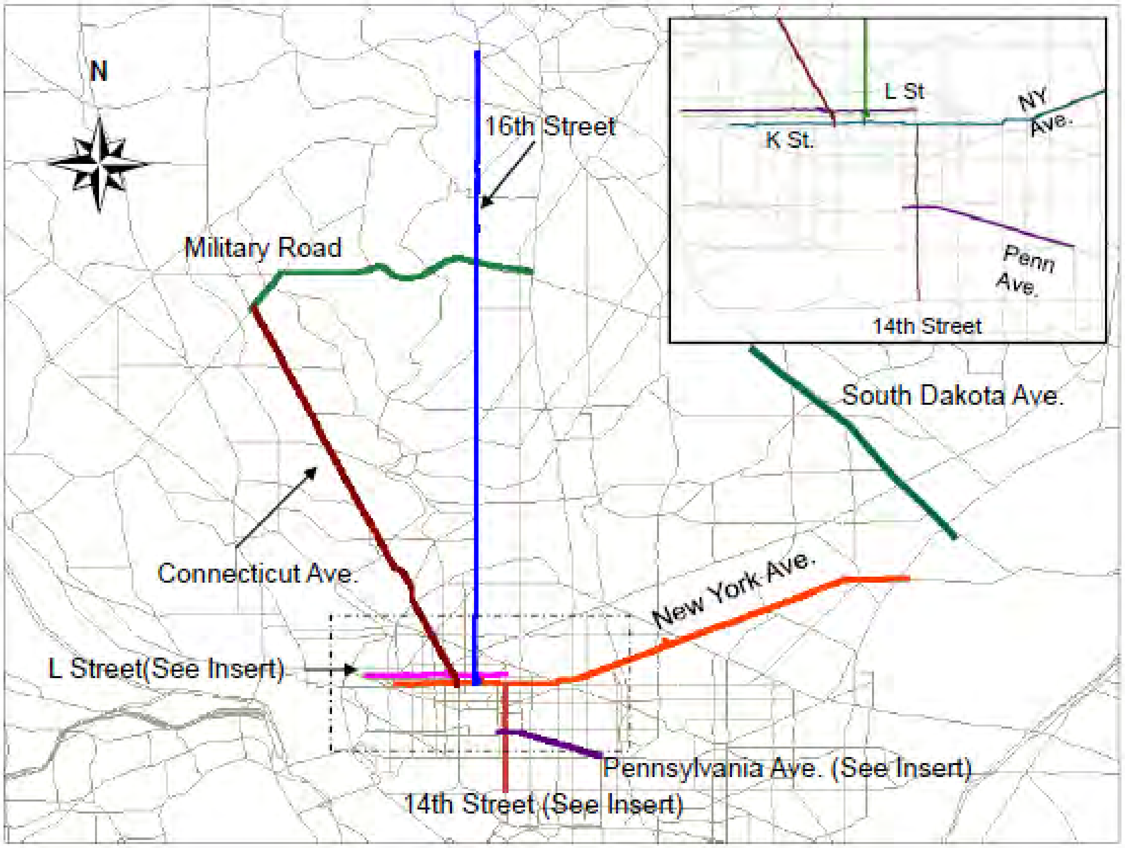
* New routes in FY 2011.

[123] http://www.mwcog.org/uploads/committee-documents/bV1fV1tc20111118133212.pdf (slides 24-37)

Table A4: LOS by Time Period and by Direction (FY 2011)

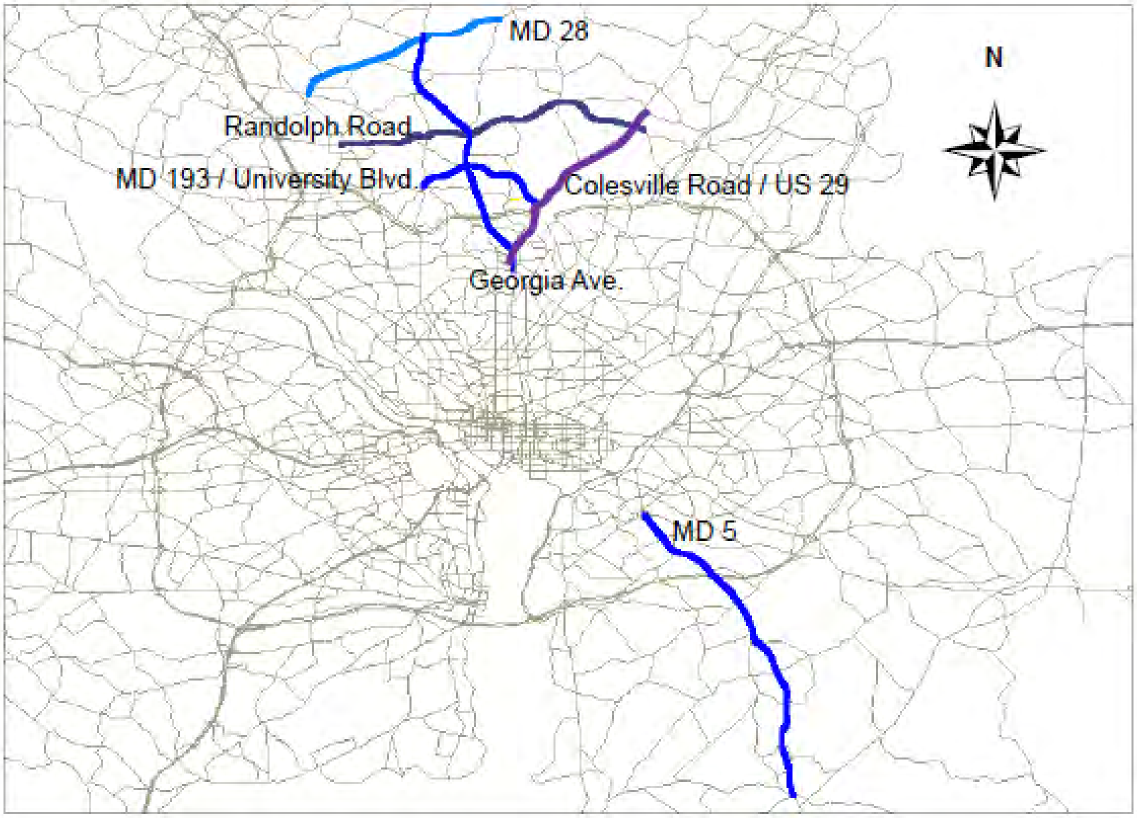
Juris-dicti-on	Route	LOS (Peak Hour)		LOS (Off-Peak Period)		LOS (Peak Period)	
		North/ Eastbound	South/ Westbound	North/ Eastbound	South/ Westbound	North/ Eastbound	South/ Westbound
MD	Georgia Avenue - Segment 1	D	D	D	D	D	D
	Georgia Avenue - Segment 2	F	D	F	D	D	D
	MD Route 5	A	C	B	C	B	B
	MD Route 28	E	C	E	C	B	C
	University Blvd / MD 193	D	D	D	D	D	C
	Randolph Road	D	C	C	C	C	C
	Colesville Rd / US29 (new)	E	D	D	D	C	C
VA	Fairfax Co. Pkwy - Segment 1	B	B	B	B	A	B
	Fairfax Co. Pakwy - Segment 2	B	B	B	B	A	A
	US 1 - Segment 1	D	E	D	D	C	C
	US 1 - Segment 2	A	B	A	B	B	A
	US 29 - Segment 1	E	E	E	D	D	D
	US 29 - Segment 2	D	F	E	E	D	E
	US 29 - Segment 3	D	D	D	D	D	C
	US 29 - Segment 4	B	B	B	B	B	A
DC	14th Street NW	E	F	E	F	D	D
	16th Street	C	C	C	C	C	C
	Connecticut Avenue NW	C	E	C	E	D	D
	K Street NW/New York Avenue	F	F	F	E	D	E
	Military Road/ Nebraska Av.	C	C	C	C	C	C
	Pennsylvania Avenue NW	E	E	D	E	E	D
	L Street	E	-	E	-	D	-
	South Dakota Av.	C	C	C	C	C	C

Figure A10: FY 2011 Surveyed Routes in DC



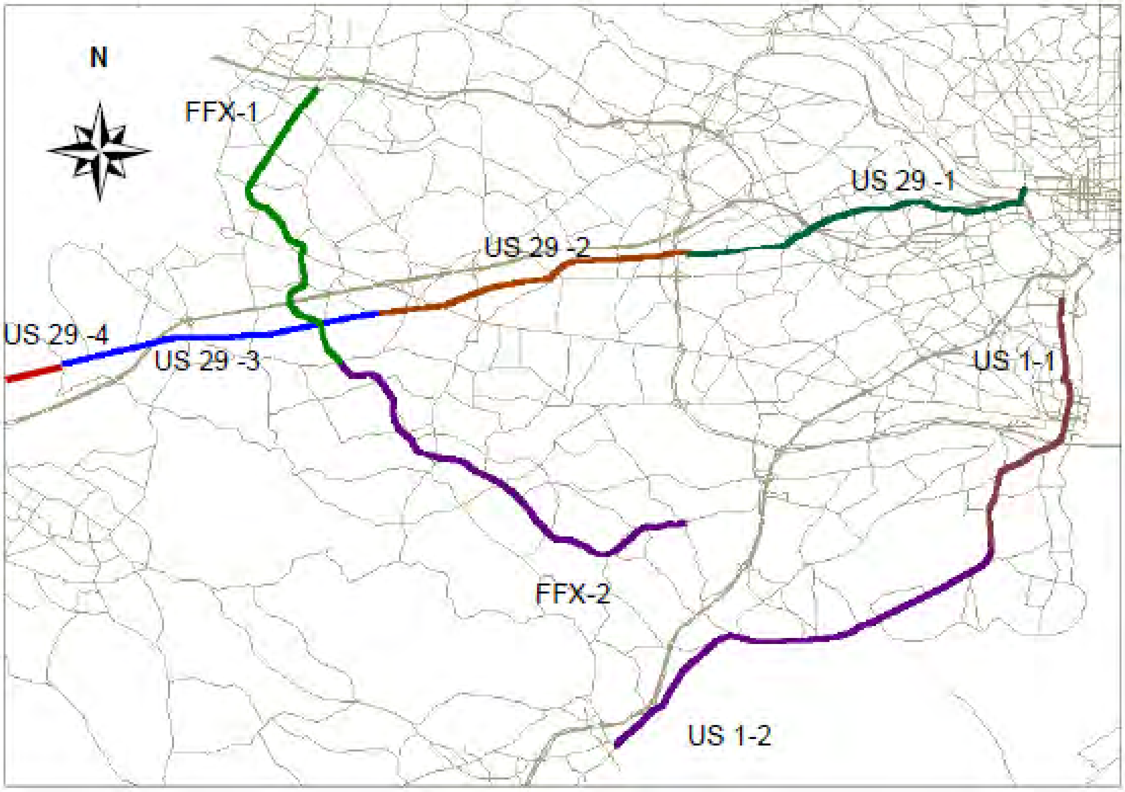
1) 14th Street NW Between Independence Avenue and K Street NW
2) 16th Street NW Between K Street NW and Eastern Avenue
3) Connecticut Avenue Between K Street NW and Nebraska Avenue
4) K Street / New York Avenue Between 21st Street and Bladensburg Road
5) L Street NW Between Pennsylvania Avenue and 14th Street NW
6) Military Road / Nebraska Avenue Between Connecticut Avenue and Georgia Avenue
7) Pennsylvania Avenue Between 15th Street NW and Constitution Avenue
8) South Dakota Avenue Between Bladensburg Road and Hamilton Street NE

Figure A11: FY 2011 Surveyed Routes in MD



1) Georgia Avenue - Segment 1 Between Eastern Avenue and University Boulevard
2) Georgia Avenue / MD97 - Segment 2 Between University Boulevard and MD 28
3) MD 5 Between Suitland Parkway and Accokeek Road
4) MD 28 from Viers Mill Road and New Hampshire Avenue
5) MD 193 (University Boulevard) Between Connecticut Avenue and US29
6) Randolph Road Between MD 355 and Columbia Pike
7) Colesville / US29 Road Between East-West Highway and Fairland Road

Figure A11: FY 2011 Surveyed Routes in VA



1) Fairfax County Parkway - Segment 1 Between Sunrise Valley and Lee Hwy.
2) Fairfax County Parkway - Segment 2 Between Lee Hwy. and Rolling Road
3) US 1 - Segment 1 Between 20th Street and Boswell Avenue
4) US 1 - Segment 2 Between Boswell Avenue and VA Route 123
5) US 29 - Segment 1 Between M Street NW and Park Road
6) US 29 - Segment 2 Between Park Road and Village Drive
7) US 29 - Segment 3 Between Village Drive and Bull Run PO Road
8) US 29 - Segment 4 Between Bull Run PO Road and Buckland Mill Road

