TRAFFIC QUALITY ON THE METROPOLITAN WASHINGTON AREA FREEWAY SYSTEM

SPRING 2005 REPORT

February 15, 2006

Prepared by
Skycomp, Inc., (Columbia, Maryland)

National Capital Region Transportation Planning Board

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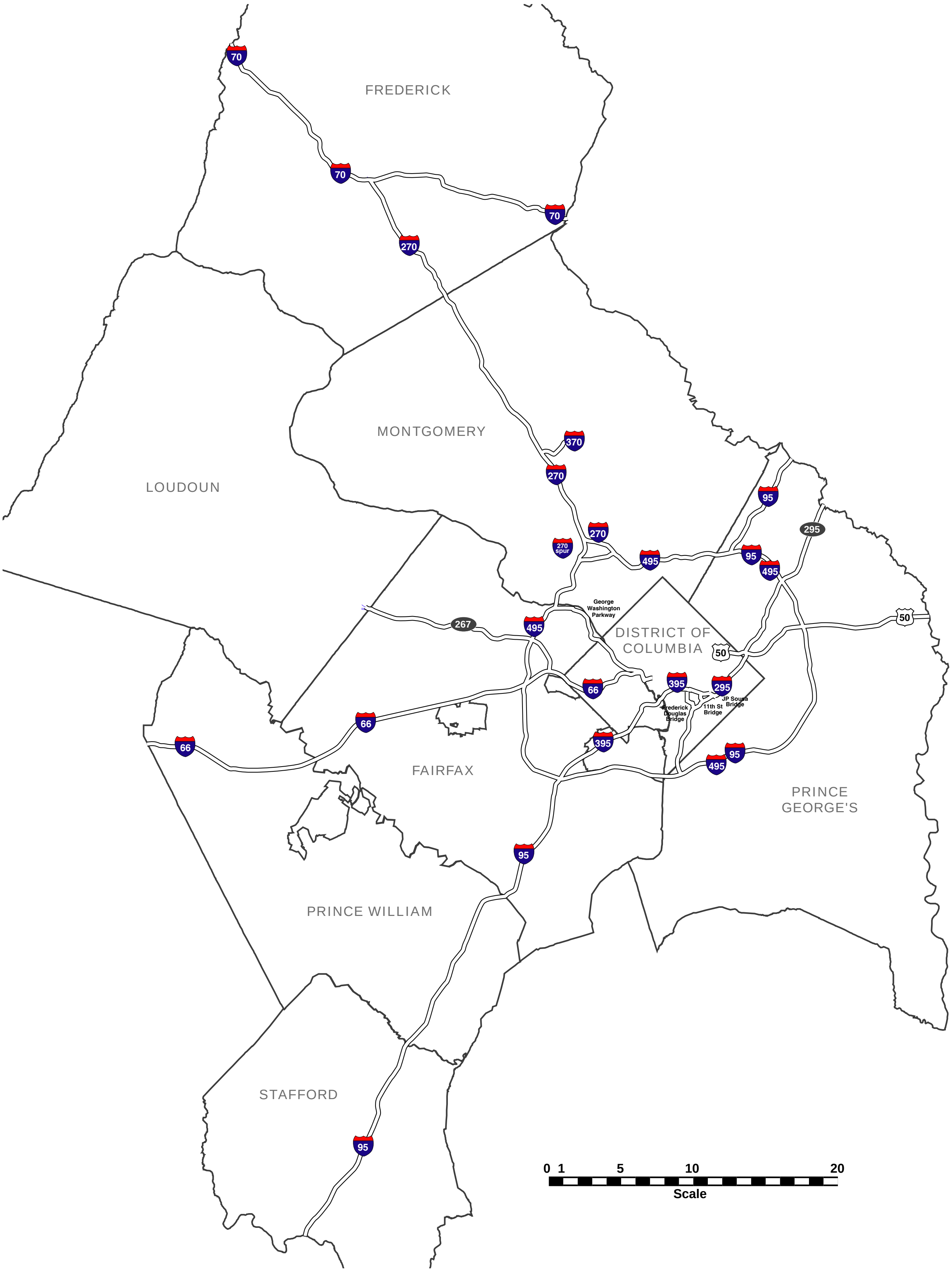
MAP OF SURVEYED HIGHWAYS, SPRING 2005



INTRODUCTION

This report details the continuation of a highway mobility-monitoring program that began in 1993. At that time, over 300 miles of limited-access facilities in the Washington, D.C. metropolitan area were surveyed, during both morning and evening peak traffic periods. An identical methodology was applied to the same highways in 1996, 1999, 2002 and again in the spring of 2005. The underlying purpose of this program is to acquire information about traffic flow conditions on a periodic basis, and to report that information to regional planners, stakeholders and decision-makers.

The survey methodology takes advantage of the mobility and vantage point of fixed-wing aircraft. During each survey period, multiple aircraft follow designated flight patterns along the primary highways; each highway segment is photographed a total of 24 times during peak commuter hours. A database of traffic flow conditions is generated from the photography; this database constitutes a direct measurement of the nature of traffic flow on a link-by-link basis.

FEATURES OF THE AERIAL SURVEY PROGRAM

During this aerial survey program, overlapping photographic coverage was obtained for each designated highway, repeated once an hour over four morning and four evening commute periods. The morning times of coverage were 6:00-9:00 a.m. outside the Capital Beltway and 6:30-9:30 a.m. inside the Capital Beltway. The evening times were 4:00-7:00 p.m. inside the Capital Beltway and 4:30-7:30 p.m. outside the Capital Beltway. Survey flights were conducted on weekdays, excluding Monday mornings, Friday evenings and mornings after holidays. Data were extracted from the aerial photographs to measure average recurring daily traffic conditions by link and by time period. Features of the aerial survey program include:

1) *Written Report*

In **Part One** of the report, a comparison of traffic conditions is provided for locations on the highway system where major trends and changes were found between the current and previous surveys. The nature of the changes and any apparent causes are discussed; level-of-service graphics from each year are also provided to illustrate the changes.

Part Two of the report presents performance-rating tables of 2005 traffic conditions on the 300+ miles of surveyed highways. The ratings are presented by highway, highway segment, direction, and time period. For uninterrupted-flow facilities, the ratings are density-based level-of-service (LOS) designations “A”, “B”, “C”, “D”, “E” and “F”, as defined in the *2000 Highway Capacity Manual*. Details on level-of-service ratings are provided in Appendix A.

The level-of-service graphics in Part Two also contain arrowheads that depict locations of recurring congestion; narratives that clarify the severity and frequency of the congestion accompany each arrowhead. Where evident, the apparent causes of the problems are also described.

2) *Speed/Density Relationship*

In order to allow the estimation of vehicle speeds from densities on the freeways, Skycomp has built a database of traffic observations collected in the Washington D.C. metropolitan area and other cities. This database demonstrates the relationship between traffic densities and speeds. From this database, a look-up table was developed relating the two variables. In order to predict average travel speeds from traffic densities, Metropolitan Washington, D.C. Council of Governments (staff) calibrated a single-regime model developed by Michael Van Aerde for use in the metropolitan Washington area. The model was submitted by Van Aerde to the Transportation Research Board in 1995 (TRB Paper No. 95082; see discussion in Appendix B). The result of Skycomp's work, the Van Aerde model, and Metropolitan Washington Council of Government's analysis is provided in Appendix B.

3) *Survey Database*

A primary deliverable for this project is the Survey Database (built in Microsoft Access). The database contains all of the collected data, from vehicle counts and road segmentation, to flight information, and the variables used to calculate densities. Using this database, a number of reports can be displayed or printed, including segment densities (averaged or by individual observation), vehicle classification, and incident information. Since all data is saved in a relational database, it is possible to customize an unlimited number of queries and reports.

4) *CD-ROM Products*

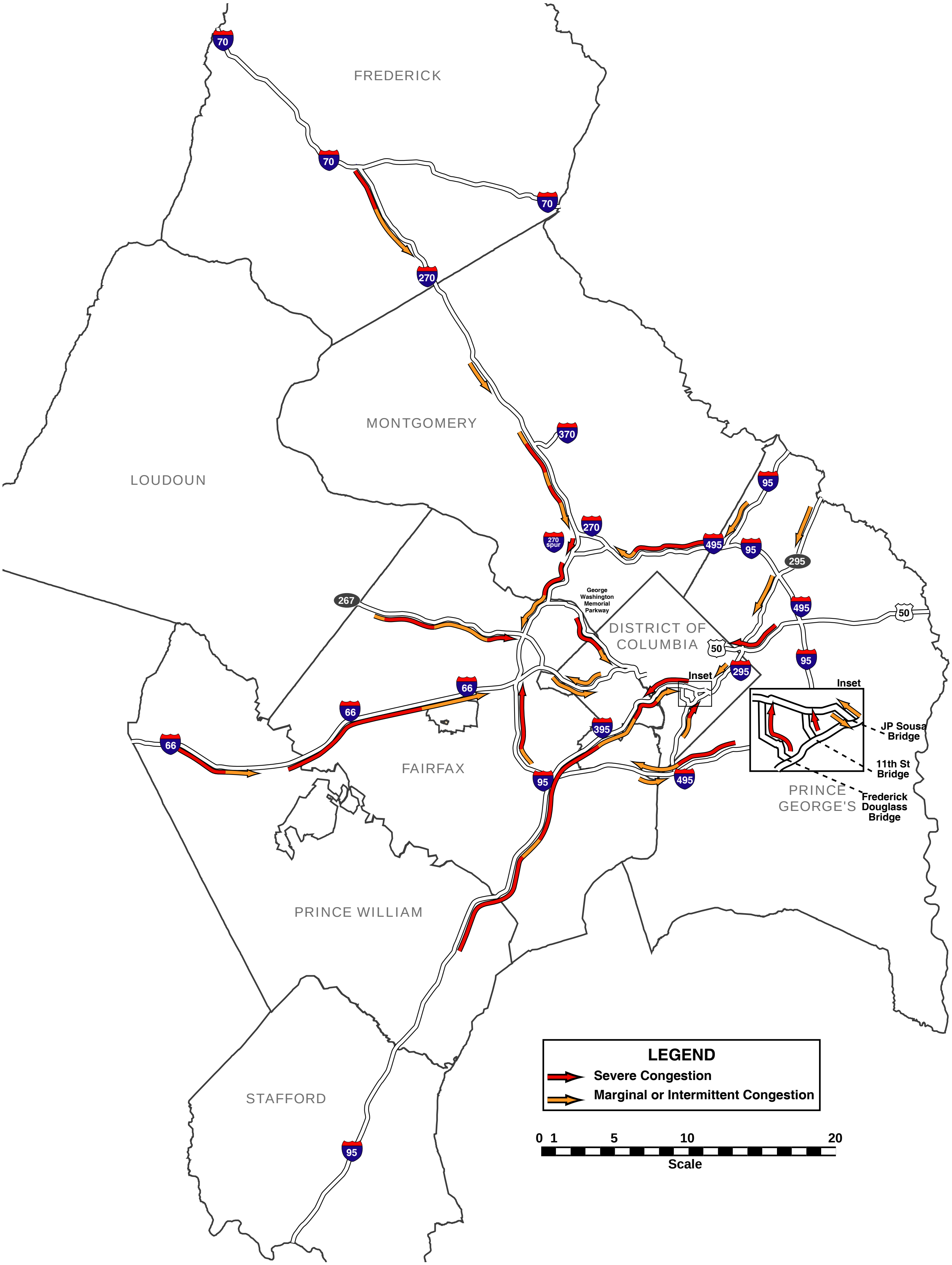
The *Congestion Highlights* interactive slide show presents the findings of this report, plus many highlight aerial photographs of congestion. This slide show can be projected to audiences "as is"; the interactive feature allows a presenter to respond to audience interests by going to specific locations as they come up in the discussion.