APPENDIX B – SHA RIDESHARING FACILITY STATISTICS

SPRING 2001 RIDESHARING INVENTORY BY COUNTY				
COUNTY	**LOTS**	**SPACES**	**PATRONS**	**AVG. % USE**
ANNE ARUNDEL	8	1386	842	61%
CALVERT	7	314	310	99%
FREDERICK	7	847	354	42%
HOWARD	8	1760	744	42%
MONTGOMERY	1	248	13	5%
PRINCE GEORGES	4	419	274	65%
TOTALS	**35**	**4974**	**2537**	**51%**

2005 RIDESHARING INVENTORY BY COUNTY				
COUNTY	**LOTS**	**SPACES**	**PATRONS**	**AVG. % USE**
ANNE ARUNDEL	8	1386	1170	84%
CALVERT	7	310	277	89%
FREDERICK	8	863	514	60%
HOWARD	9	1760	888	50%
MONTGOMERY	3	1019	252	25%
PRINCE GEORGES	4	868	333	38%
TOTALS	**39**	**6,206**	**3,434**	**55%**

2006 RIDESHARING INVENTORY BY COUNTY				
COUNTY	**LOTS**	**SPACES**	**PATRONS**	**AVG. % USE**
ANNE ARUNDEL	8	1586	1200	76%
CALVERT	7	362	316	87%
FREDERICK	8	863	525	61%
HOWARD	8	1833	1000	55%
MONTGOMERY	3	1019	311	31%
PRINCE GEORGES	4	868	358	41%
TOTALS	**38**	**6,531**	**3,710**	**57%**

2007 RIDESHARING INVENTORY BY COUNTY				
COUNTY	**LOTS**	**SPACES**	**PATRONS**	**AVG. % USE**
ANNE ARUNDEL	8	1586	1225	77%
CALVERT	7	312	297	95%
FREDERICK	8	902	517	57%
HOWARD	8	1833	1041	57%
MONTGOMERY	3	1019	255	25%
PRINCE GEORGES	4	840	354	42%
TOTALS	**38**	**6,492**	**3,689**	**57%**

APPENDIX C – 2009 CENTRAL EMPLOYMENT CORE CORDON COUNT

Figure C1: Trends in Person Trips: 1999-2009 (Inbound 6:30-9:30 AM)

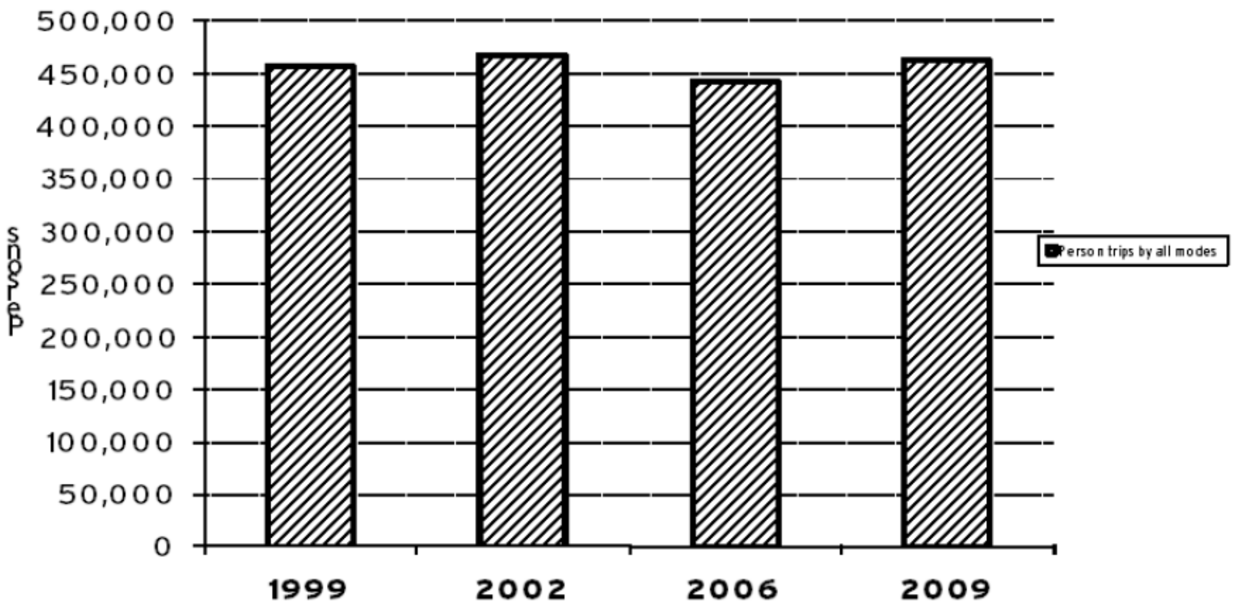


Figure C2: Trends in Person Trips: 1999-2009 (Outbound 3:30-6:30 PM)

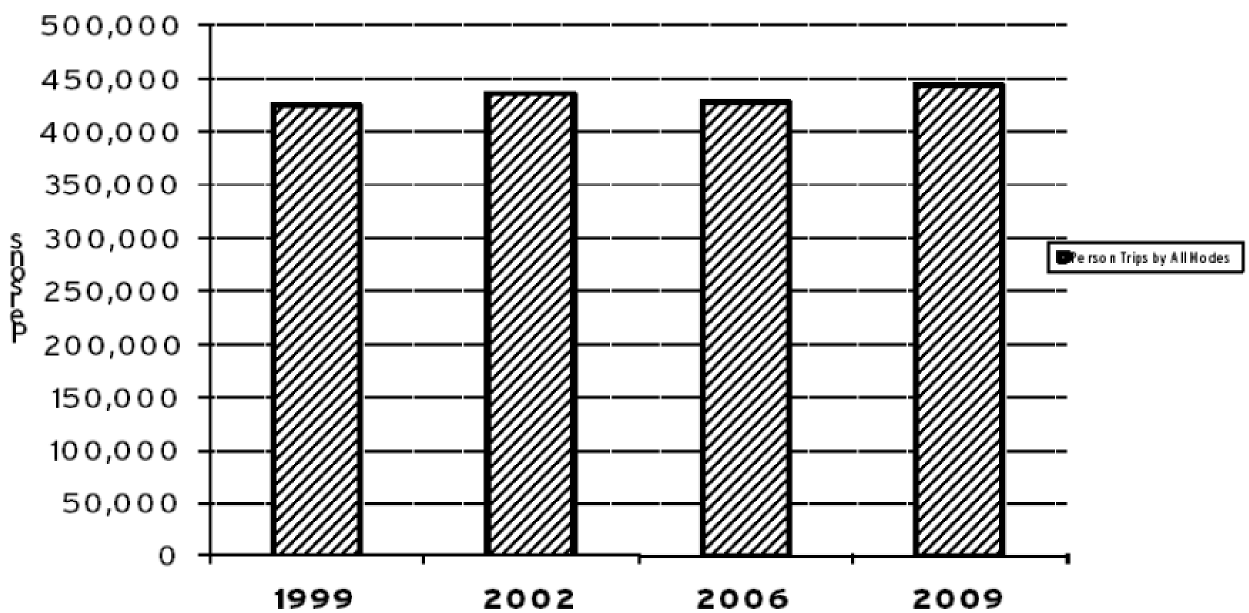


Figure C3: Trends in Person Trips by Mode: 1999-2009 (Inbound 6:30-9:30 AM)

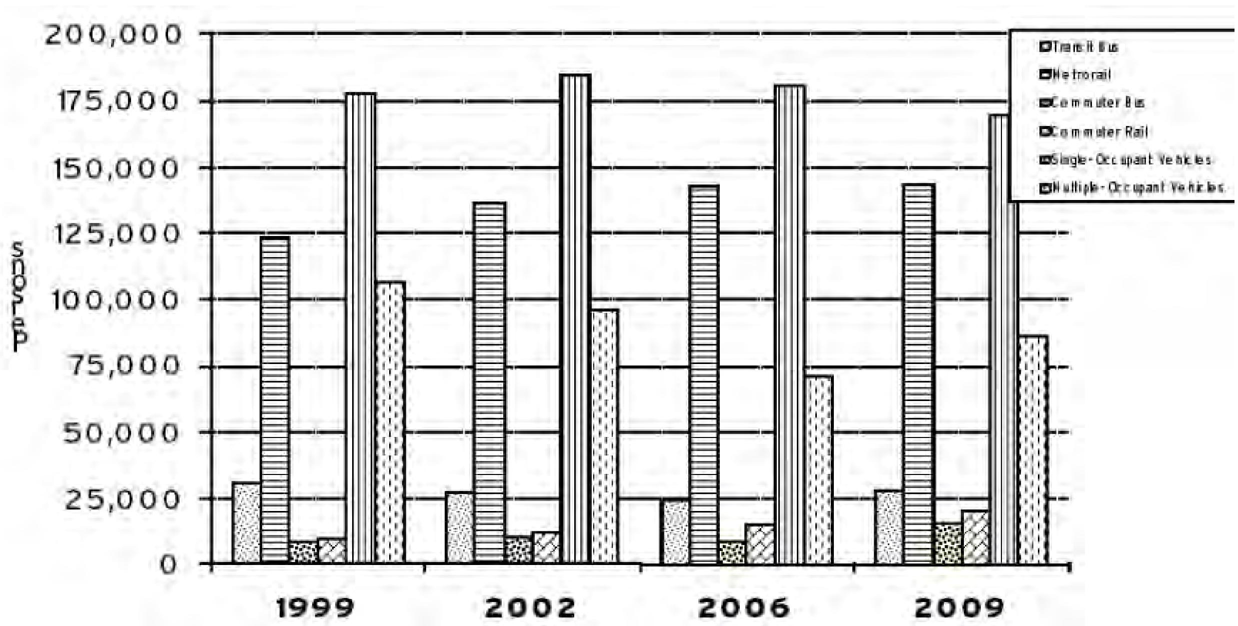
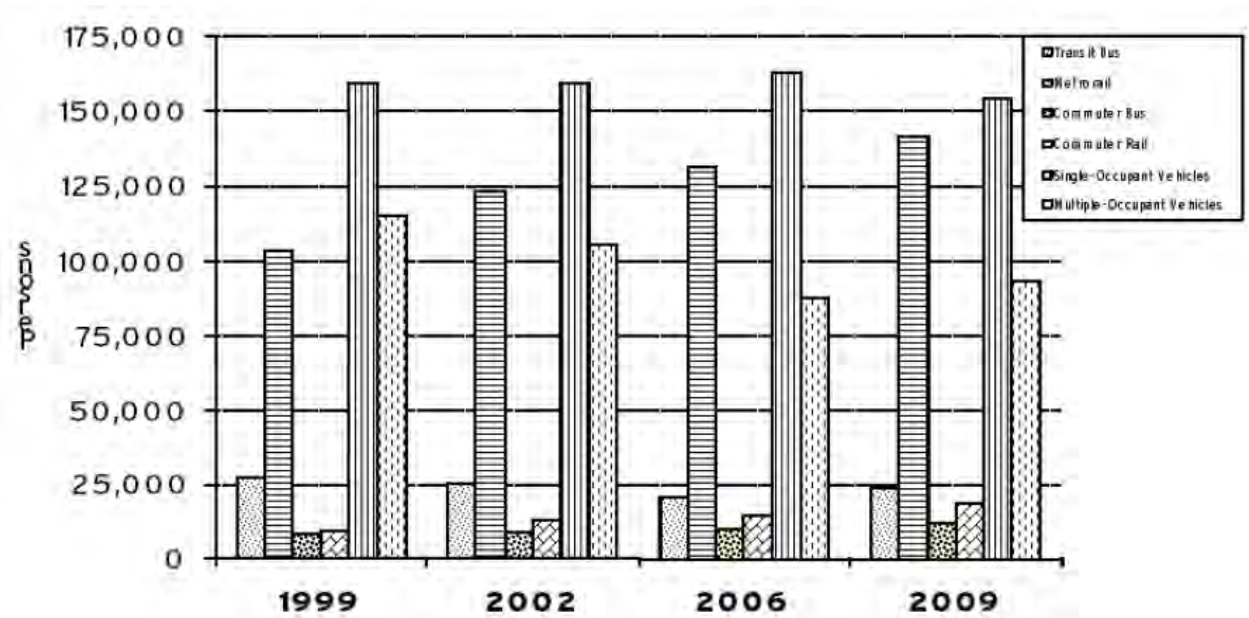


Figure C4: Trends in Person Trips by Mode: 1999-2009 (Outbound 3:30-6:30 PM)



APPENDIX D – 2010 PERFORMANCE OF HIGH-OCCUPANCY VEHICLE FACILITIES ON FREEWAYS IN THE WASHINGTON REGION

Figure D1: HOV Facilities in the Washington Region

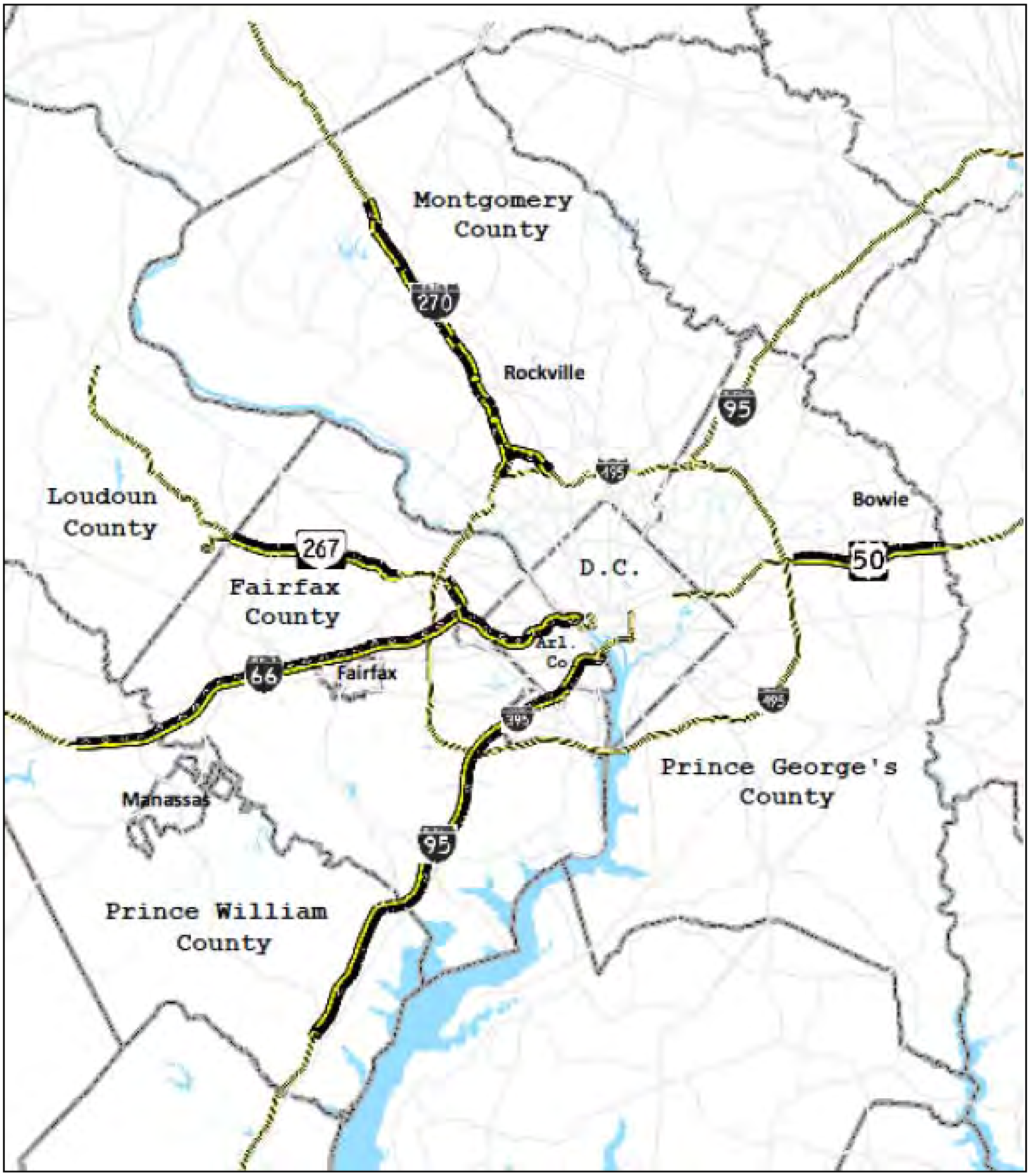


Table D1: Observed Average Auto Occupancies in the AM Peak Direction during HOV-Restricted Periods (Spring 2010)

Observed average auto occupancies in the A.M. peak direction during HOV-restricted periods (Spring, 2010)				
Facility	HOV lane average auto occupancies	Number of autos needed to move 1000 persons	Non-HOV lane average auto occupancies	Number of autos needed to move 1000 persons
I-395 Shirley Highway between Va. 120 (S. Glebe Road) and Arlington Ridge Road	2.8	360	1.1	910
I-95 Shirley Highway between Va. 7100 (Fairfax County Parkway) and Va. 7900 (Franconia Springfield Parkway)	2.5	400	1.1	910
I-66 between Sycamore Street and Fairfax Drive	1.5	670	N/A	N/A
I-66 between Va. 243 (Nutley Street) and I-495	1.8	560	1.1	910
Va. 267 (Dulles Toll Road) west of Va. 7 (Leesburg Pike)	1.7	590	1.1	910
I-270 between Montrose Road and the "split" (Max Load Point)	1.9	530	1.0	1000
I-270 between the "split" and Rockledge Drive	2.0	500	1.0	1000
I-270Y (I-270 Spur) between the "split" and Democracy Boulevard	1.9	530	1.0	1000
U.S 50 between Md. 197 (Collington Road) and Md. 704 (MLK, Jr. Hwy)	1.8	560	1.0	1000

Table D2: Observed Average Auto Occupancies in the PM Peak Direction during HOV-Restricted Periods (Spring 2010)

Observed average auto occupancies in the P.M. peak direction during HOV-restricted periods (Spring, 2010)				
Facility	HOV lane average auto occupancies	Number of autos needed to move 1000 persons	Non-HOV lane average auto occupancies	Number of autos needed to move 1000 persons
I-395 Shirley Highway between Arlington Ridge Road and Va. 120 (S. Glebe Road)	2.8	360	1.1	910
I-95 Shirley Highway between Va. 7900 (Franconia Springfield Parkway) and Va. 7100 (Fairfax County Parkway)	2.9	340	1.1	910
I-66 between Fairfax Drive and Sycamore Street	1.4	710	N/A	N/A
I-66 between I-495 and Va. 243 (Nutley Street)	1.9	530	1.1	910
Va. 267 (Dulles Toll Road) west of Va. 7 (Leesburg Pike)	1.5	670	1.1	910
I-270 between Rockledge Drive and the "split"	1.9	530	1.1	910
I-270Y (I-270 Spur) between Democracy Boulevard and the "split"	2.0	500	1.1	910
I-270 between the "split" and Montrose Road (Max Load Point)	2.0	500	1.1	910
U.S 50 between Md. 704 (MLK. Jr. Hwy) and Md. 197 (Collington Road)	1.7	590	1.0	1000

Table D3: Observed Average HOV Auto Occupancies in the AM Peak Direction Over Time

2010 Observed average HOV auto occupancies in the A.M. Peak Direction Over Time						
Facility	Year					
	1997	1998	1999	2004	2007	2010
I-395 Shirley Highway between Va. 120 (S. Glebe Road) and Arlington Ridge Road	2.7	2.6	2.9	2.5	2.5	2.8
I-95 Shirley Highway between Va. 7100 (Fairfax County Parkway) and Va. 7900 (Franconia Springfield Parkway)	2.6	2.8	2.8	2.6	2.6	2.5
I-66 between Sycamore Street and Fairfax Drive	1.8	1.8	1.8	1.7	1.8	1.5
I-66 between Va. 243 (Nutley Street) and I-495	2.0	1.7	1.9	2.0	1.9	1.8
Va. 267 (Dulles Toll Road) west of Va. 7 (Leesburg Pike)	N/A	N/A	1.8	1.8	1.8	1.7
I-270 between Montrose Road and the "split" (Max Load Point)	N/A	N/A	N/A	1.7	1.6	1.9
I-270 between the "split" and Rockledge Drive	1.9	1.7	1.7	1.9	1.5	2.0
I-270Y (I-270 Spur) between the "split" and Democracy Boulevard	1.9	1.8	1.8	1.5	1.8	1.9
U.S 50 between Md. 197 (Collington Road) and Md. 704 (MLK, Jr. Hwy)	N/A	N/A	N/A	1.6	1.9	1.8

Notes: Data in table are rounded.

Table D4: Observed Average HOV Auto Occupancies in the PM Peak Direction Over Time

2010 Observed average HOV auto occupancies in the P.M. Peak Direction Over Time						
Facility	Year					
	1997	1998	1999	2004	2007	2010
I-395 Shirley Highway between Arlington Ridge Road and Va. 120 (S. Glebe Road)	3.1	3.1	3.2	2.8	2.9	2.8
I-95 Shirley Highway between Va. 7900 (Franconia Springfield Parkway) and Va. 7100 (Fairfax County Parkway)	2.9	2.7	3.0	2.7	2.8	2.9
I-66 between Fairfax Drive and Sycamore Street	1.8	1.8	1.9	1.7	1.8	1.4
I-66 between I-495 and Va. 243 (Nutley Street)	2.0	2.0	1.9	2.0	2.0	1.9
Va. 267 (Dulles Toll Road) west of Va. 7 (Leesburg Pike)	N/A	N/A	1.8	1.8	1.6	1.5
I-270 between Rockledge Drive and the "split"	2.1	1.8	1.6	2.1	1.9	1.9
I-270Y (I-270 Spur) between Democracy Boulevard and the "split"	2.1	1.8	2.1	1.5	2.1	2.0
I-270 between the "split" and Montrose Road (Max Load Point)	N/A	N/A	N/A	1.8	2.0	2.0
U.S 50 between Md. 704 (MLK, Jr. Hwy) and Md. 197 (Collington Road)	N/A	N/A	N/A	2.1	1.8	1.7

Notes: Data in table are rounded.

Table D5: Observed Person Movements in the AM Peak Direction during HOV-Restricted Periods (Spring 2010)

Observed person movements in the A.M. peak direction during HOV-restricted periods (Spring, 2010)						
Facility And Hours of HOV-restricted operation	Number of HOV lanes	HOV lane person movements during HOV-restricted period	HOV lane persons per lane per hour	Number of non-HOV lanes	Non-HOV lane person movements during HOV-restricted period	Non-HOV lane persons per lane per hour
I-395 between Va. 120 and Arlington Ridge Rd 6:00 A.M. to 9:00 A.M.	2	30,800	5,100	4	24,200	2,000
I-95 between Va. 7100and Va. 7900 6:00 A.M. to 9:00 A.M.	2 *Includes Newington Flyover Ramp*	24,200	4,000	4	17,000	1,400
I-66 between Sycamore St and Fairfax Dr 6:30 A.M. to 9:00 A.M.	2	15,800	3,200	0 *No non-HOV lanes*	N/A	N/A
I-66 between Va. 243 & I-495 5:30 A.M. to 9:30 A.M.	1	10,400	2,600	3	20,100	1,700
Va. 267 west of Va. 7 6:30 A.M. to 9:00 A.M.	1	10,200	4,100	3	12,800	1,700
I-270 between Montrose Road and the "split" 6:00 A.M. to 9:00 A.M.	1	8,900	3,000	5	27,800	1,900
I-270 between the "split" and Rockledge Drive 6:00 A.M. to 9:00 A.M.	1	5,500	1,800	3	15,000	1,700
I-270 Spur between the "split" and Democracy Blvd 6:00 A.M. to 9:00 A.M.	1 *Includes Westlake Drive Ramp*	3,400	1,100	2	12,800	2,100
U.S 50 between Md. 197 & Md. 704 24 Hours, 7 Days/Week (5:00 A.M. to 10:00 A.M. assumed in calculations)	1	4,600	900	3	21,800	1,500

Note: All person movements rounded to nearest 100

Table D6: Observed Person Movements in the PM Peak Direction during HOV-Restricted Periods (Spring 2010)