QUESTIONS

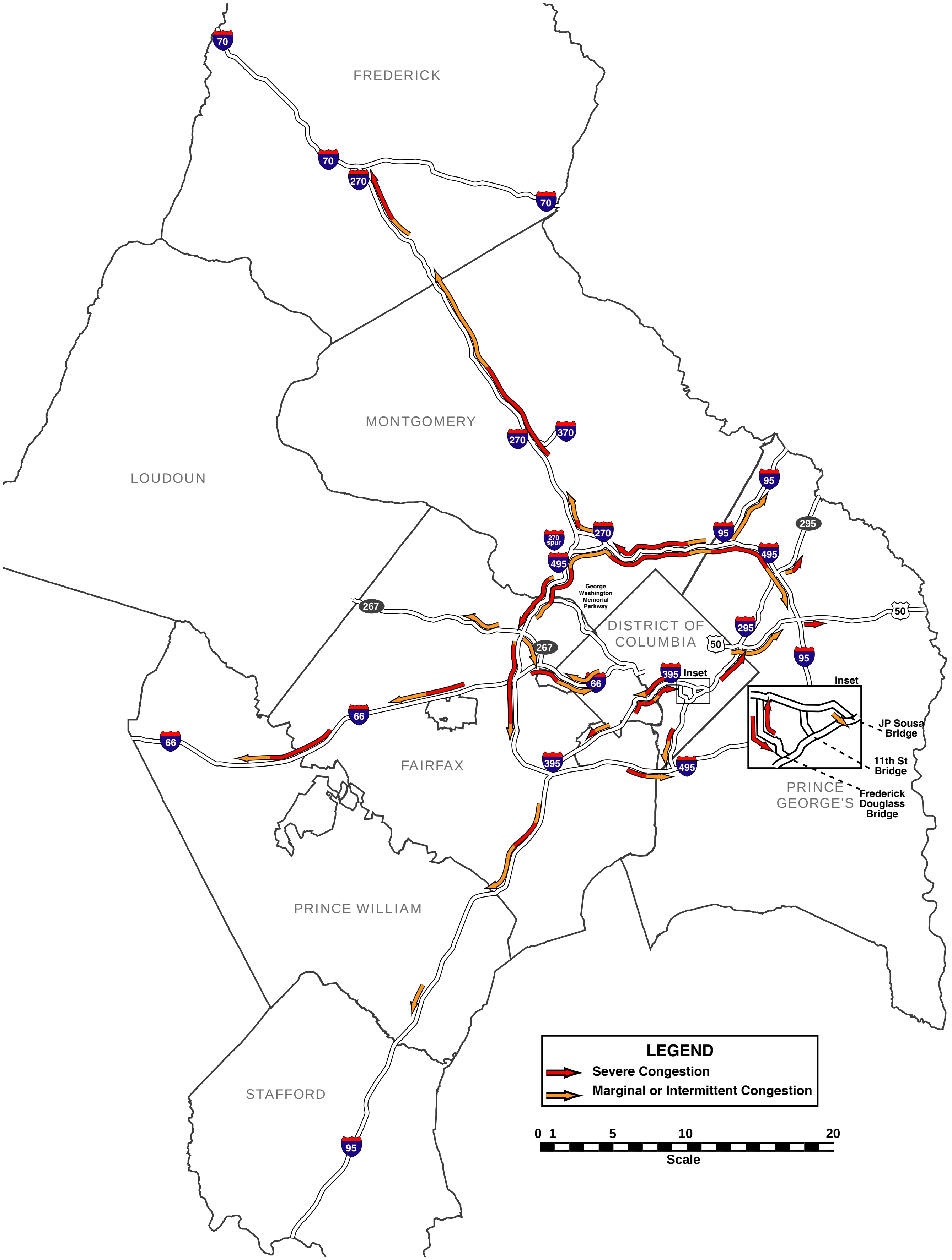
If there are any questions about this survey program or the underlying methodology, please direct them to Greg Jordan (Skycomp) at 410-884-6900 or Daivamani Sivasailam (TPB Staff) at 202-962-3226.

Morning and Evening Regional Congestion Maps

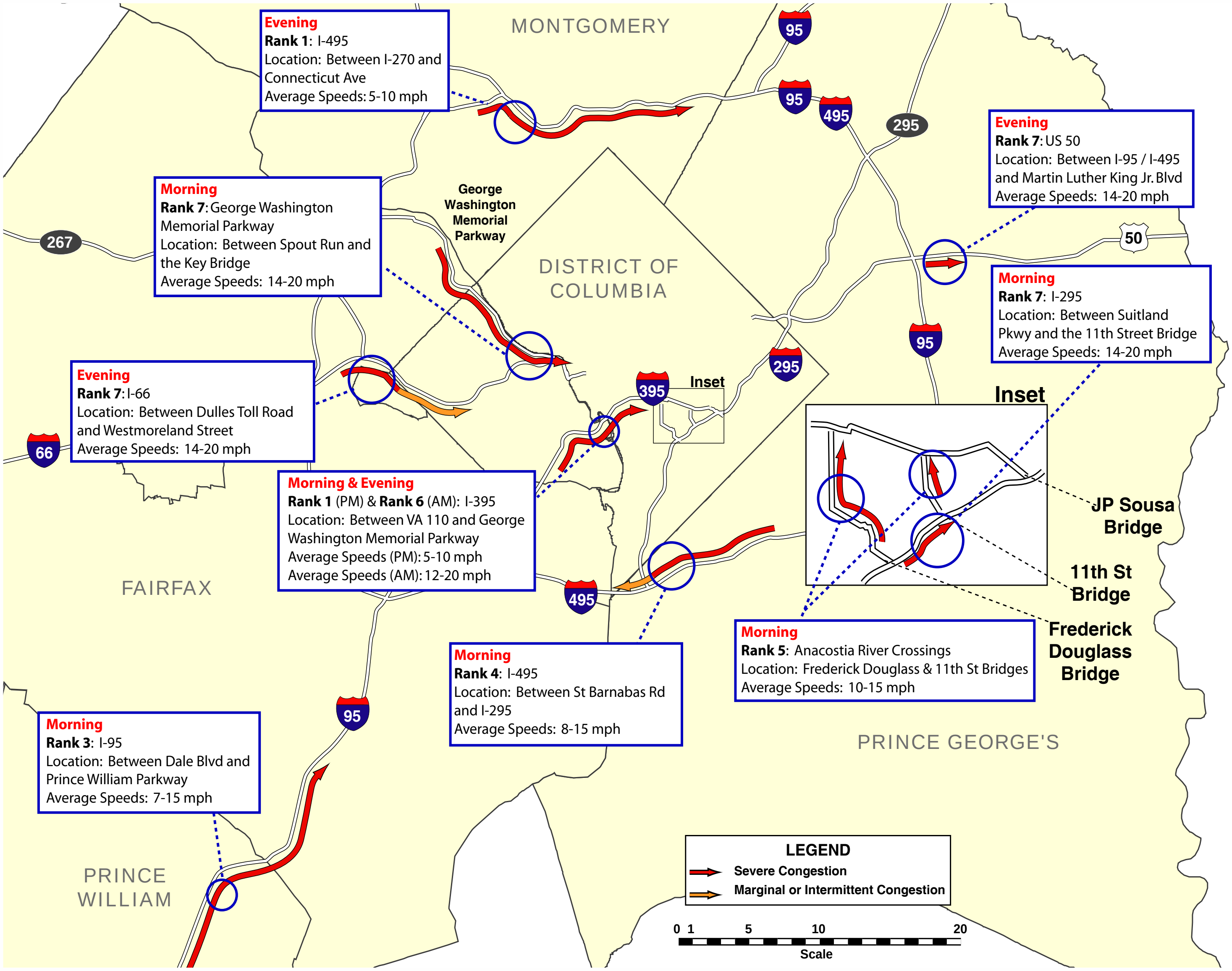
Morning Regional Congestion-Spring 2005



Evening Regional Congestion-Spring 2005



Top Ten Congested Locations



Evening
Rank 1: I-495
Location: Between I-270 and Connecticut Ave
Average Speeds: 5-10 mph

Evening
Rank 7: US 50
Location: Between I-95 / I-495 and Martin Luther King Jr. Blvd
Average Speeds: 14-20 mph

Morning
Rank 7: George Washington Memorial Parkway
Location: Between Spout Run and the Key Bridge
Average Speeds: 14-20 mph

Morning
Rank 7: I-295
Location: Between Suitland Pkwy and the 11th Street Bridge
Average Speeds: 14-20 mph

Evening
Rank 7: I-66
Location: Between Dulles Toll Road and Westmoreland Street
Average Speeds: 14-20 mph

Morning & Evening
Rank 1 (PM) & **Rank 6** (AM): I-395
Location: Between VA 110 and George Washington Memorial Parkway
Average Speeds (PM): 5-10 mph
Average Speeds (AM): 12-20 mph

Morning
Rank 5: Anacostia River Crossings
Location: Frederick Douglass & 11th St Bridges
Average Speeds: 10-15 mph

Morning
Rank 4: I-495
Location: Between St Barnabas Rd and I-295
Average Speeds: 8-15 mph

Morning
Rank 3: I-95
Location: Between Dale Blvd and Prince William Parkway
Average Speeds: 7-15 mph

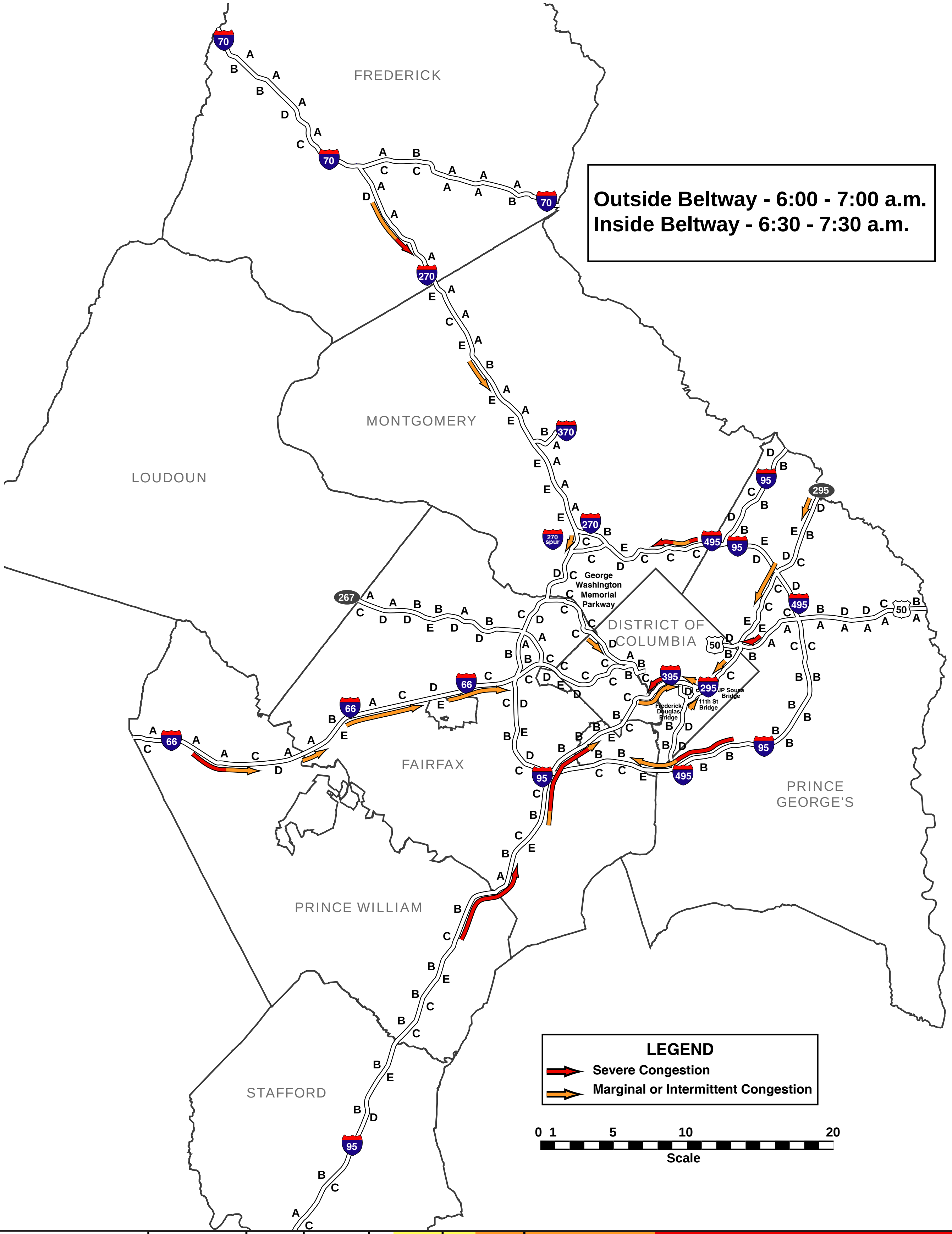
Top Ten Congested Segments on the Freeway System (2005)

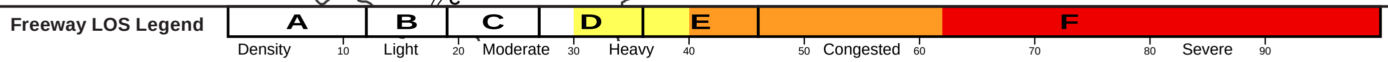
Rank	Route	From	To	Density *	Speed Range
1	IL I-495 (4 to 4:30 PM)	I-270	Connecticut Avenue	130	5 to 10 MPH
1	NB I-395 (5 to 6 PM)	VA 110	GW Pkwy	130	5 to 10 MPH
3	NB I-95 (6 to 8 AM)	Dale Blvd	Prince William Pkwy	125	7 to 15 MPH
4	IL I-495 – (6:30 to 7AM)	St Barnabas Rd	I-295	120	8 to 15 MPH
5	WB Frederick Douglass and 11th Street Bridges – (8:30 to 9:30 AM)	Anacostia Bridges		115	10 to 15 MPH
6	NB I-395 (7:30 to 8:30 AM)	VA 110	GW Pkwy	105	12 to 20 MPH
7	NB I-295 (7:30 to 8:30 AM)	Suitland Pkwy	11th Bridge	100	14 to 20 MPH
7	GW Pkwy (7:30 to 8:30 AM)	Spout Run	Key Bridge	100	14 to 20 MPH
7	EB I-66 – (6 to 7 PM)	Dulles Toll Rd	Westmoreland St	100	14 to 20 MPH
7	EB US 50 – (5 to 6 PM)	I-95/I-495	Martin Luther King Jr. Blvd.	100	14 to 20 MPH

*** Density measured in passenger cars per mile per lane**

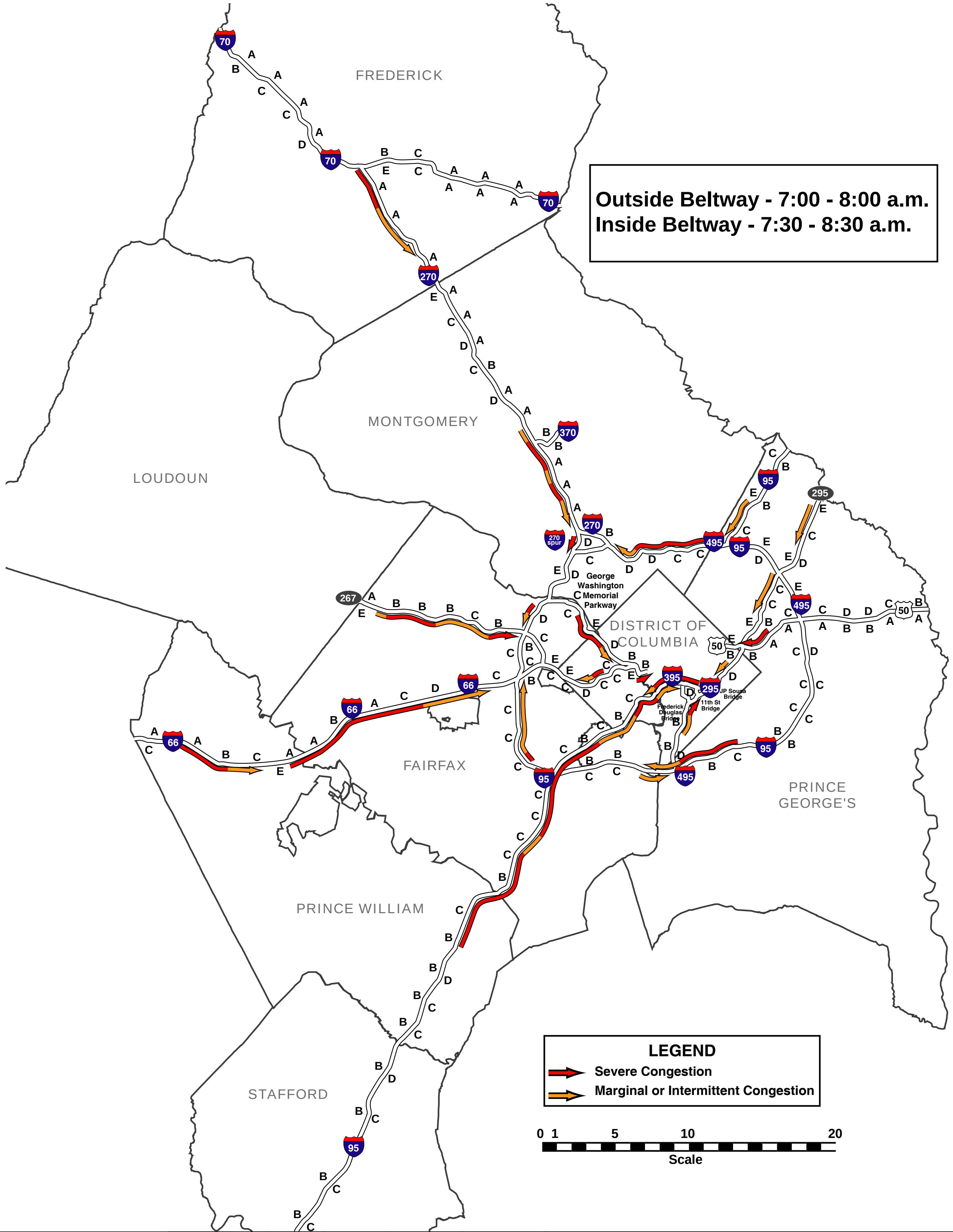
Hourly Morning and Evening Level-of-Service/ Congestion Maps

Morning - First Time Period





Morning - Second Time Period



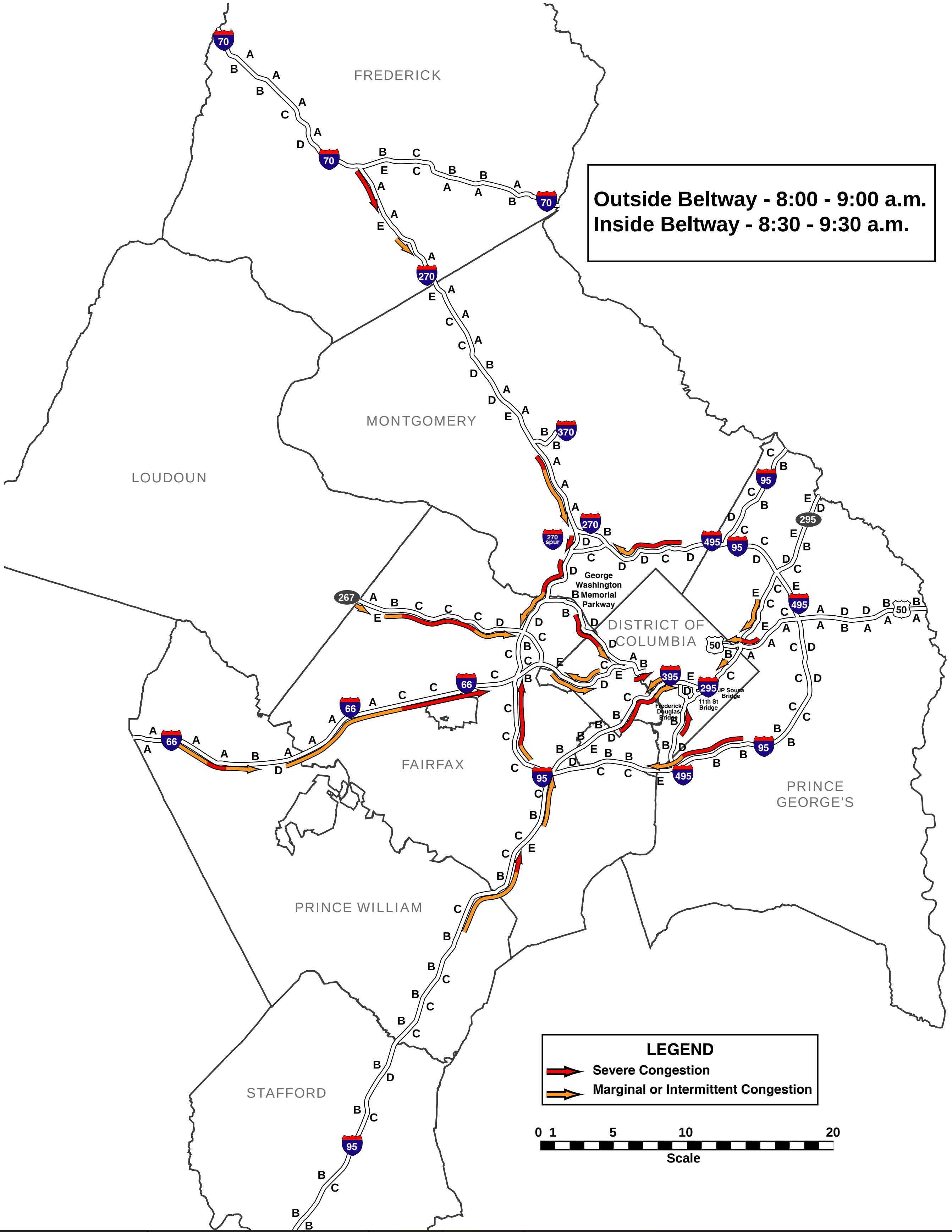
Outside Beltway - 7:00 - 8:00 a.m.
Inside Beltway - 7:30 - 8:30 a.m.