Observed person movements in the P.M. peak direction during HOV-restricted periods (Spring, 2010)						
Facility And Hours of HOV operation	Number of HOV lanes	HOV lane person movements during HOV-restricted period	HOV lane persons per lane per hour	Number of non-HOV lanes	Non-HOV lane person movements during HOV-restricted period	Non-HOV lane persons per lane per hour
I-395 between Arlington Ridge Rd. and Va. 120 3:30 P.M. to 6:00 P.M.	2	25,600	5,100	4	22,200	2,200
I-95 between Va. 7900 and Va. 7100 3:30 P.M. to 6:00 P.M.	2	24,000	4,800	4	9,300	900
I-66 between Fairfax Dr and Sycamore St 4:00 P.M. to 6:30 P.M.	2	14,000	2,800	0 *No non-HOV lanes*	N/A	N/A
I-66 between I-495 and Va. 243 3:00 P.M. to 7:00 P.M.	1	9,200	2,300	3	17,500	1,500
Va. 267 west of Va. 7 4:00 P.M. to 6:30 P.M.	1	11,100	4,400	3	15,300	2,000
I-270 between Rockledge Drive and the "split" 3:30 P.M. to 6:30 P.M.	1	5,700	1,900	2	12,400	2,100
I-270Y Spur between Democracy Blvd & the "split" 3:30 P.M. to 6:30 P.M.	1 *Includes Westlake Drive Ramp*	6,700	2,200	2	13,300	2,200
I-270 between the "split" and Montrose Road 3:30 P.M. to 6:30 P.M.	1	12,400	4,100	5	25,700	1,700
U.S 50 between Md. 704 and Md. 197 24 Hours, 7 Days/Week (3:00 P.M. to 8:00 P.M. assumed in calculations)	1	8,100	1,600	3	22,200	1,500

Note: All person movements rounded to nearest 100

Table D7: AM Peak Hour Person Movements during HOV-Restricted Periods (Spring 2010)

A.M. peak hour person movements during HOV-restricted periods (Spring 2010)						
Facility And peak hour within HOV-restricted period	Number of HOV lanes	HOV lane person movements during peak hour in HOV-restricted period	HOV lane persons per lane per hour	Number of non-HOV lanes	Non-HOV lane person movements during HOV-restricted period	Non-HOV lane persons per lane per hour
I-395 between Va. 120 and Arlington Ridge Rd. 7:30 A.M. to 8:30 A.M.	2	11,000	5,500	4	9,300	2,300
I-95 between Va. 7100 and Va. 7900 5:30 A.M. to 6:30 A.M.	2 *Includes Newington Flyover Ramp*	8,400	4,200	4	6,200	1,600
I-66 between Sycamore St and Fairfax Dr 5:30 A.M. to 6:30 A.M.	2	4,900	2,500	0 *No non-HOV lanes*	N/A	N/A
I-66 between Va. 243 & I-495 5:45 A.M. to 6:45 A.M.	1	3,000	3,000	3	5,100	1,700
Va. 267 west of Va. 7 6:45 A.M. to 7:45 A.M.	1	4,400	4,400	3	5,900	2,000
I-270 between the "split" and Rockledge Dr 7:00 A.M. to 8:00 A.M.	1	2,200	2,200	3	6,100	2,000
I-270 Spur between the "split" & Democracy Blvd 7:00 A.M. to 8:00 A.M.	1 *Includes Westlake Drive Ramp*	1,400	1,400	2	4,400	2,200
I-270 between Montrose Road and the "split" 6:45 A.M. to 7:45 A.M.	1	3,700	3,700	5	10,500	2,100
U.S 50 between Md. 197 and Md. 704 7:30 A.M. to 8:30 A.M.	1	700	700	3	6,400	2,100

Note: All person movements rounded to nearest 100

Table D8: PM Peak Hour Person Movements during HOV-Restricted Periods (Spring 2010)

P.M. peak hour person movements during HOV-restricted periods (Spring 2010)						
Facility And peak hour within HOV-restricted period	Number of HOV lanes	HOV lane person movements during peak hour in HOV-restricted period	HOV lane persons per lane per hour	Number of non-HOV lanes	Non-HOV lane person movements during HOV-restricted period	Non-HOV lane persons per lane per hour
I-395 between Arlington Ridge Rd. and Va. 120 4:30 P.M. to 5:30 P.M.	2	12,800	6,400	4	9,600	2,400
I-95 between Va. 7100 and Va. 7900 6:00 P.M. to 7:00 P.M.	2	6,000	3,000	4	4,200	1,100
I-66 between Fairfax Dr and Sycamore St 6:45 P.M. to 7:45 P.M.	2	4,900	2,500	0 *No non-HOV lanes*	N/A	N/A
I-66 between I-495 & Va. 243 6:15 P.M. to 7:15 P.M.	1	2,400	2,400	3	5,500	1,800
Va. 267 west of Va. 7 5:15 P.M. to 6:15 P.M.	1	4,900	4,900	3	6,500	2,200
I-270 between Rockledge Drive and the "split" 3:45 P.M. to 4:45 P.M.	1	2,000	2,000	2	3,900	2,000
I-270 Spur between Democracy Blvd & the "split" 3:30 P.M. to 4:30 P.M.	1 *Includes Westlake Drive Ramp*	2,600	2,600	2	4,900	2,500
I-270 between the "split" and Montrose Road 3:45 P.M. to 4:45 P.M.	1	4,300	4,300	5	8,500	1,700
U.S 50 between Md. 704 and Md. 197 5:30 P.M. to 6:30 P.M.	1	2,300	2,300	3	5,500	1,800

Note: All person movements rounded to nearest 100

Table D9: Mean AM Peak Period / Peak Direction Travel Times Over Time by Facility

Facility	HOV route travel time (minutes)					Non-HOV route travel time (minutes)					Time Savings (HOV Time - Non-HOV Time)				
	1997	1999	2004	2007	2010	1997	1999	2004	2007	2010	1997	1999	2004	2007	2010
I-95/I-395 (northbound) From Va.234 (Dumfries) to Va. end of 14th St. Bridge; HOV route is 28.1 miles	26 (+/- 1)	27 (+/- 1)	29 (+/- 4)	31 (+/- 6)	35 (+/- 8)	65 (+/- 6)	58 (+/- 3)	66 (+/- 15)	82 (+/- 22)	76 (+/- 26)	39	31	37 *	51 *	41 *
I-66 (eastbound) From Va.234 Business (Manassas) to Va. end of T. Roosevelt Bridge; HOV route is 27.8 miles	43 (+/- 3)	41 (+/- 8)	53 (+/- 8)	48 (+/- 9)	66 (+/- 17)	71 (+/- 11)	69 (+/- 5)	70 (+/- 14)	76 (+/- 13)	102 (+/- 29)	28	28	17 *	28 *	36 *
Va.267/I-66 (eastbound) From Va.28 to Va. end of T. Roosevelt Bridge HOV route is 23.4 miles; HOV route is 23.4 miles	N/A	31 (+/- 1)	28 (+/- 1)	26 (+/- 2)	47 (+/- 9)	N/A	51 (+/- 5)	48 (+/- 2)	33 (+/- 5)	77 (+/- 17)	N/A	20	20 *	7	30
I-270 & East Spur (southbound) From I-370 to Old G'town Road; HOV route is 8.8 miles	11 (+/- 1)	18 (+/- 1)	13 (+/- 2)	12 (+/- 4)	12 (+/- 3)	16 (+/- 3)	22 (+/- 4)	19 (+/- 3)	20 (+/- 8)	18 (+/- 3)	5	4	6	8	6
I-270 and West Spur (southbound) From I-370 to S end of I-270 Spur; HOV route is 8.6 miles	11 (+/- 2)	16 (+/- 3)	14 (+/- 7)	13 (+/- 3)	12 (+/- 3)	17 (+/- 4)	23 (+/- 3)	22 (+/- 3)	18 (+/- 5)	16 (+/- 5)	6	7	8	5	4
U.S.50 (westbound) From U.S.301/Md.3 to I-95/I-495; HOV route is 9.0 miles	N/A	N/A	9 (+/- 0)	7 (+/- 1)	7 (+/- 1)	N/A	13 (+/- 2)	12 (+/- 2)	8 (+/- 2)	8 (+/- 1)	N/A	N/A	3	1	1

Notes:
- Data in table are rounded to whole minutes.
- I-66 (eastbound) non-HOV route uses I-66 to I-495 (southbound) to U.S.50 (eastbound) to I-66 on T. Roosevelt Bridge
- Va.267 (eastbound) HOV route uses Va. 267 to Dulles Connector Road to I-66 (eastbound)
- Va.267 (eastbound) non-HOV route uses Va.267 to I-495 (northbound) to G.Washington Mem. Parkway (southbound) to I-66 on T. Roosevelt Bridge
- All travel time runs on Va.267 (HOV and non-HOV) performed with an EZ-Pass transponder.
- Travel time savings shown with an asterisk (*) are statistically significant at the 95% confidence level using a Tukey Test for 2004-2010. Time savings without an asterisk are not statistically significant.
- Margins of Error computed at 95% confidence level using two-tailed test.

Table D10: Mean PM Peak Period / Peak Direction Travel Times Over Time by Facility

Facility	HOV route travel time (minutes)					Non-HOV route travel time (minutes)					Time Savings (Non-HOV Time - HOV Time)				
	1997	1999	2004	2007	2010	1997	1999	2004	2007	2010	1997	1999	2004	2007	2010
I-95/I-395 (southbound) From Va. end of 14th St. Bridge to south of Va. 234 HOV route is 27.9 miles	26 (+/- 2)	28 (+/- 1)	25 (+/- 0)	33 (+/- 11)	30 (+/- 6)	60 (+/- 6)	64 (+/- 12)	53 (+/- 10)	61 (+/- 23)	73 (+/- 19)	39	31	37 *	28 *	43 *
I-66 (westbound) From Va. end of T. Roosevelt Bridge to Va.234 Business (Manassas) HOV route is 30.7 miles	27 (+/- 1)	32 (+/- 2)	34 (+/- 3)	37 (+/- 8)	44 (+/- 7)	44 (+/- 7)	55 (+/- 11)	56 (+/- 6)	55 (+/- 11)	68 (+/- 12)	28	28	17 *	18 *	24 *
Va.267/I-66 (westbound) From Va. end of T. Roosevelt Bridge to Va.28 HOV route is 24.2 miles	N/ A	31 (+/- 1)	28 (+/- 1)	24 (+/- 1)	27 (+/- 3)	N/ A	51 (+/- 5)	48 (+/- 2)	32 (+/- 3)	42 (+/- 7)	N/ A	20	20	8	15
I-270 & E.Spur (northbound) just north of I-495 to Md. 121 (Clarksburg) HOV route is 18.4 miles	11 (+/- 1)	18 (+/- 1)	13 (+/- 2)	22 (+/- 7)	21 (+/- 3)	16 (+/- 3)	22 (+/- 4)	19 (+/- 3)	29 (+/- 1)	31 (+/- 5)	5	4	6 *	7	10
I-270Y (I-270 Spur) and I-270 (northbound) From I-495 to Md. 121 (Clarksburg) HOV route is 18.5 miles	11 (+/- 2)	16 (+/- 3)	14 (+/- 7)	20 (+/- 2)	19 (+/- 2)	17 (+/- 4)	23 (+/- 3)	22 (+/- 3)	29 (+/- 5)	28 (+/- 4)	6	7	8 *	9	9
U.S.50 (eastbound) From I-95/I-495 to U.S.301/Md.3 HOV route is 8.4 miles	N/ A	N/ A	9 (+/- 0)	7 (+/- 0)	8 (+/- 2)	N/ A	13 (+/- 2)	12 (+/- 2)	8 (+/- 2)	10 (+/- 4)	N/ A	N/ A	3	1	2

Notes:
- Data in table are rounded to whole minutes.
- I-66 (westbound) non-HOV route uses T. Roosevelt Bridge to U.S. 50 (westbound) to I-495 (northbound) to I-66 (westbound)
- Va.267 (westbound) HOV route uses I-66 (westbound) to Dulles Connector Road to Va. 267 (westbound)
- Va.267 (westbound) non-HOV route uses T.Roosevelt Bridge to G.Washington Mem.Parkway (northbound) to I-495 (southbound) to Va.267 (wes
- All travel time runs on Va.267 (HOV and non-HOV) performed with an EZ-Pass transponder.
- Travel time savings shown with an asterisk (*) are statistically significant at the 95% confidence level using a Tukey Test for 2004-2010. Time savings without an asterisk are not statistically significant.
- Margins of Error computed at 95% confidence level using two-tailed test.