LEGEND
🟥 **Severe Congestion**
🟧 **Marginal or Intermittent Congestion**

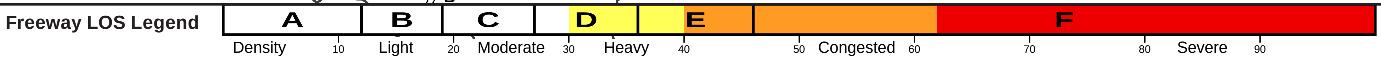
Freeway LOS Legend A B C D E F

Density 10 Light 20 Moderate 30 Heavy 40 50 Congested 60 70 80 Severe 90

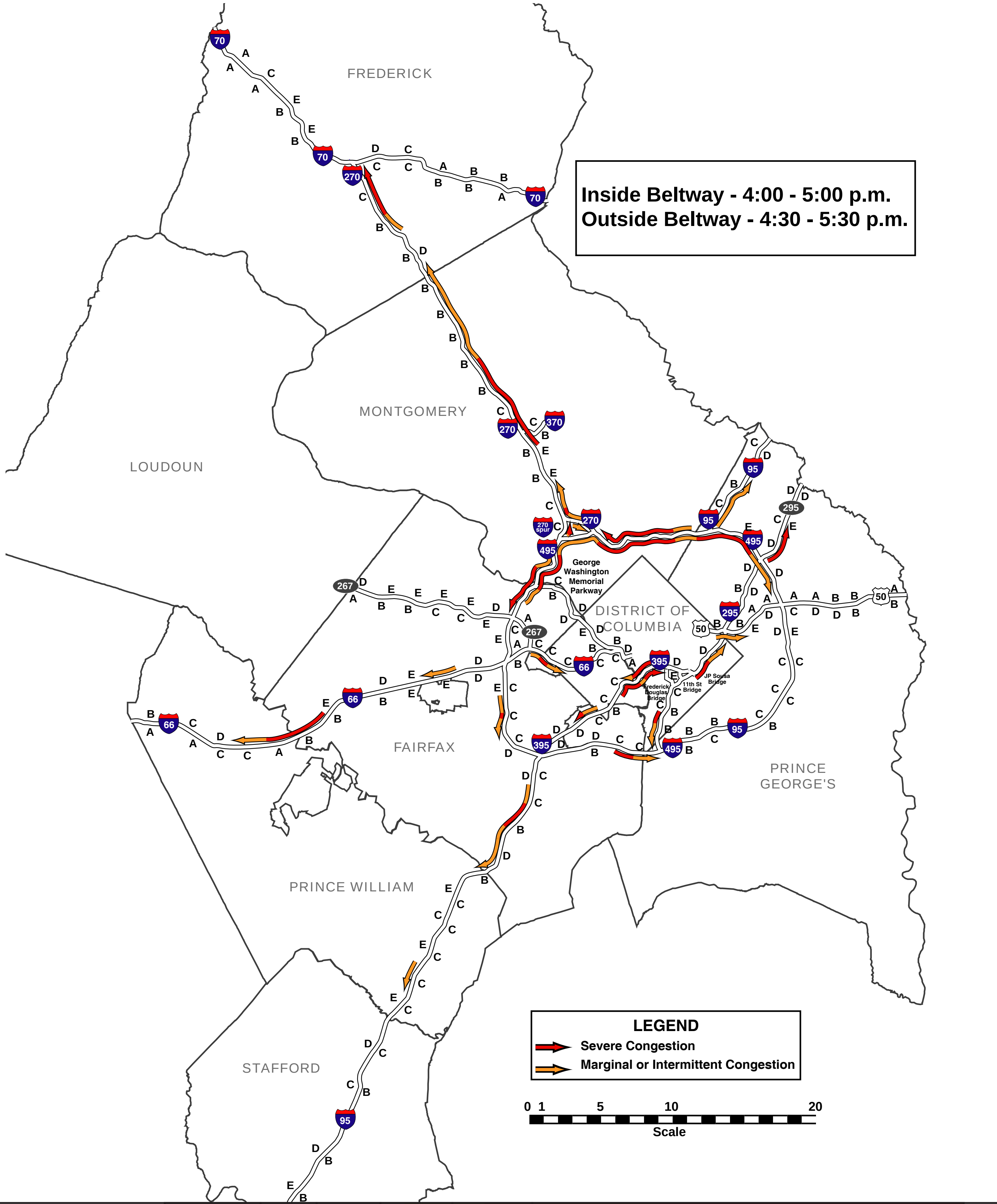
Morning - Third Time Period

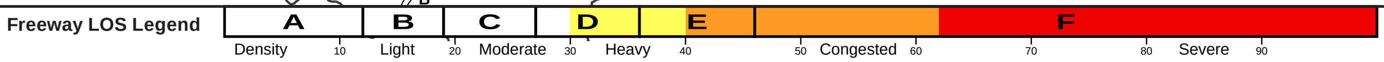


Outside Beltway - 8:00 - 9:00 a.m.
Inside Beltway - 8:30 - 9:30 a.m.

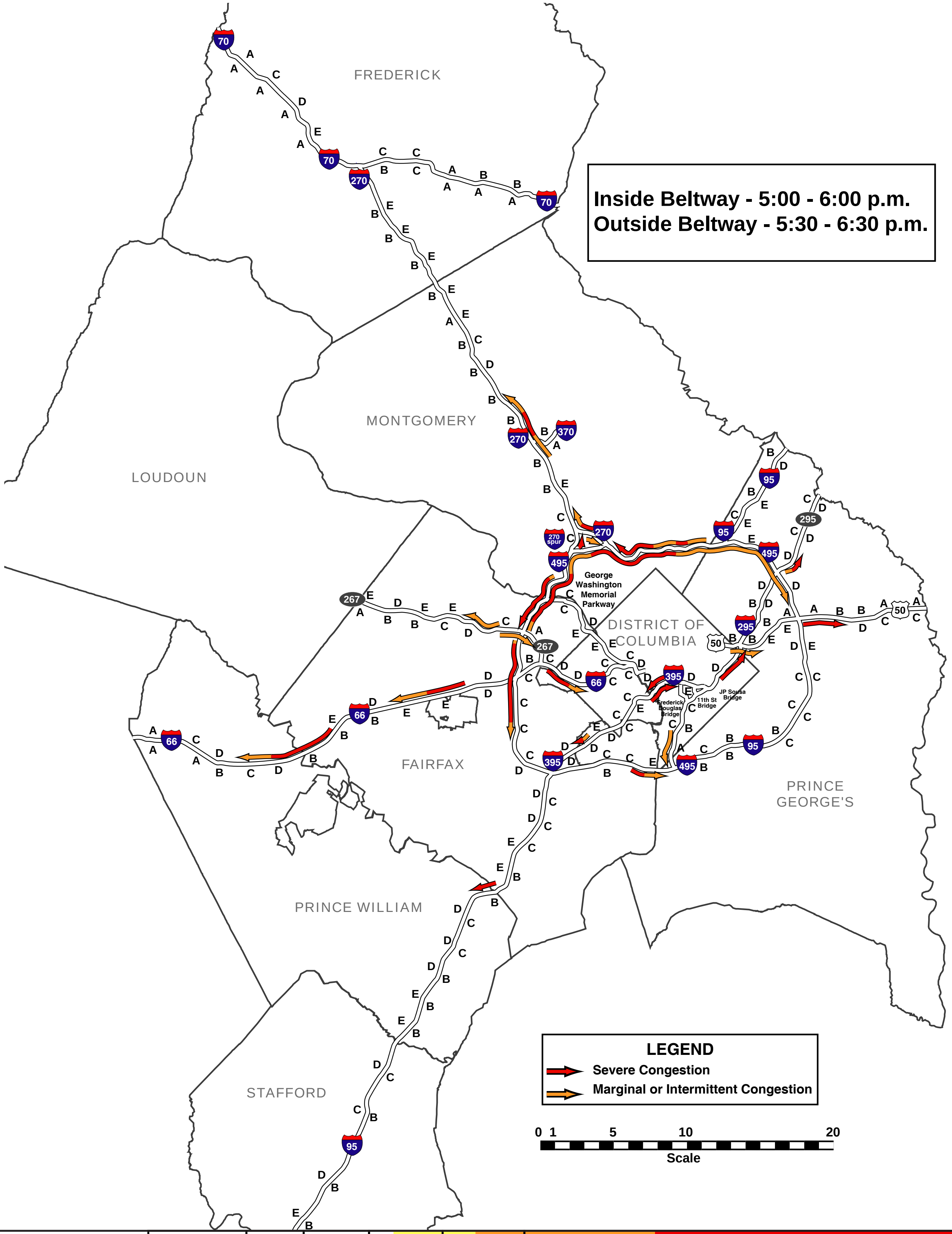


Evening - First Time Period





Evening - Second Time Period



Inside Beltway - 5:00 - 6:00 p.m.
Outside Beltway - 5:30 - 6:30 p.m.