Table D11: AM Peak Direction Travel Time Summary for HOV and non-HOV Lanes (Spring 2010)

Facility	Facility Section	Length (miles)	HOV Time (mins.)	Non-HOV Time (mins.)	Time Savings In Minutes	Time Savings in Min./Mi.	Average Speed HOV (MPH)	Average Speed Non-HOV (MPH)
I-95/I-395	From Va. 234 to the Pentagon	27.6	35	76	41	1.5	50	24
	Outside Beltway	*18.0*	*18*	*31*	*13*	*0.7*	*64*	*37*
	Inside Beltway	*9.6*	*17*	*45*	*28*	*2.9*	*36*	*16*
I-66	From Va. 234 (Business) to the T. Roosevelt Bridge	28.8	66	102	36	1.3	31	20
	Outside Beltway	*17.8*	*45*	*57*	*12*	*0.7*	*30*	*24*
	Inside Beltway	*10.5*	*20*	*45*	*25*	*2.4*	*35*	*18*
Va. 267	From Va.28 to to the T. Roosevelt Bridge	23.4	47	77	30	1.3	29	20
	Va. 267 only	*14.9*	*25*	*32*	*7*	0.5	*29*	*25*
I-270	From I-370 to I-495 (passing Md. 187)	8.8	12	18	6	0.7	44	30
	I-270Y (I-270 Spur) From I-370 to I-495 (passing Democracy Blvd.)	8.6	12	16	4	0.5	46	34
U.S. 50	From U.S. 301/Md. 3 to Capital Beltway	9.0	7	8	1	0.1	67	60

Notes:
- Facility Length rounded to nearest 1/10 of a mile
- HOV Times, Non-HOV Times and Time Savings in Minutes rounded to nearest whole minute
- Time Savings rounded to nearest 1/10 of a minute

Table D12: PM Peak Direction Travel Time Summary for HOV and non-HOV Lanes (Spring 2010)

Facility	Facility Section	Length (miles)	HOV Time (mins.)	Non-HOV Time (mins.)	Time Savings In Minutes	Time Savings in Min./Mi.	Average Speed HOV (MPH)	Average Speed Non-HOV (MPH)
I-95/I-395	From The Pentagon to Va. 234	27.9	30	73	43	1.5	58	24
	Outside Beltway	17.7	21	55	34	1.9	56	22
	Inside Beltway	10.2	9	18	9	0.9	64	33
I-66	From T. Roosevelt Bridge to Va. 234 (Business)	30.7	44	68	24	0.8	43	29
	Outside Beltway	20.3	31	39	8	0.4	42	35
	Inside Beltway	10.4	13	29	16	1.5	51	23
Va. 267	From the T. Roosevelt Bridge to Va. 28	24.2	27	42	15	0.6	47	33
	Va. 267 only	15.5	17	30	13	0.8	35	32
I-270	From I-495 (passing Md. 187) to Md. 121 (Clarksburg)	18.4	21	31	10	0.5	53	36
	I-270Y (I-270 Spur) From I-495 (passing Democracy Blvd.) to Md. 121 (Clarksburg)	18.5	19	28	9	0.5	59	41
U.S. 50	From the Capital Beltway to U.S. 301/Md. 3	8.4	8	10	2	0.2	65	58

Notes:
- Facility Length rounded to nearest 1/10 of a mile
- HOV Times, Non-HOV Times and Time Savings in Minutes rounded to nearest whole minute
- Time Savings rounded to nearest 1/10 of a minute

APPENDIX E – SUMMARY OF TRANSPORTATION EMISSION REDUCTION MEASURE (TERM) ANALYSIS FY 2009-2011

Background

The Transportation Emission Reduction Measures (TERM) Analysis FY 2009-2011 Report[124] presents the results of an evaluation of four TERMs, voluntary Transportation Demand Management (TDM) measures implemented by the National Capital Region Transportation Planning Board's (TPB) Commuter Connections program at the Metropolitan Washington Council of Governments (COG) to support the Washington, DC metropolitan region's air quality conformity determination and congestion management process. This evaluation documents transportation and air quality impacts for the three-year evaluation period between July 1, 2008 and June 30, 2011, for the following TERMs:

- Maryland and Virginia Telework – Provides information and assistance to commuters and employers to further in-home and telecenter-based telework programs.
- Guaranteed Ride Home – Eliminates a barrier to use of alternative modes by providing free rides home in the event of an unexpected personal emergency or unscheduled overtime to commuters who use alternative modes.
- Employer Outreach – Provides regional outreach services to encourage large, private-sector and non-profit employers voluntarily to implement commuter assistance strategies that will contribute to reducing vehicle trips to worksites, including the efforts of jurisdiction sales representatives to foster new and expanded trip reduction programs.
- Mass Marketing – Involves a large-scale, comprehensive media campaign to inform the region's commuters of services available from Commuter Connections as one way to address commuters' frustration about the commute.

COG's National Capital Transportation Planning Board (TPB), the designated Metropolitan Planning Organization (MPO) for the Washington, DC metropolitan region, adopted and continues to support these TERMs, among others, as part of the regional Transportation Improvement Program (TIP) to help the region reach emission reduction targets that would maintain a positive air quality conformity determination for the region and to meet federal requirements for the congestion management process. It is also important to note that the regional travel demand model was calibrated and validated against the year 2000 traffic counts and regional emission credits are only taken for TERM benefits that occurred after the year 2000 in the regional TERM tracking sheet and might not be consistent with results in this report.

COG/TPB's Commuter Connections program, which also operates an ongoing regional rideshare program, is the central administrator of the TERMs noted above. Commuter Connections elected

[124] http://www.mwcog.org/store/item.asp?PUBLICATION_ID=425

to include a vigorous evaluation element in the implementation plan for each of the adopted TERMs to develop information to be used to guide sound decision-making about the TERMs. This report summarizes the results of the TERM evaluation activities and presents the transportation and air quality impacts of the TERMs and the Commuter Operations Center (COC).

This evaluation represents a quite comprehensive evaluation for these programs. It should be noted that the evaluation still remains conservative in the sense that it includes credit only for impacts that can be reasonably documented with accepted measurement methods and tools. However, we also note that many of the calculations used survey data from surveys that are subject to statistical error rates.

A primary purpose of this evaluation was to develop useful and meaningful information for regional transportation and air quality decision-makers, COG/TPB staff, COG/TPB program funding agencies, and state and local commute assistance program managers to guide sound decision-making about the TERMs. The results of this evaluation will provide valuable information for regional air quality conformity and the region's congestion management process, improve the structure and implementation procedures of the TERMs themselves, and to refine future data collection methodologies and tools.

Summary of Results

The objective of the evaluation is to estimate reductions in vehicle trips (VT), vehicle miles traveled (VMT), and tons of vehicle pollutants (Nitrogen Oxides (NOx), Volatile Organic Compounds (VOC), Particulate Matter (PM2.5), Particulate Matter NOx precursors (PM_NOx), and Carbon Dioxide (CO2)) resulting from implementation of each TERM and compare the impacts against the goals established for the TERMs. The impact results for these measures are shown in Table E1 for each TERM individually. Results for all TERMs collectively and for the Commuter Operations Center (COC) are presented in Table E2.

As shown in Table E1, the TERMs combined exceeded the collective goals for both vehicle trips reduced and VMT reduced by about 21%. The TERMs did not reach the emission goals; the impact for NOx was about 15% under the goal and VOC impact was 12% under the goal, but this was due entirely to a change in the emission factors. The goals were set in 2006, using 2006 emission factors, but the 2011 factors used in the 2011 evaluation were considerably lower.

When the COC results are added to the TERM impacts, as presented in Table E2, the combined impacts again met both the vehicle trip and VMT reduction goals, in this case by 15% and 12% respectively. The combined TERM – COC programs fell about 21% short of the NOx goal and 18% under the VOC goal. Again, the change in the emission factors affected the emission results.

Two TERMs, Telework and Employer Outreach, met their individual participation and travel impact goals. Telework exceeded its vehicle trip reduction goal by about five percent and just met the VMT goal. Employer Outreach, both the overall program and the New/Expanded component, exceeded its vehicle trip and VMT goals by a margin substantial enough to overcome the difference between the 2006 and 2011 emission rates; Employer Outreach met all the emission goals as well as the travel goals. Employer Outreach for Bicycling also met its goals.

The Mass Marketing (MM) TERM came within 10% of its vehicle trip reduction goals, but was substantially under the goal for VMT reduction, primarily because 2011 Mass Marketing program participants traveled much shorter distances to work (9.6 miles one-way) than did 2008 MM participants (31 miles). In 2011, MM influenced a greater share of commuters to shift to bicycle and transit, both of which have short-distance travel profiles. Thus, even with robust participation and vehicle trip reduction, the TERM missed the VMT goal.

Finally, impacts for Guaranteed Ride Home were well below the goals for this program. The Commuter Operations Center and the Software Upgrades TERM also missed their goals. The reasons for the shortfalls from the goals vary by TERM and are discussed in individual report sections on each TERM.

Table E1: Summary of Daily Impact Results for Individual TERMs (7/08– 06/11) and Comparison to Goals

TERM	Participation [1]	Daily Vehicle Trips Reduced	Daily VMT Reduced	Daily Tons NOx Reduced	Daily Tons VOC Reduced
Maryland and Virginia Telework [2]					
2011 Goal	31,854	11,830	241,208	0.122	0.072
Impacts (7/08 – 6/11)	35,237	12,499	241,834	0.099	0.062
Net Credit or (Deficit)	**3,383**	**669**	**626**	**(0.023)**	**(0.011)**
Guaranteed Ride Home					
2011 Goal	36,992	12,593	355,136	0.177	0.097
Impacts (7/08 – 6/11)	22,984	7,983	208,346	0.076	0.042
Net Credit or (Deficit)	**(14,008)**	**(4,610)**	**(146,790)**	**(0.101)**	**(0.055)**
Employer Outreach – all employers participating [3]					
2011 Goal	581	64,644	1,065,851	0.549	0.343
Impacts (7/08 – 6/11)	1,119	90,350	1,657,809	0.578	0.367
Net Credit or (Deficit)	538	**25,706**	**591,958**	**0.029**	**0.024**
Employer Outreach – new / expanded employer services since July 2008 [3]					
2011 Goal	96	8,618	140,622	0.072	0.046
Impacts (7/08 – 6/11)	551	28,098	461,250	0.177	0.108
Net Credit or (Deficit)	**455**	**19,480**	**320,628**	**0.105**	**0.062**
Employer Outreach for Bicycling [3]					
2011 Goal	61	130	567	0.001	0.001
Impacts (7/08 – 6/11)	274	180	1,083	0.001	0.001
Net Credit or (Deficit)	**213**	**50**	**516**	**0.000**	**0.000**
Mass Marketing					
2011 Goal	11,023	7,758	141,231	0.072	0.044
Impacts (7/08 – 6/11)	10,438	6,922	78,297	0.031	0.021
Net Credit or (Deficit)	**(585)**	**(836)**	**(62,934)**	**(0.041)**	**(0.023)**
TERMS (all TERMs collectively)					
2011 Goal		96,825	1,803,426	0.920	0.556
Impacts (7/08 – 6/11)		117,754	2,186,286	0.784	0.492
Net Credit or (Deficit)		**20,929**	**382,860**	**(0.136)**	**(0.064)**

1) Participation refers to number of commuters participating, except for the Employer Outreach TERM. For this TERM, participation equals the number of employers participating.

2) Impact represents portion of regional telework attributable to TERM-related activities. Total telework credited for conformity is higher than reported for the TERM.

3) Impacts for Employer Outreach - all employers participating includes impacts for Employer Outreach – new / expanded employer services since July 2008 and for Employer Outreach for Bicycling.

Table E2: Summary of TERM and COC Results (7/08 – 6/11) and Comparison to Goals

TERM	Participation 1)	Daily Vehicle Trips Reduced	Daily VMT Reduced	Daily Tons NOx Reduced	Daily Tons VOC Reduced
TERMS (all TERMs collectively)					
2011 Goal		96,825	1,803,426	0.920	0.556
Impacts (7/08 – 6/11)		117,754	2,186,286	0.784	0.492
Net Credit or (Deficit)		**20,929**	**382,860**	**(0.136)**	**(0.064)**
Commuter Operations Center – Basic Services 2)					
2011 Goal	152,356	10,399	296,635	0.147	0.081
Impacts (7/08 – 6/11)	81,675	6,190	180,409	0.066	0.036
Net Credit or (Deficit)	(70,681)	**(4,209)**	**(116,226)**	**(0.081)**	**(0.045)**
Commuter Operations Center – Software Upgrades 2)					
2011 Goal		2,370	62,339	0.031	0.017
Impacts (7/08 – 6/11)	3,373	1,717	51,569	0.020	0.010
Net Credit or (Deficit)		**(653)**	**(10,770)**	**(0.012)**	**(0.007)**
All TERMS plus COC					
2011 Goal		109,594	2,162,400	1.098	0.654
Impacts (7/08 – 6/11)		125,661	2,418,264	0.870	0.538
Net Credit or (Deficit)		**16,067**	**255,864**	**(0.228)**	**(0.116)**

1) Participation refers to number of commuters participating, except for the Employer Outreach TERM. For this TERM, participation equals the number of employers participating.

2) Impacts for Commuter Operations Center – software Upgrades are in addition to the impacts for the Commuter Operations Center – Basic Services. This project was part of the Integrated Rideshare TERM.

Table E3, on the following page, presents annual emission reduction results for PM 2.5, PM 2.5 pre-cursor NOx, and CO2 emissions (Greenhouse Gas Emissions - GHG) for each TERM and for the COC. COG/TPB did not establish specific targets for these impacts for the Commuter Connections TERMs. But COG has begun to measure these impacts for other TERMs, thus these results are provided.

As shown, the TERMs collectively reduce 6.43 annual tons of PM 2.5, 223.1 annual tons of PM 2.5 precursor NOx, and 254,277 annual tons of CO2 (greenhouse gas emissions). When the Commuter Operations Center is included, these emissions impacts rise to 7.1 annual tons of PM 2.5, 246.4 annual tons of PM 2.5 pre-cursor NOx, and 282,001 annual tons of CO2 (greenhouse gas emissions).

Table E3: Summary of Annual PM 2.5 and CO2 (Greenhouse Gas) Emission Results for Individual TERMs

TERM	Annual Tons PM 2.5 Reduced	Annual Tons PM 2.5 Precursor NOx Reduced	Annual Tons CO2 Reduced
Maryland and Virginia Telework [1]	0.8	27.0	30,770
Guaranteed Ride Home	0.7	22.2	26,272
Employer Outreach – all employers [2]	4.7	165.5	189,976
Employer Outreach – new / expanded Employers [2]	1.4	48.5	55,584
Employer Outreach for Bicycling	0.0	0.1	138
Mass Marketing	0.2	8.4	9,259
TERMS (all TERMs collectively)	6.4	223.1	254,277
Commuter Operations Center – basic services (not including Software Upgrades)	0.5	18.0	21,393
Commuter Operations Ctr – Software Upgrades	0.2	5.3	6,331
All TERMs plus Commuter Operations Center	7.1	246.4	282,001

1) Impact represents portion of regional telecommuting attributable to TERM-related activities. Total telecommuting credited for conformity is higher than reported for the TERM.

2) Impacts for new / expanded employer programs and Employer Outreach for Bicycling are included in the Employer Outreach – all employers.

Finally, Table E4 shows comparisons of daily reductions in vehicle trips, VMT, NOx, and VOC from the 2008 T ERM analysis to results of the 2011 r esults. Note that, as described in the footnotes to the table, the emission factors declined between 2008 a nd 2011, r esulting in decreased emission reductions, even though the TERMs achieved greater vehicle trip and VMT reductions in 2011.

Table E4: Summary of Results for Individual TERMs 7/08– 6/11 Compared to 7/05 – 6/08

TERM	Daily Vehicle Trips Reduced	Daily VMT Reduced	Daily Tons NOx Reduced	Daily Tons VOC Reduced
Maryland and Virginia Telework				
July 2008 – June 2011	12,499	241,834	0.099	0.062
July 2005 – June 2008	21,866	413,703	0.211	0.126
Change [1]	(9,367)	(171,869)	(0.112)	(0.064)
Guaranteed Ride Home				
July 2008 – June 2011	7,983	208,346	0.076	0.042
July 2005 – June 2008	8,680	227,428	0.106	0.056
Change [1]	(697)	(19,082)	(0.030)	(0.014)
Employer Outreach – All services except Employer Outreach for Bicycling				
July 2008 – June 2011	90,170	1,656,727	0.577	0.366
July 2005 – June 2008	59,163	969,174	0.443	0.266
Change [1]	31,007	687,553	0.134	0.100
Employer Outreach for Bicycling				
July 2008 – June 2011	180	1,083	0.001	0.001
July 2005 – June 2008	188	1,127	0.001	0.001
Change [1]	(8)	(44)	0.000	0.000
Mass Marketing				
July 2008 – June 2011	6,922	78,297	0.031	0.021
July 2005 – June 2008	2,577	69,274	0.032	0.017
Change [1]	4,345	9,023	(0.001)	0.004
InfoExpress Kiosks [2]				
July 2008 – June 2011	Deleted	Deleted	Deleted	Deleted
July 2005 – June 2008	2,840	52,638	0.027	0.016
Change [1]	N/A	N/A	N/A	N/A
All TERMs				
July 2008 – June 2011	117,754	2,186,287	0.784	0.492
July 2005 – June 2008	95,314	1,733,344	0.820	0.482
Change [1]	22,440	452,943	(0.036)	0.010
Commuter Operations Center (Basic Services + Software Upgrades)				
July 2008 – June 2011	7,907	231,978	0.086	0.046
July 2005 – June 2008	22,473	721,678	0.320	0.158
Change [1]	(14,566)	(489,700)	(0.234)	(0.112)

1) Change in emissions is due in part to reduction in emission factors from 2008 to 2011.
2) InfoExpress Kiosks TERM eliminated prior to July 2008 – no longer in TERM calculation.

APPENDIX F – SAMPLE CMP DOCUMENTATION FORM

Congestion Management Documentation Form for Projects in the 2030 CLRP

DRAFT

BASIC PROJECT INFORMATION

1. Agency: Secondary Agency:

2. Project Title: **GENERIC TEMPLATE (SAMPLE)**

	Prefix	Route	Name	Modifier
4. Facility:				
5. From (_ at):				
6. To:				

7. Jurisdiction(s):

8. Indicate whether the proposed project's location is subject to or benefits significantly from any of the following in-place congestion management strategies:

X Metropolitan Washington Commuter Connections program (ridesharing, telecommuting, guaranteed ride home, employer programs)

X A Transportation Management Association is in the vicinity

_ Channelized or grade-separated intersection(s) or roundabouts

_ Reversible, turning, acceleration/deceleration, or bypass lanes

_ High occupancy vehicle facilities or systems

X Transit stop (rail or bus) within a 1/2 mile radius of the project location

X Park-and-ride lot within a one-mile radius of the project location

_ Real-time surveillance/traffic device controlled by a traffic operations center

X Motorist assistance/hazard clearance patrols

X Interconnected/coordinated traffic signal system

X Other in-place congestion management strategy or strategies (briefly describe below:)

This corridor also benefits from carsharing offered at transit stations and park-and-ride lots in the vicinity, which encourages people to leave their cars at home. In addition, there are extensive pedestrian connections in the area, including sidewalks and bicycle paths along this roadway. (Customize and/or add agency specifics…)

9. List and briefly describe how the following categories of (additional) strategies were considered as full or partial alternatives to single-occupant vehicle capacity expansion in the study or proposal for the project.

a. Transportation demand management measures, including growth management and congestion pricing

The status of and potential impacts of transportation demand management measures, including growth management and congestion pricing, have been considered for this corridor. The facility benefits from the regional alternative commute program, Commuter Connections, jointly funded by Virginia, Maryland, and the District of Columbia. Commuter Connections encourages ridesharing, teleworking, carpooling, vanpooling, and riding/biking to work, among other demand management measures. Additionally, the County promotes its own ridesharing program, providing a wealth of free information on commuting options, and promotes flexible/compressed workweeks. (Customize and/or add agency specifics…)

b. Traffic operational improvements

The status of and potential impacts of traffic operational improvements have been considered for this corridor. Feasible traffic operations management activities have been or will be implemented along the corridor, as well as traffic signal coordination. Strategies include those that aid in reducing non-recurring congestion. (Customize and/or add agency specifics…)

c. Public transportation improvements

The status of and potential impacts of feasible public transportation improvements have been considered for this corridor. Public transportation in the corridor includes regional bus and rail, along with locally-operated bus services. Park-and-Ride lots are also provided in the vicinity of the project. (Customize and/or add agency specifics…)

d. Intelligent Transportation Systems technologies

The status of and potential impacts of feasible Intelligent Transportation Systems (ITS) technologies have been considered for this corridor. ITS technologies providing traveler information and/or traffic management have been or will be implemented along the corridor. (Customize and/or add agency specifics…)

e. Other congestion management strategies

(Customize and/or add agency specifics…)

f. Combinations of the above strategies

The status of and potential impacts of feasible combinations of the above strategies have been considered for this corridor. The above strategies work together to reduce recurring and non-recurring congestion. (Customize and/or add agency specifics…)

10. Could congestion management alternatives fully eliminate or partially offset the need for the proposed increase in single-occupant vehicle capacity? Explain why or why not.

No. While the above congestion management alternatives help manage existing traffic flow on the corridor, additional capacity is needed. However, additional congestion management strategies will continue to be considered and implemented to help manage future capacity in the corridor. (Customize and/or add agency specifics…)

11. Describe all congestion management strategies that are going to be incorporated into the proposed highway project.

The following congestion management strategies (#9a,b,c,d,e,and/or f) will be implemented and improved upon, and/or additional feasible strategies will be considered… (Customize and/or add agency specifics…)

12. Describe the proposed funding and implementation schedule for the congestion management strategies to be incorporated into the proposed highway project. Also describe how the effectiveness of strategies implemented will be monitored and assessed after implementation.

Feasible congestion management strategies are or will be in place along the corridor, and will continue to be in place as the project is implemented, under funding identified within the project. Consideration will be given on how to enhance these existing strategies and to what extent feasible new strategies can be implemented. (Customize and/or add agency specifics…)

APPENDIX G – REVIEW OF CONGESTION MANAGEMENT STRATEGIES

This appendix references the Table 16 and Table 17 on pages 180 and 181, which are repeated on the next two pages for convenience.

GENERAL CHARACTERISTICS

Strategy Name and Number:

The strategies down the left-hand side of the lists were developed based on the types of strategies being pursued in the region and elsewhere, and could be considered for implementation in our region. Inclusion of any given strategy on the list does not imply endorsement, but rather is included on the list only for consideration and comparison purposes.

Each strategy has a number associated with it (C.1.0, C.1.1, etc.) to make it easier to find and discuss the strategies. The number is not in any way a ranking.

Those listed in bold italics are the strategy categories and underneath them are the specific strategies in that category.

Table L1: Congestion Management Process (CMP) Demand Management Strategies Criteria

1. Some Impact (x)
2. Significant Impact (xx)
3. High Impact (xxx)

STRATEGY		QUALITATIVE CRITERIA: Impacts on Congestion: Reduces Overall Congestion	Reduces Incident-related Congestion	Supports/Promotes Multi-modal Transportation	Regional Applicability	Local Applicability	Existing Level of Deployment	Ease of Implementation	Cost	Cost Effectiveness	Enhance Existing Programs
C.5.0	***Alternative Commute Programs***										
C.5.1	Carpooling	xxx	x	x	xxx	xxx	xxx	xx	x	xxx	xxx
C.5.2	Ridematching Services	xxx	x	x	xxx	xxx	xxx	xx	x	xxx	xxx
C.5.3	Vanpooling	xxx	x	x	xxx	xx	xx	xx	x	xxx	xxx
C.5.4	Telecommuting	xx	x	x	xxx	xx	xx	xxx	x	xx	xxx
C.5.5	Promote Alternate Modes	xx	x	xxx	xxx	xxx	xxx	xxx	x	xx	xxx
C.5.6	Compressed/flexible w orkw eeks	xx	x	x	xxx	xxx	xxx	xxx	x	x	xx
C.5.7	Employer outreach/mass marketing	xx	x	xxx	xxx	xxx	xx	xx	xx	xx	xxx
C.5.8	Parking cash-out	xx	x	xxx	x	xxx	x	x	xx	xx	x
C.5.9	Alternative Commute Subsidy Program	xx	x	xxx	xxx	xx	xx	x	x	xxx	xxx
C.6.0	***Managed Facilities***										
C.6.1	HOV	xx	x	xxx	xxx	xx	xx	xx	xxx	xxx	xxx
C.6.2	Variably Priced Lanes (VPL)	xxx	x	xx	xxx	xx	x	x	xxx	xxx	xx
C.6.3	Cordon Pricing	xxx	x	xxx	xxx	x	x	x	xx	xxx	xx
C.6.4	Bridge Tolling	xxx	x	x	xx	xx	x	x	xxx	xx	x
C.7.0	***Public Transportation Improvements***										
C.7.1	Electronic Payment Systems	xx	x	xxx	xx	xx	xxx	xx	xx	xxx	xx
C.7.2	Improvements/added capacity to regional rail and bus transit	xx	xx	xxx	xx	xxx	xx	x	xxx	xxx	xx
C.7.3	Improving accessibility to multi-modal options	xx	x	xxx	xx	xxx	xx	xx	xx	xx	xxx
C.7.4	Park-and-ride lot improvements	xx	x	xx	xx	xx	xx	xx	xx	xx	xx
C.7.5	Carsharing Programs	xx	x	xxx	xxx	xxx	xx	xxx	xx	xx	xxx
C.8.0	***Pedestrian, bicycle, and multi-modal improvements***										
C.8.1	Improve pedestrian facilities	xx	x	xxx	xx	xxx	xx	xx	xx	xx	xxx
C.8.2	Creation of new bicycle and pedestrian lanes and facilities	xx	x	xxx	xxx	xxx	xx	xx	xx	xx	xxx
C.8.3	Addition of bicycle racks at public transit stations/stops	x	x	xx	xxx	xxx	xx	xxx	x	x	xxx
C.8.4	Bike sharing programs	xx	x	xxx	xxx	xxx	xx	xxx	xx	xx	xxx
C.9.0	***Growth Management***										
C.9.1	Coordination of Regional Activity Centers	xx	x	xxx	xxx	xxx	xx	x	xxx	xxx	xx
C.9.2	Implementation of TLC program (i.e. coordination of transportation and land use w ith local gov'ts)	xx	x	xxx	xxx	xxx	xx	xxx	x	xxx	xxx
C.9.3	"Live Near Your Work" program	xx	x	xx	xxx	xx	x	xx	x	x	xx