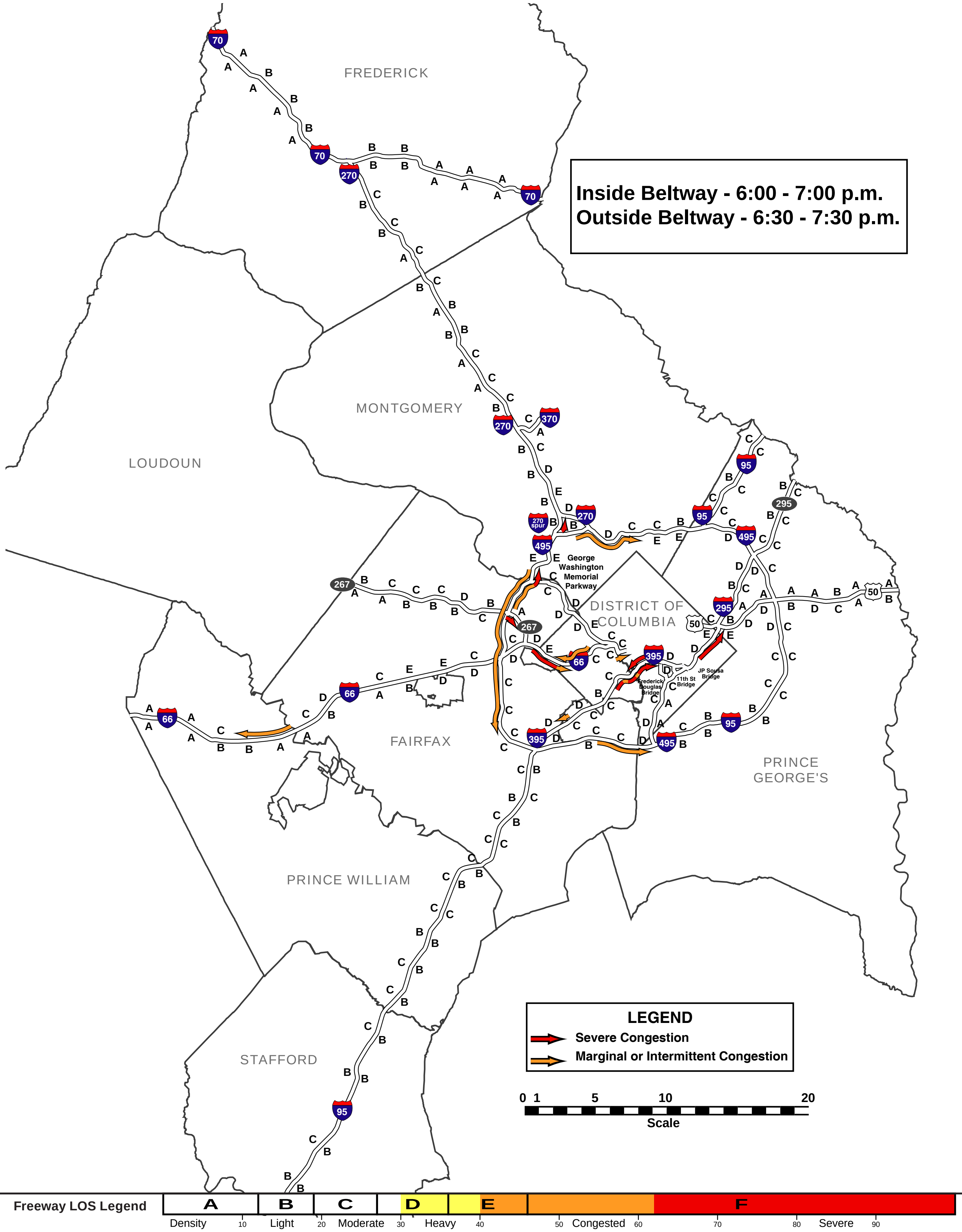
LEGEND
🟥 Severe Congestion
🟧 Marginal or Intermittent Congestion

Freeway LOS Legend

A	B	C	D	E	F

Density 10 Light 20 Moderate 30 Heavy 40 50 Congested 60 70 80 Severe 90

Evening - Third Time Period



Inside Beltway - 6:00 - 7:00 p.m.
Outside Beltway - 6:30 - 7:30 p.m.

Part One

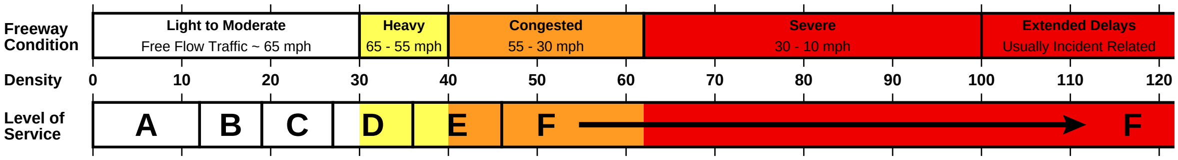
Major Trends and Changes in Traffic Conditions Between 1993 and 2005

This section of the report identifies locations on the highway system where major trends or changes in traffic conditions were found since the first aerial survey in 1993. On some highways, the absence or presence of construction contributed to the changed conditions. On other highways, added capacity contributed to improved flow; in some cases, no apparent cause could be attributed to the improvement or degradation of traffic flow.

Excerpts from the level-of-service (LOS) tables contained in Part Two have been used in this section of the report to depict the changes in traffic conditions. For the purpose of comparing conditions from year to year, density data from the 1993, 1996, and 1999 surveys have been converted to levels-of-service using the boundaries outlined in the 2000 Highway Capacity Manual.

A summary of traffic conditions for each level-of-service is provided below.

TRAFFIC QUALITY RATINGS:



US 50 MARYLAND (PRINCE GEORGE'S COUNTY)

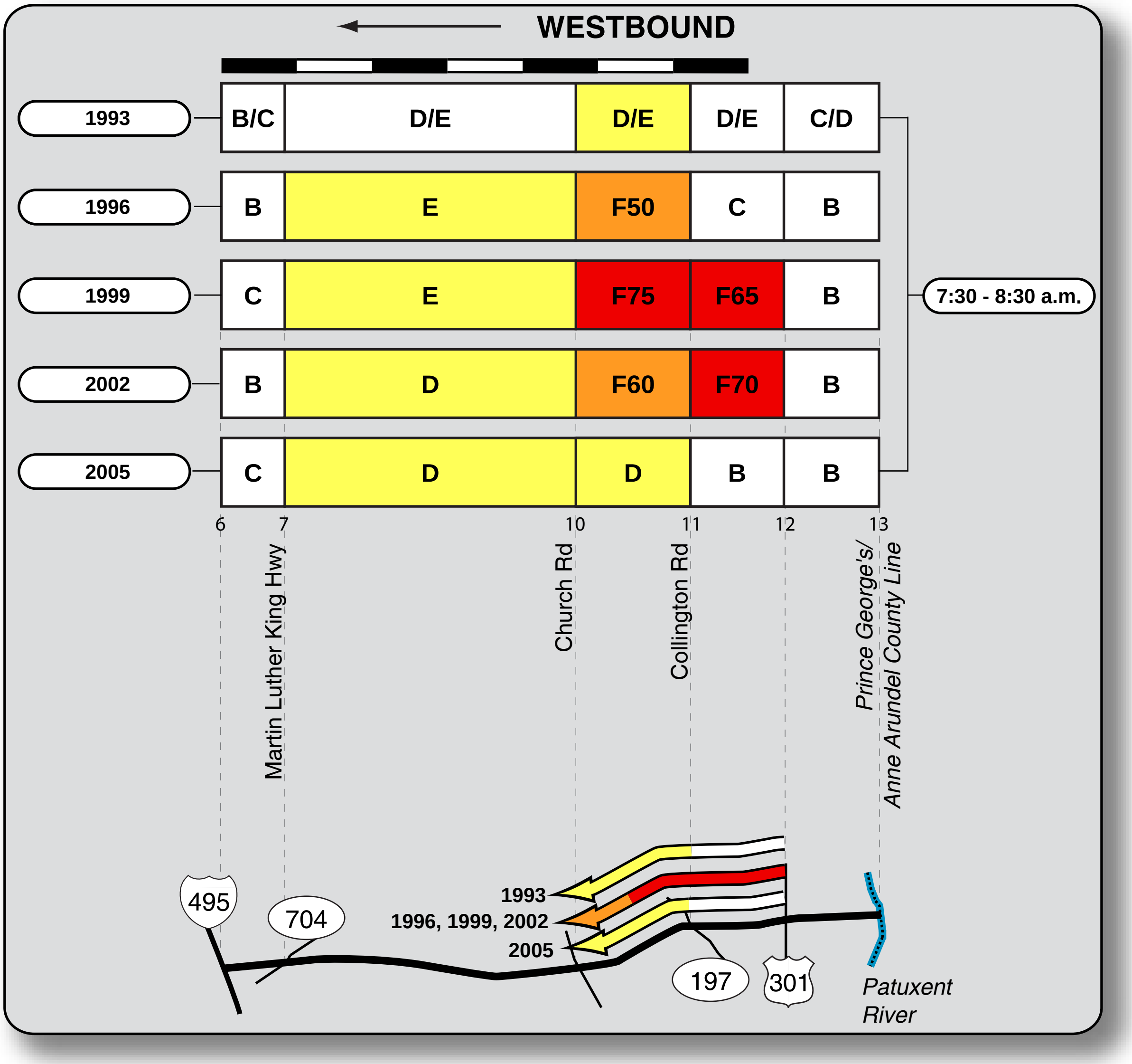
Location: Westbound between the Anne Arundel/Prince George's County Line and the Church Rd overpass

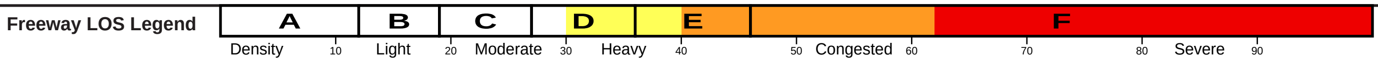
Time Period: Morning (7:30-8:30 a.m.)

Type of Change: **Improved**

Cause of Change: Addition of an HOV lane (new capacity)

The graphic below shows level-of-service (LOS) along US 50 between the Anne Arundel/Prince George's County line and the Capital Beltway; the 1993 LOS data correspond to mostly free-flow conditions, while 1996 to 2002 data correspond to congested conditions (particularly in the vicinity of the interchanges at US 301 and MD 197). Prior to the survey in 2005, an HOV lane was added to US 50 in each direction (24-hour enforcement. The additional capacity of the highway has clearly improved traffic flow on US 50 (see 2005 level-of-service data).





I-95 VIRGINIA (PRINCE WILLIAM & STAFFORD COUNTIES)