Table L2: Congestion Management Process (CMP) Operational Management Strategies Criteria

1. Some Impact (x)
2. Significant Impact (xx)
3. High Impact (xxx)

		QUALITATIVE CRITERIA									
		Impacts on Congestion									
STRATEGY		Reduces Overall Congestion	Reduces Incident-related Congestion	Supports/Promotes Multi-modal Transportation	Regional Applicability	Local Applicability	Existing Level of Deployment	Ease of Implementation	Cost	Cost Effectiveness	Enhance Existing Programs
C.1.0	***Incident Mngt./Non-recurring***										
C.1.1	Imaging/Video for surveillance and Detection	xx	xxx	xx	xxx	xxx	xx	xx	xx	xxx	xxx
C.1.2	Service patrols	xx	xxx	x	xxx	xxx	xx	xxx	xx	xxx	xxx
C.1.3	Emergency Mngt. Systems (EMS)	x	xx	x	xx	xxx	xxx	xx	xxx	xxx	xxx
C.1.4	Emergency Vehicle Preemption	x	xx	x	x	xxx	xx	xx	xx	x	xx
C.1.5	Road Weather Management	x	xxx	x	xxx	xxx	xx	xx	xx	xx	xx
C.1.6	Traffic Mngt. Centers (TMCs)	xx	xxx	xx	xxx	xx	xx	xx	xx	xxx	xxx
C.1.7	Curve Speed Warning System	xx	xx	x	x	xx	x	xx	xx	xx	x
C.1.8	Work Zone Management	xx	xxx	x	xx	xxx	xx	xx	xx	xx	xx
C.1.9	Automated truck rollover systems	x	xx	x	x	xx	xx	xx	xx	xx	xx
C.2.0	***ITS Technologies***										
C.2.1	Advanced Traffic Signal Systems	xxx	xx	xx	xxx	xxx	xx	xx	xxx	xxx	xxx
C.2.2	Electronic Payment Systems	xxx	x	xx	xxx	xx	xx	xx	xx	xxx	xx
C.2.3	Freew ay Ramp Metering	xx	x	x	xx	xx	x	xx	xx	xx	xx
C.2.4	Bus Priority Systems	x	x	xxx	xxx	xxx	x	xx	xxx	xx	xx
C.2.5	Lane Management (e.g. Variable Speed Limits)	xx	xx	x	xx	xxx	x	xx	xx	xx	xx
C.2.6	Automated Enforcement (e.g. red light cameras)	x	x	x	x	xxx	xx	xx	xx	xx	xx
C.2.7	Traffic signal timing	xxx	x	xx	xxx	xxx	xx	xxx	x	xxx	xxx
C.2.8	Reversible Lanes	xx	x	x	xx	xxx	x	x	xx	xx	xx
C.2.9	Parking Management Systems	xx	x	xx	xx	xxx	x	x	xxx	xx	xx
C.2.10	Dynamic Routing/Scheduling	xx	x	xx	xxx	xxx	x	x	xxx	xx	xx
C.2.11	Service Coordination and Fleet Mngt. (e.g. buses and trains sharing real-time information)	xx	x	xxx	xxx	xxx	x	x	xx	xx	xx
C.2.12	Probe Traffic Monitoring	xx	xxx	x	xx	xx	x	xx	xx	xxx	xx
C.3.0	***Advanced Traveler Information Systems***										
C.3.1	511	xx	xxx	xx	xxx	x	xx	xx	xxx	xx	xxx
C.3.2	Variable Message Signs (VMS)	xx	xxx	xx	xx	xxx	xx	xx	xx	xxx	xxx
C.3.3	Highw ay Advisory Radio (HAR)	x	xx	x	xx	xxx	xx	xxx	xx	x	xx
C.3.4	Transit Information Systems	xx	xx	xxx	xx	xxx	xx	x	xx	xx	xxx
C.4.0	***Traffic Engineering Improvements***										
C.4.1	Safety Improvements	x	xxx	x	x	xxx	xx	xxx	x	xxx	xxx
C.4.2	Turn Lanes	xx	x	x	x	xxx	xx	xx	xx	xx	x
C.4.3	Roundabouts	x	xx	x	x	xxx	x	x	x	xx	xx

Qualitative Criteria:

The qualitative criteria listed across the top of the lists are used to show what kind of impact strategies have on various areas. The first three criteria listed are all impacts on congestion. However, there are several other criteria that could be looked at to determine if a strategy should be considered. The following is a definition of each criterion, and the questions we may want to ask when giving each strategy a "high," "medium," or "low" indicator:

- ***Reduces Overall Congestion***
  - How much of an impact does a strategy have in reducing overall traffic congestion?
- ***Reduces Incident-related Congestion***
  - How much of an impact does a strategy have in reducing incidents and incident-related congestion?
- ***Support/Promotes Multi-modal Transportation***
  - Does this strategy play a particular role in supporting multi-modal transportation, such as the use of bus, rail, bicycling, or pedestrian facilities?
- ***Regional Applicability***
  - Is this the type of strategy that would be easier to implement at the regional level (e.g. alternative commute programs across the region)?
- ***Local Applicability***
  - Is this the type of strategy that would be easier to implement at the local level (e.g. Automated Enforcement, which depends greatly on the local laws and law enforcement)?
- ***Existing Level of Deployment***
  - Is this strategy implemented anywhere in the region now, and if so, to what extent?
- ***Ease of Implementation***
  - How easy is the strategy to implement? Not only in terms of complexity, but in also in terms of funding, and a local jurisdiction's unique programs and laws. Some strategies are more common and more promising, while others may be more difficult to implement.
- ***Cost***
  - How much does a strategy cost to implement?
- ***Cost Effectiveness***
  - How much does the value outweigh the cost (i.e. how high are the benefits)? This is different than the previous "cost" category. For example, carpooling may be indicated as low in terms of cost, because the cost is generally low to implement. However, carpooling may be indicated as high in terms of cost effectiveness, because the benefits and value gained in the region far outweigh the cost.
- ***Enhance Existing Programs***
  - How well does this strategy fit in with existing strategies in the region? Is it new and something that existing strategies would benefit from? This category, previously broken down into "DC," "MD," and "VA," was collapsed into one category. It was found that when trying to determine if a strategy enhanced existing programs, there was not much variation among the jurisdictions.

Some, Significant, and High Indicators:

Each strategy was given an indicator of "some impact (x)," "significant impact (xx)," or "high impact (xxx)," which was based on a similar nomenclature used in the TERM process. Each indicator was developed from the knowledge and research of what sorts of activities are going on in our region. By nature of various strategies, some will be evaluated with greater or lesser impacts (e.g. a strategy may be listed as "low" for regional applicability but "high" for local applicability"). That being said, some strategies that are "low" in some categories may be of interest for other reasons.

To further explain and clarify the reason for these indicators, let's walk through the indicators of one strategy, *C.8.1 – Improve Pedestrian Facilities*:

- Improving pedestrian facilities was thought to have a medium impact on reducing overall congestion in the region. Improving pedestrian facilities provides an alternative mode of transportation and takes some cars off the road.
- Its contribution to reducing incident-related congestion is limited; therefore it is indicated low in that category.
- Improving pedestrian facilities greatly support and promote multi-modal transportation, therefore indicated high.
- It is something that can be implemented region-wide, but is more likely to be applied more on a local level, given the unique programs and laws of jurisdictions (thus a medium indicator for regional applicability and a high indicator for local applicability).
- It has a fairly good existing level of deployment across the region (although given the high demand for pedestrian facilities in this region, some areas are lacking facilities).
- Ease of implementation for improving pedestrian facilities could be less expensive than building new roadways, and it could be easier to implement than ITS technologies. However, challenges such as local approval, and demand for these facilities, still remain. Indicator: medium.
- Cost is neither extremely low nor especially high, and it really depends on what type of pedestrian facility is being implemented. Cost effectiveness was indicated medium, as pedestrian facilities provide a good benefit for what it costs to implement them.
- Improvement of pedestrian facilities enhance existing programs. Pedestrian facilities support local growth management plans and provide access to transit options. Indicator: high.

Tying It All Together:

The strategy long lists are important to the regional CMP for several reasons:

- The lists outline various existing and potential strategies that could be considered for our region. As congestion is becoming and epidemic here and elsewhere, these strategies will serve as a point of reference to indicate what is being done in this region to address this.
- The "high," "medium," and "low" indicators characterize the impact strategies have. They provide a starting point for discussion show that there are various reasons why one

may want to implement a strategy. While something may have a high cost, it may also have a high impact on reducing congestion and a high cost effectiveness.
- The lists address federal requirements, which state that the region should identify and evaluate anticipated performance and expected benefits of existing strategies.

As the region continues to grow these are just some of the strategies that could be considered for our region. Many strategies on these lists are ongoing and will continue to be implemented on a greater scale. For other strategies these lists may act as a starting point for future consideration. Regardless, congestion management strategies will be at the forefront of discussion as the Washington region continues to be a dynamic living and working environment.

DETAILED DESCRIPTIONS OF STRATEGIES

Following is a list of congestion management strategies listed in the Strategy Long Lists. The numbers correspond with the numbered strategies in the list.

Operational Management Strategies:

C.1.0 - Incident Management./Non-recurring - This category of strategies are aimed at reducing non-recurring congestion; congestion caused primarily by incidents and events. Many of these incident management systems are aimed at clearing an incident so that traffic can resume its normal flow.

- *C.1.1 – Imaging/Video for Surveillance and Detection*
  - Cameras throughout our transportation system, on roadways, at intersections, and at transit stations. Help detect incidents quickly, help emergency response units arrive quickly and help travelers safely negotiate around incidents.
- *C.1.2 – Service Patrols*
  - Specially equipped motor vehicles and trained staff that help in clearing incidents off a roadway and navigating traffic safely around an incident.
- *C.1.3 – Emergency Management Systems (EMS)*
  - EMS notify, dispatch, and guide emergency responders to an incident. Aid in detecting, tracking, and clearing incidents.
- *C. 1.4 – Emergency Vehicle Preemption*
  - Signal preemption for emergency vehicles use sensors to detect and emergency vehicle and provide a green signal to the vehicle. This is important to incident management in that it allows for emergency vehicles to get to the scene of and incident and clear it so that traffic can resume its normal flow.
- *C.1.5 – Road Weather Management*
  - Can take the forms of information dissemination, response and treatment, surveillance monitoring, and prediction, and traffic control. Helps prevent incidents due to inclement weather (snow, ice).
- *C.1.6 – Traffic Management Centers (TMCs)*
  - Centers that collect and analyze traffic data and then disseminate data to the public. Data collection elements might include CCTVs, cameras, and loop detectors. M ight relay information to the public through radio, TV, or the Internet. This is important to the public, as it allows them to get information about existing traffic conditions and plan their route and timing accordingly.

- *C.1.7 – Curve Speed Warning System*
  - GPS and digital devices on a highway that assess and detect the threat of vehicles moving toward a curve too quickly. This is important in preventing incidents and thus preventing non-recurring congestion.
- *C.1.8 – Work Zone Management*
  - Can take the form of traffic workers, signs, and temporary road blockers used to direct traffic during an incident or construction. The temporary implementation of traffic management or incident management capabilities can help direct the flow of traffic, keep traffic moving, and prevent additional incidents.
- *C.1.9 – Automated truck rollover systems*
  - Detectors deployed on r amps to warn trucks if they are about to exceed their rollover threshold. If the data concludes a truck's maximum safe speed is to be exceeded around a turn, then a message sign would flash, "TRUCKS REDUCE SPEED." This is important in preventing incidents caused by large trucks, and thus preventing non-recurring congestion.