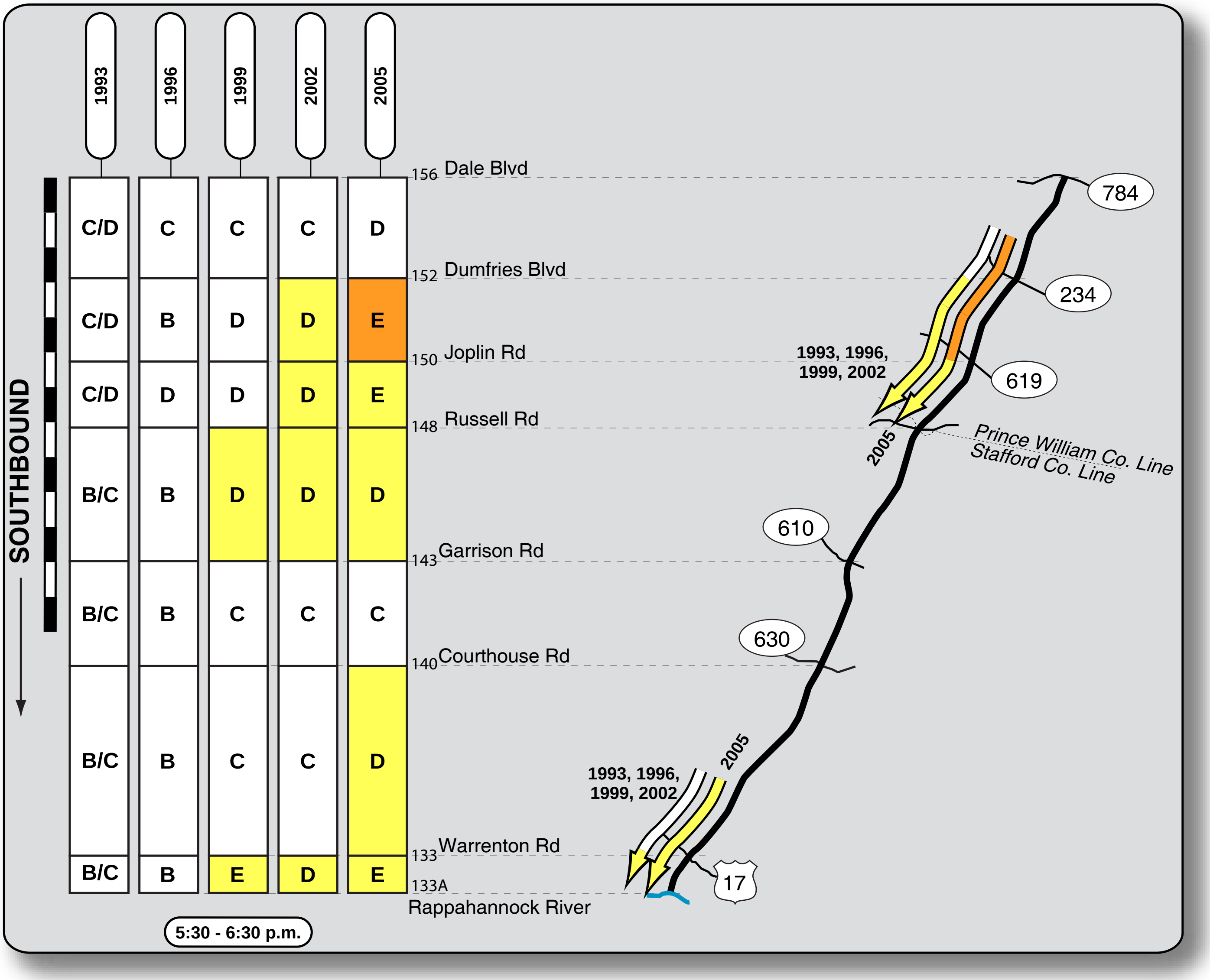
Location: Southbound between Dale Blvd and the Rappahannock River

Time Period: Evening

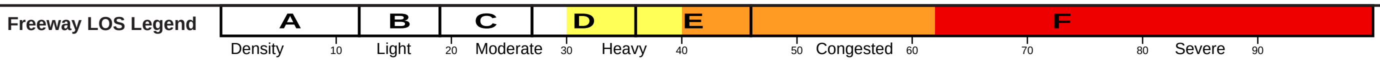
Type of Change: **Degraded**

Potential Cause of Trend: Increased Demand

The graphic below clearly shows a degradation of level-of-service on I-95 between the first aerial survey conducted in 1993 and the spring survey in 2005. The level-of-service "E" in the 2005 table reflects congestion found on some days and not others; when congested, average estimated speeds ranged from 20 to 50 mph.



	1993	1996	1999	2002	2005
156 Dale Blvd – 152 Dumfries Blvd	C/D	C	C	C	D
152 Dumfries Blvd – 150 Joplin Rd	C/D	B	D	D	E
150 Joplin Rd – 148 Russell Rd	C/D	D	D	D	E
148 Russell Rd – 143 Garrison Rd	B/C	B	D	D	D
143 Garrison Rd – 140 Courthouse Rd	B/C	B	C	C	C
140 Courthouse Rd – 133 Warrenton Rd	B/C	B	C	C	D
133 Warrenton Rd – 133A Rappahannock River	B/C	B	E	D	E



VA 267 - Dulles Toll Road (Fairfax County)

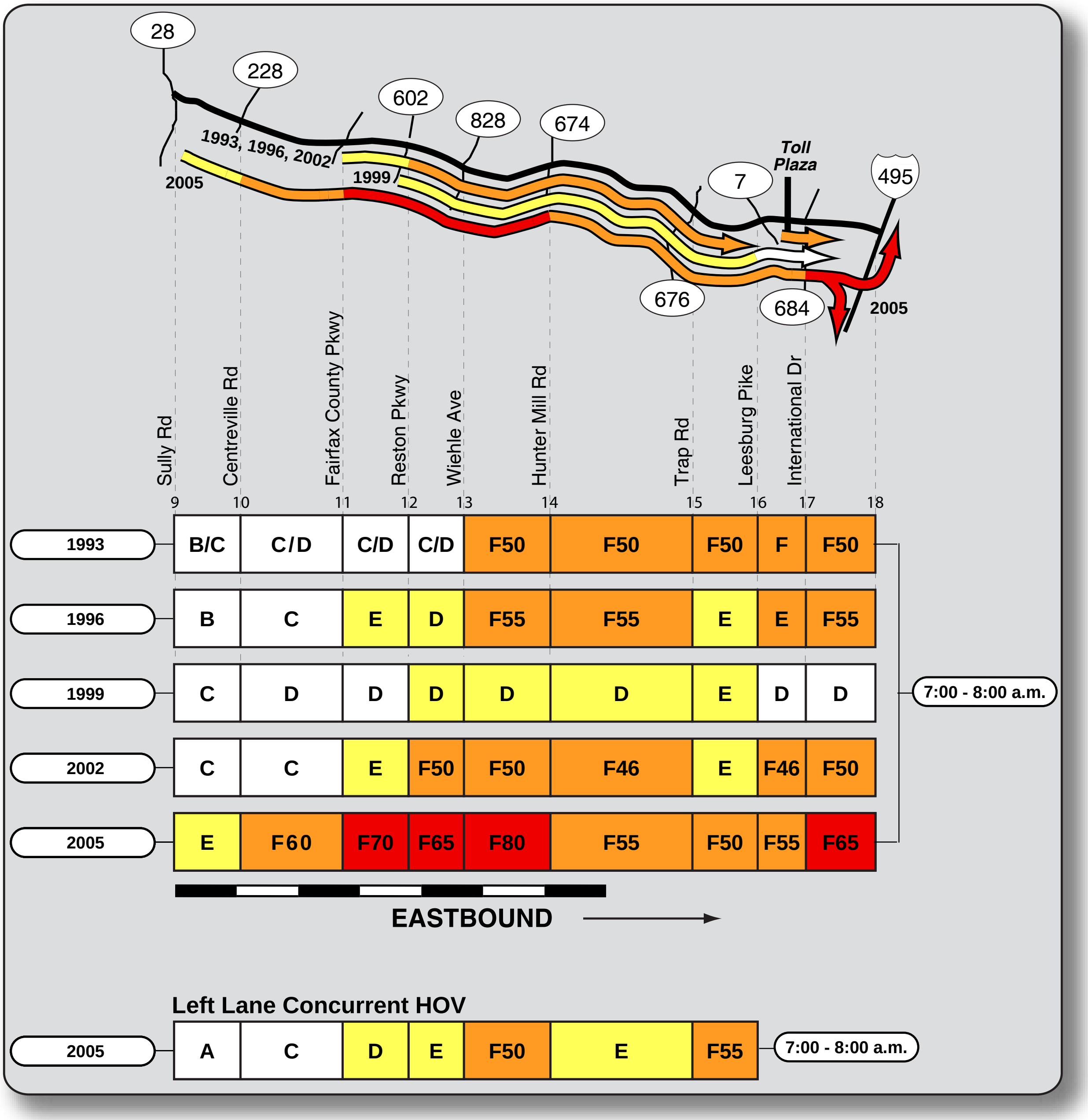
Location: Eastbound between VA 28 and the Capital Beltway

Time Period: Morning (7:00-8:00 a.m.)

Type of Change: **Degraded**

Potential Cause of Trend: Increased Demand

The graphic below depicts level-of-service on the Dulles Toll Road during the 1993 and 1996 aerial surveys; during the peak hour, eastbound travelers typically encountered congestion between Wiehle Ave and the Capital Beltway. Prior to the survey conducted in 1999, the toll road was widened from three to four lanes in each direction, with the left lane restricted to HOV vehicles in the peak direction (morning/eastbound; evening/westbound). The 1999 data show improvement in level-of-service after the HOV facility opened; 2002 and 2005 data show degraded conditions.



1993	B/C	C/D	C/D	C/D	F50	F50	F50	F	F50
1996	B	C	E	D	F55	F55	E	E	F55
1999	C	D	D	D	D	D	E	D	D
2002	C	C	E	F50	F50	F46	E	F46	F50
2005	E	F60	F70	F65	F80	F55	F50	F55	F65

Left Lane Concurrent HOV

2005	A	C	D	E	F50	E	F55

7:00 - 8:00 a.m.

Freeway LOS Legend

A	B	C	D	E	F

Density 10 Light 20 Moderate 30 Heavy 40 50 Congested 60 70 80 Severe 90

D.C. 295/MD 295 (Washington D.C. / P.G. County)

Location: Southbound MD 295 between MD 450 and Pennsylvania Ave

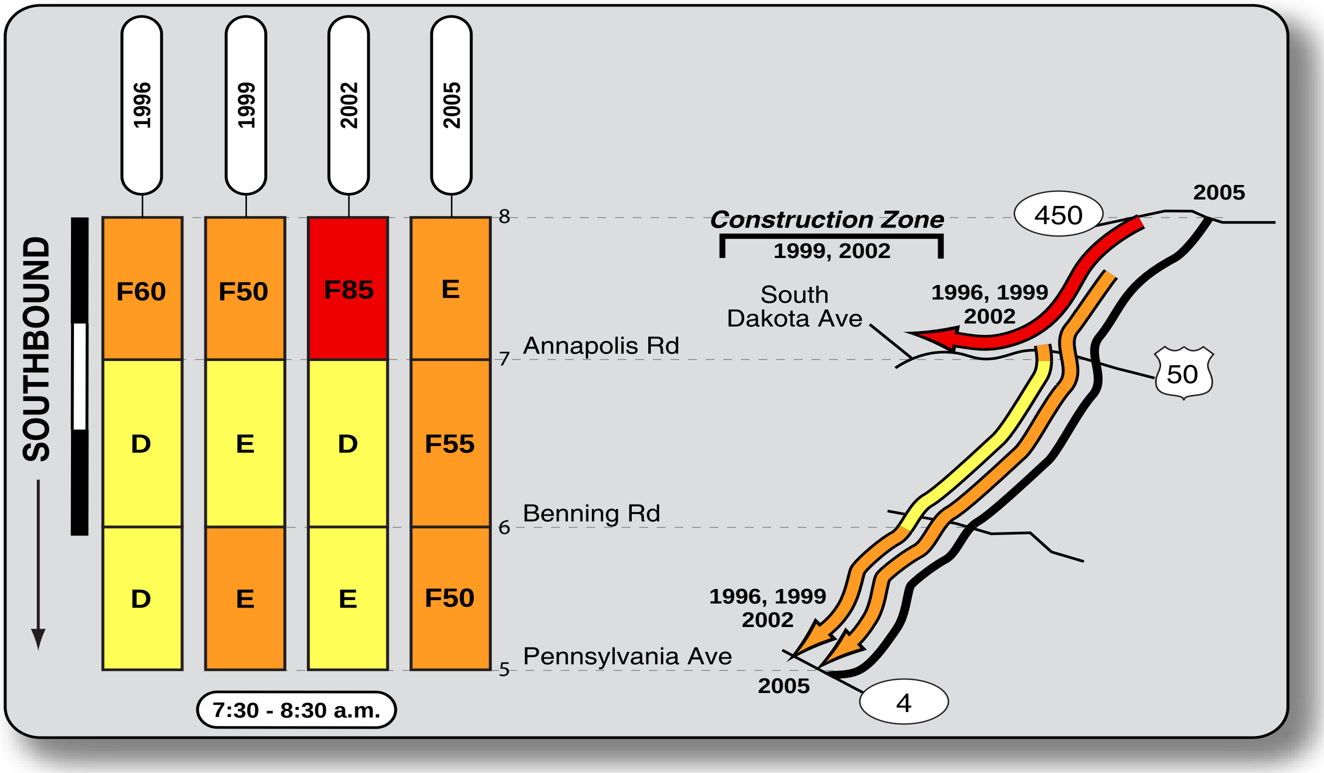
Time Period: Morning

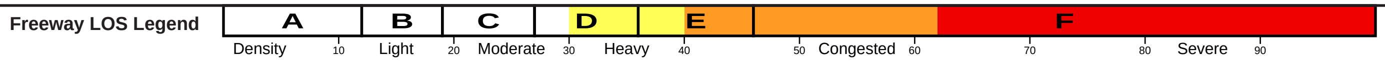
Type of Change: **Improved / Degraded**

Potential Cause of Change: Completion of construction on US 50

During the aerial surveys conducted between 1996 and 2002, construction projects contributed to congestion on the ramp from southbound MD 295 to westbound US 50; during the peak period congestion on the ramp typically extended back into the mainline of MD 295. The level-of-service (LOS) depicted in the graphic below shows congestion between MD 450 and US 50, while south of US 50 LOS data correspond to mostly free-flow conditions.

The level-of-service depicted in 2005 (construction completed) reflects the changes in southbound traffic flow without ramp congestion (to US 50) affecting thru-traffic on MD 295.





D.C. 295 (WASHINGTON D.C. / P.G. COUNTY)

Location: Northbound between Pennsylvania Ave and US 50

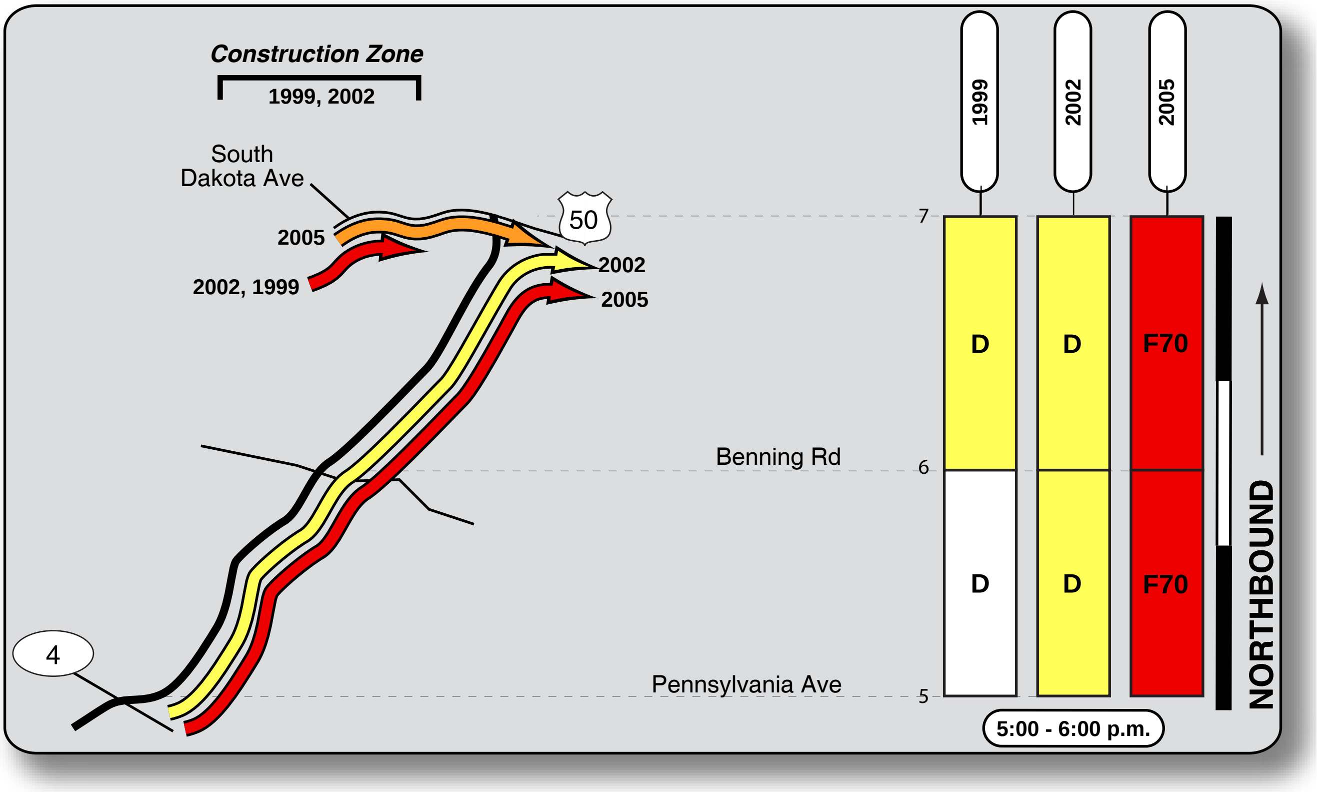
Time Period: Evening

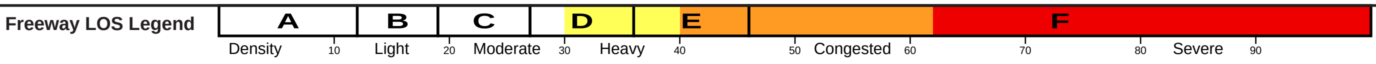
Type of Change: **Degraded**

Potential Cause of Change: Completion of construction on US 50

The graphic below shows level-of-service (LOS) on D.C. 295 between Pennsylvania Ave and US 50; congestion depicted in the 2005 table (LOS F) appeared to be caused by vehicles exiting to eastbound US 50 (vehicles on the ramp backed into the mainline of D.C. 295).

The absence of congestion in 1999 and 2002 may have been related to the construction zone on US 50 at South Dakota Ave; the construction may have metered eastbound traffic such that vehicles exiting D.C. 295 were able to merge onto US 50 without causing congestion on the ramp.





CAPITAL BELTWAY - INNER LOOP (PRINCE GEORGE'S COUNTY)

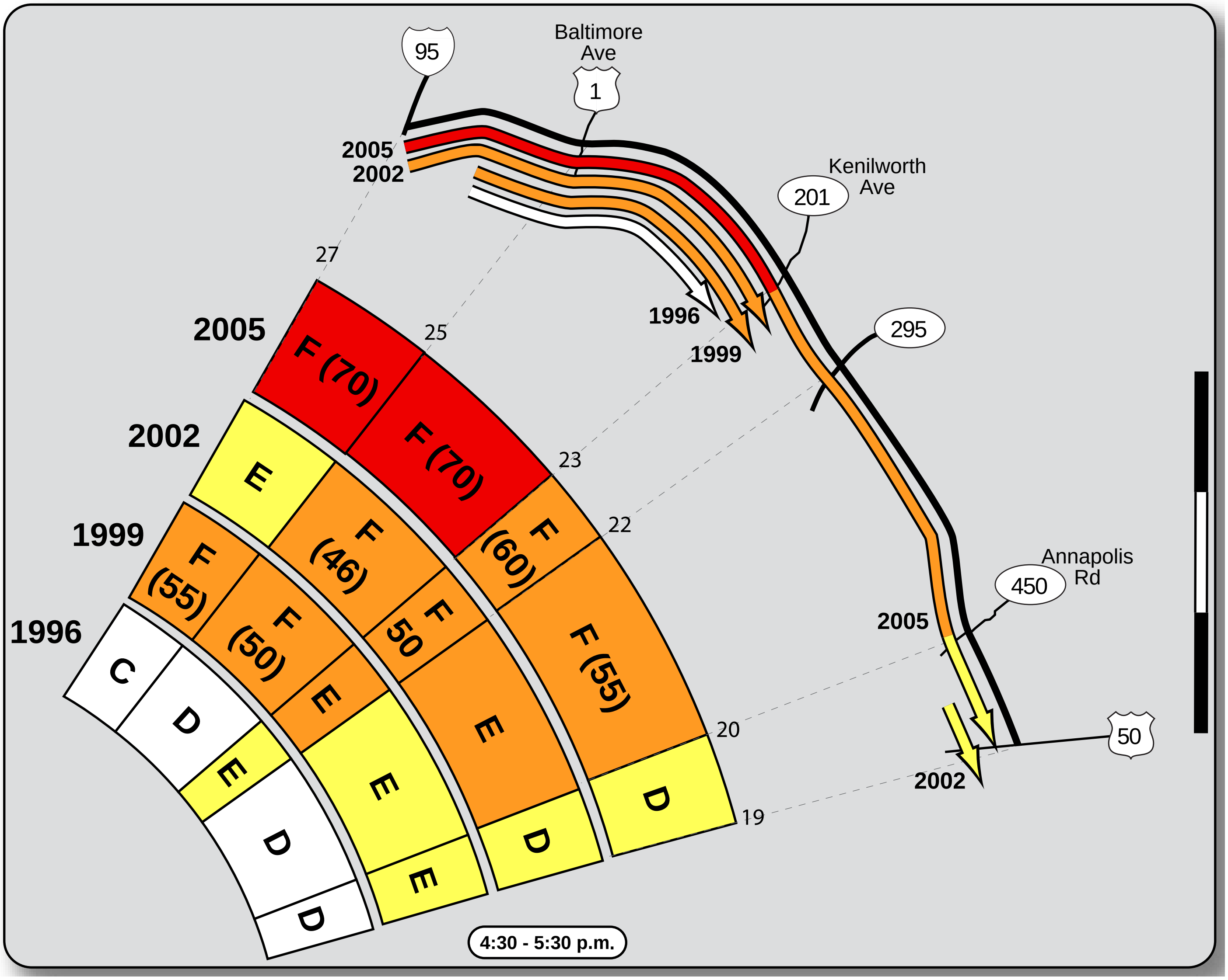
Location: Inner Loop between I-95 and US 50

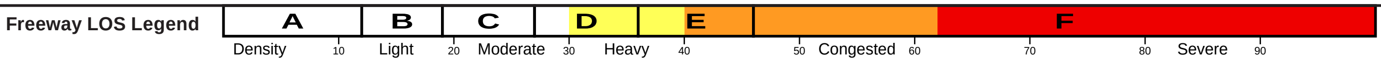
Time Period: Evening (4:30-5:30 p.m.)

Type of Change: **Degraded**

Potential Cause of Trend: Increased Demand

This graphic shows the levels-of-service on the inner loop of the Beltway between I-95 and US 50 in Prince George's County, Maryland. The head of the queue was found at the MD 450 interchange; traffic entering at Kenilworth Ave and MD 295 appeared to exacerbate the congestion. The 1996 LOS data correspond to mostly free-flow conditions. Data from subsequent surveys shows the gradual degradation of traffic flow such that by the spring of 2005, congestion was consistently found along this eight-mile corridor.