C.2.0 – ITS Technologies – This category of strategies can be defined as electronic technologies and communication devices aimed at monitoring traffic flow, detecting incidents, and providing information to the public and emergency systems on w hat is happening on our roadways and transit communities. Much of what is done with ITS helps in reducing non-recurring and incident-related congestion, and works hand-in-hand with those strategies listed in the above category (C.1.0).

C.2.1 – Advanced Traffic Signal Systems
  - The coordination of traffic signal operation in a jurisdiction, or between jurisdictions. T his is important to congestion, as it reduces delay and improves travel times.
- *C.2.2 – Electronic Payment Systems*
  - These systems can make transit use more convenient by allowing a user to pay for bus, rail, park-and-ride lots, and other transit services with one card. Convenience an appealing factor, and helps increase transit ridership and transfers among different transit modes.
- *C.2.3 – Freeway Ramp Metering*
  - Traffic signals on freeway ramps that alternate between red and green to control the flow of vehicles entering the freeway. This prevents incidents that may occur from vehicles entering the freeway too quickly, and also prevents a backup of traffic on the on-ramp.
- *C.2.4 – Bus Priority Systems*
  - Bus priority systems are sensors used to detect approaching transit vehicles an alter signal timings to improve transit performance. F or example, some systems extend the duration of green signals for public transportation vehicles when necessary. This is important because improved transit performance, including a more precisely predicted time for bus arrivals, makes public transit a more appealing option for travelers.
- *C.2.5 – Lane Management (e.g. Variable Speed Limits)*

- Variable Speed Limits are sensors used to monitor prevailing weather or traffic conditions, and message signs posting enforceable speed limits. These systems can promote the most effective use of available capacity during emergency evacuations, incidents, construction, and a variety of other traffic and/or weather conditions.

- *C.2.6 – Automated Enforcement (e.g. red light cameras)*
    - Still or video cameras that monitor things such as speed, ramp metering, and the running of red lights, to name a few. They are important to preventing non-recurring and incident related congestion.
- *C.2.7 – Traffic Signal Timing*
    - Traffic signal timing plans adjust traffic signals during an incident, during inclement weather, or to improve transit performance. The overall objective is to reduce backups at traffic signals and to increase the level of service.
- *C.2.8 – Reversible Lanes*
    - Traffic sensors and lane control signs reverse the flow of traffic and allow travel in the peak direction during rush hours. This is important to alleviating congestion that may occur in one direction during a peak hour.
- *C.2.9 – Dynamic Routing/Scheduling*
    - Public transportation routing and scheduling can automatically detect a vehicle's location, and dispatching and reservation technologies can facilitate the flexibility of routing/scheduling. This is can help increase the timeliness of public transportation, keep transit on schedule, which in turn increases ridership.
- *C.2.11 – Service Coordination and Fleet Management (e.g. buses and trains sharing real-time information*
    - Monitoring and communication technologies in a vehicle that facilitate the coordination of passenger transfers between vehicles or transit systems. This is important and appealing to passengers that use more than one type of transit.
- *C.2.12 – Probe Traffic Monitoring*
    - Using individual vehicles in the traffic stream to measure the time it takes them to travel between two points and also to report abnormal traffic flow caused by incidents. Tracking could be done with the use of cellular phones, and in the future with the installation of a system in the vehicle which would send information to transportation operators. This is important to monitoring recurring and non-recurring congested locations, and travel time.

C.3.0 – Advanced Traveler Information Systems – Provide information to travelers which allow them to adjust the timing of their travels or the route that they take to avoid any incidents, construction, or weather problems.

- *C.3.1 – 511*
    - A variety of applications for travelers to use either before their trip or en-route, such as 511 telephone systems, internet websites, pagers, cell phones, and radio, to obtain up-to-date traveler information. This helps travelers plan their timing and routes accordingly.
- *C.3.2 – Variable Message Signs (VMS)*
    - One way ITS operators can share traffic information with travelers is through a Variable Message Sign (VMS) along the roadway. Such signs could provide

information on road closures, emergency messages, weather message, and construction. This helps travelers plan their timing and routes accordingly. These signs can also prevent incidents from occurring as they provide warnings about speed, weather, construction, etc.

- *C.3.3 – Highway Advisory Radio (HAR)*
  - Another way ITS operators can share traffic information with travelers is through Highway Advisory Radio (HAR). The radio can provide information on road closures, emergency messages, weather, and construction (such as the Woodrow Wilson Bridge Project). Travelers can plan their timing and route accordingly.
- *C.3.4 – Transit Information Systems*
  - Can provide up-to-date transit information, such as arrival times for bus and rail. The WMATA Metrorail display signs depicting arrival times for trains are examples of this. Having this type of information available can increase transit ridership, and can also allow riders to make decisions on what type of transit to use based on up-to-date information.

C.4.0 – Traffic Engineering Improvements – Improvements implemented on roadways where congestion problems have occurred in the past or are anticipated to occur in the future. Some of these engineering improvements can be aimed at reducing incidents on a particularly dangerous section of roadway, while others may be attempting to relieve a choke-point or bottleneck.

- *C.4.1 – Safety Improvements*
  - Improvements done to increase safety and reduce incident-related congestion. Examples of some improvements include traffic calming devices, speed bumps, widening or narrowing a roadway, and textured pavement. These safety improvements can prevent incidents and non-recurring congestion resulting from incidents.
- *C.4.2 – Turn lanes*
  - Might be implemented to reduce the queuing of cars waiting to make a right or left turn at an intersection, thus reducing congestion.
- *C.4.3 – Roundabouts*
  - Barriers placed in the middle of an intersection, creating a circle, and thus directing vehicles in the same direction. This can help reduce congestion by slowing the speed of cars on a street and/or preventing thru traffic on a neighborhood street.

Demand Management Strategies:

C.5.0 – Alternative Commute Programs – Provides travelers with options other than the single-occupant vehicle. These programs are aimed in reducing the amount of single-occupant vehicles are on our roadways.

- *C.5.1 – Carpooling*
  - Two or more people traveling together in one vehicle. This reduces the amount of vehicles on the road.
- *C.5.2 – Ridematching Services*
  - Enables commuters to find other individuals that share the same commute route and can carpool/vanpool together. This provides carpooling options for people

who may not know of someone to carpool with, thus broadening the carpooling option.

- *C.5.3 – Vanpooling*
  - When a group of individuals (usually long-distance commuters) travel together by van, which is sometimes provided by employers. This reduces the amount of vehicles on t he road, which is especially important for long-distance transportation modes.
- *C.5.4 – Telecommuting*
  - Workers either work from home or from a regional telecommute center for one or more days of the week. This reduces the amount of vehicles on t he road, especially during rush hour when many commuters are going to work at once.
- *C.5.5 – Promote Alternate Modes*
  - Programs, such as Commuter Connections, or regional Transportation Management Areas (TMAs) provide information to the public on a lternative commute programs. This gets the word out about commute options in the region, many who may not have considered alternative commute programs as an option before.
- *C.5.6 – Compressed/flexible workweeks*
  - Employees compressing their work week into a shorter number of days, which allows them to avoid commuting one or more days a week. This reduces the amount of vehicles on the road.
- *C.5.7 – Employer outreach/mass marketing*
  - Organizations, such as Commuter Connections, providing information to employers on the benefits of alternative commute programs for their employees. This allows employers to see the benefits that alternative commute programs can have in their organization.
- *C.5.8 – Parking cash-out*
  - Employees essentially pay their employees not to park at work. The employees receive compensation for the parking space they would have otherwise used if they did not walk, bike, take transit, etc. This encourages more people to leave their car at home in favor of another mode of transportation.
- *C.5.9 – Alternative Commute Subsidy Program*
  - Employees provide a transit subsidy to their employees, which encourages them to use public transit instead of driving to work. This reduces the amount of vehicles on the road.

C.6.0 – Managed Facilities – These facilities have restrictions for use of the roadways. In some cases, only those other than single-occupant vehicles can use the lane or roadway. In other cases, a fee is implemented for single-occupant vehicles. Still, in other case, a f ee might be implemented for every car on the roadway entering a city. They all have a common goal of reducing the amount of single-occupant vehicles on the roadways and promoting other forms of transportation.

- *C.6.1 - HOV*

- High Occupancy Vehicle (HOV) are lanes reserved for vehicles with a driver and one or more passengers. This promotes the use of carpools, which can use a less-congested lane on the highway.

- *C.6.2- Variably Priced Lanes (VPL)*
  - Lanes which are typically used by carpoolers for free, while solo drivers pay tolls that change according to varying congestion levels. This encourages the use of carpooling, but also raises revenue for additional transportation projects that would reduce congestion.
- *C.6.3 – Cordon Pricing*
  - Cordon area congestion pricing is a fee paid by users to enter a restricted area in the city center. This is a way of promoting other alternative modes of transportation, while raising revenue for other transportation projects that would reduce congestion.
- *C.6.4 – Bridge Tolling*
  - Tolling over a bridge, in either one or both directions. This may decrease congestion on a bridge, as people may find an alternative route in lieu of paying the fee. Also, it raises revenue for transportation projects that would help in reducing congestion.

C.7.0 – Public Transportation Improvements – These improvements are done to the region's public transportation to ensure that it remains a safe and viable mode for travelers. Improvements can maintain the amount of users and attract new ones who never considered public transit as an option before.

- *C.7.1 – Electronic Payment Systems*
  - These systems can make transit use more convenient by allowing a user to pay for bus, rail, park-and-ride lots, and other transit services with one card. Convenience an appealing factor, and helps increase transit ridership and ridership between different transit modes.
- *C.7.2 – Improvements/added capacity to regional rail and bus transit*
  - Added capacity and improvements to rail and bus to help keep up with increasing demand on public transportation. This is important in keeping with the growing demand on public transportation as an alternative mode.
- *C.7.3 – Improving accessibility to multi-modal options*
  - Ensuring that connections are provided to multi-modal options, such as bus, rail, and pedestrian and bicycle facilities. More connections makes it easier for people to access multi-modal options, thus increasing use.
- *C.7.4 – Park-and-Ride Lot Improvements*
  - Improvements to park-and-ride lots to keep up with increasing demand and growth in the region. Park-and-Ride lots allow people to access public transportation, who may not be able to access it from their home. Improvements to these lots can ensure that this growing need is met and that people can continue to have transit access.
- *C.7.5 – Carsharing Programs*
  - A convenient and cost-effective mobility option for those that typically do not have a need to own a car. This reduces the amount of cars on the road because

generally the car is only used when needed, and public transportation or other modes are used most of the time.

C.8.0 – Pedestrian, Bicycle, and Multi-modal Improvements – Maintaining and creating new pedestrian, bicycle, and multi-modal facilities is improvement in that it improves accessibility. If something is accessible by a walk or bike path, people are more likely to leave their car at home.

- *C.8.1- Improve Pedestrian Facilities*
  - Improvement and addition of new pedestrian and bicycle facilities to keep up with a growing demand and ensure safety for users. This ensures that those using these facilities will continue to do so, and that potential users will find pedestrian facilities more appealing and accessible.
- *C.8.2 – Creation of new bicycle and pedestrian lanes and facilities*
  - Addition of new lanes to keep up w ith a growing demand and created new connections throughout the region. This will extend the option of bicycle and pedestrian lanes to those that may not already have access to it, as well as provide increased access to employment, recreation, retail, and housing in the region.
- *C.8.3 – Addition of bicycle racks at public transit stations/stops*
  - Allows people who bike to connect to other forms of transportation. This gives people another option for traveling other than a single-occupant vehicle.
- *C.8.4 – Bike sharing Programs*
  - A convenient and cost-effective mobility option for those that typically do not have a need to own a bicycle. This allows people to shift easily from other forms of transport to bicycle and back again.

C.9.0 – Growth Management – Growth Management is the term used in the Federal Rule, but really this term pertains to ensuring the coordination of transportation and land use. In terms of Growth Management we are talking about making sure that everyone has the option to public transportation and alternative modes no matter where they live or work in the region.

- *C.9.1 – Coordination of Regional Activity Centers*
  - Help coordinate transportation and land use planning in specific areas in the Washington region experiencing and anticipating growth. Focusing growth in Regional Activity Centers is important to congestion management, where transportation options for those who live and work there can be provided.
- *C.9.2 – Implementation of TLC program (i.e. coordination of transportation and land use with local governments).*
  - Provides support and assistance to local governments in the Washington region as they implement their own strategies to improve coordination between transportation and land use. The idea is to provide public transit options to everyone in the region.
- *C.9.3 – "Live Near Your Work" program*
  - Supporting the idea that locating jobs and housing closer together can provide alternative commuting options that may not have been options otherwise.