CAPITAL BELTWAY - OUTER LOOP (FAIRFAX COUNTY)

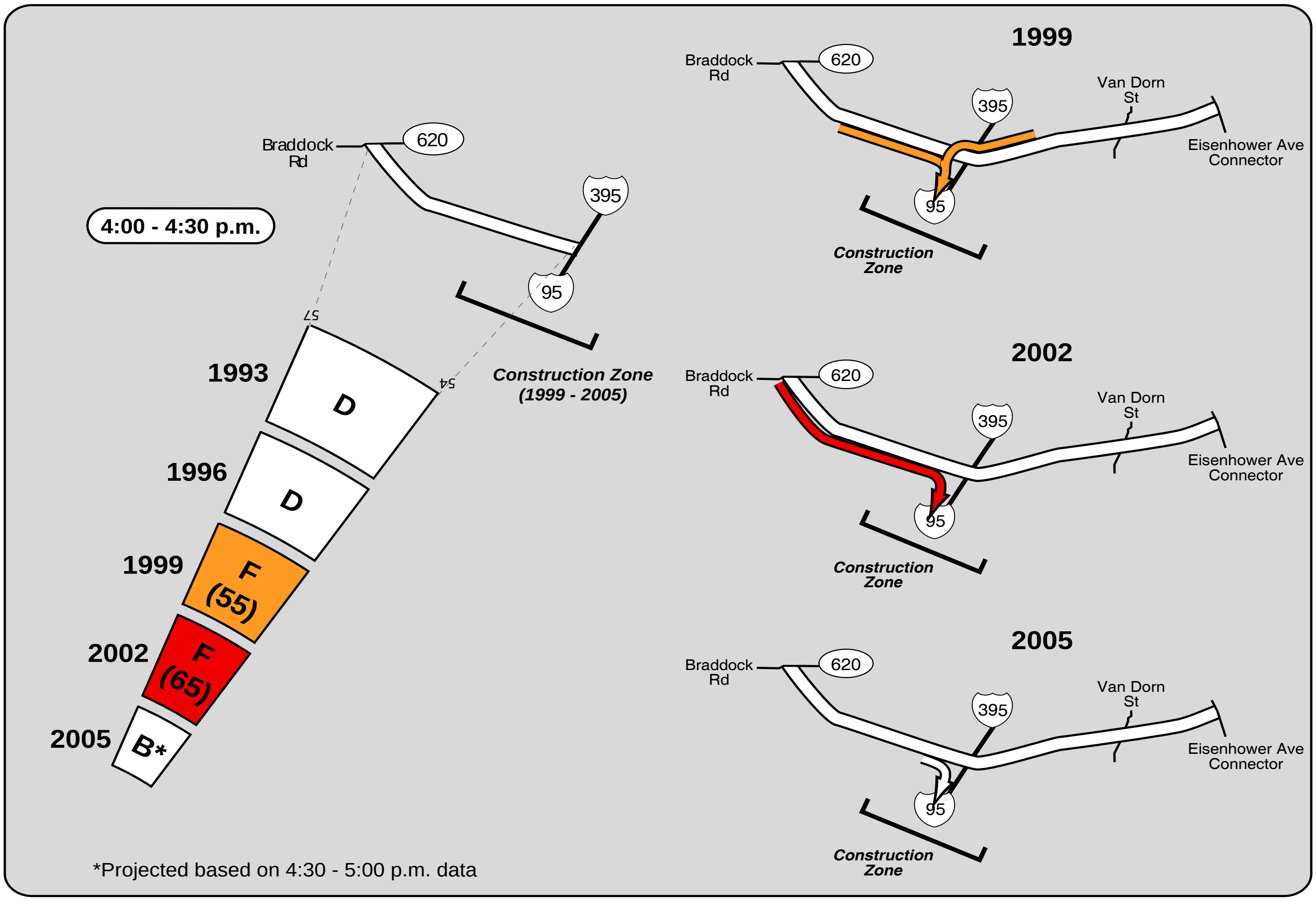
Location: Eastbound and westbound approaches to I-95

Time Period: Evening

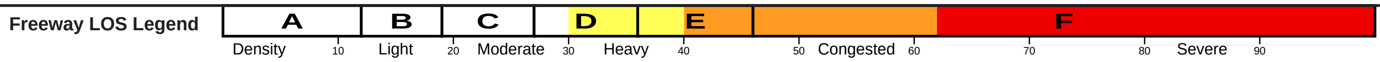
Type of Change: **Improved**

Potential Cause of Change: Construction of new ramps at the Springfield Interchange

During the aerial surveys in 1999 and 2002, congestion was typically found on the Beltway approaching I-95. The primary bottleneck was found where vehicles on the ramps from the inner and outer loops merged prior to entering the mainline of I-95. During some observations in 2002, congestion on the outer loop extended back to the vicinity of Braddock Rd (a distance of approximately 2.5 miles). Between 1999 and 2005, the Springfield Interchange had undergone major reconstruction (ongoing); construction of new ramps appears to have eliminated congestion on the Beltway approaches.



*Projected based on 4:30 - 5:00 p.m. data



I-495/95 CAPITAL BELTWAY (OUTER LOOP) - MORNING

Location: Between I-270 Spur and I-66

Time Period: Morning (8:00 - 9:00 a.m.)

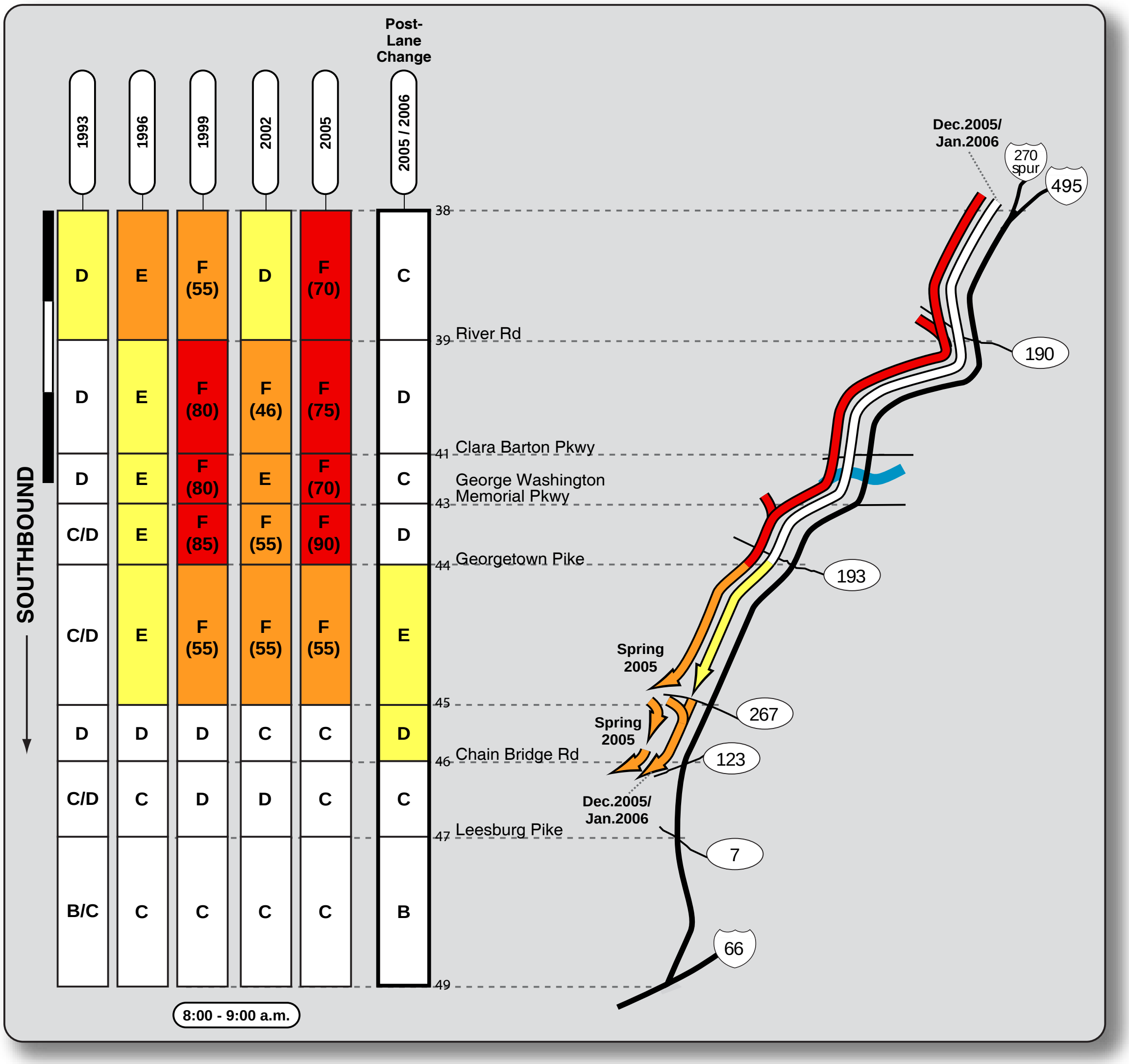
Type of Change: **Improved**

Potential Cause of Trend: Widened exit ramp

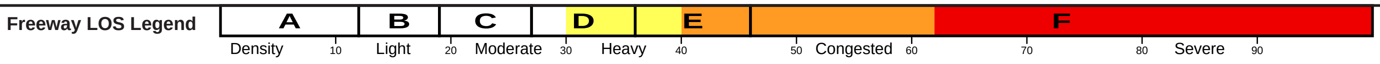
During the spring 2005 survey flights, construction to widen the ramp from the outer loop of I-495 to the Dulles Toll Road from one lane to two lanes was underway. This project was completed after all spring survey flights had ended. When the extra lane opened, there were anecdotal reports in the media that the entire trip from the I-270 spur in Maryland to the Dulles Toll Road was suddenly free of congestion, during both the morning and evening survey periods.

To confirm these reports and quantify the benefits, four one-hour supplementary flights were conducted of this section of the beltway, two in December 2005 and two in January 2006 (split between morning and evening periods of peak congestion). These flights confirmed that significant beltway delays between the I-270 spur and ramp to the Dulles Toll Road indeed were gone; for the 7-mile trip, what used to take 15 to 20 minutes during the morning survey period now takes about 6-8 minutes.

With regard to the ability of segments downstream to accept increased flow following the removal of this bottleneck, during the morning survey period, traffic was slightly more dense but new congestion did not form on the main line. The exit queue to VA 123, however, was longer; it appears that increased upstream traffic flow on the beltway may have exacerbated this condition.



1993	1996	1999	2002	2005	2005 / 2006
D	E	F (55)	D	F (70)	C
D	E	F (80)	F (46)	F (75)	D
D	E	F (80)	E	F (70)	C
C/D	E	F (85)	F (55)	F (90)	D
C/D	E	F (55)	F (55)	F (55)	E
D	D	D	C	C	D
C/D	C	D	D	C	C
B/C	C	C	C	C	B



I-495/95 Capital Beltway (Outer Loop) - Evening

Location: Between I-270 Spur and I-66

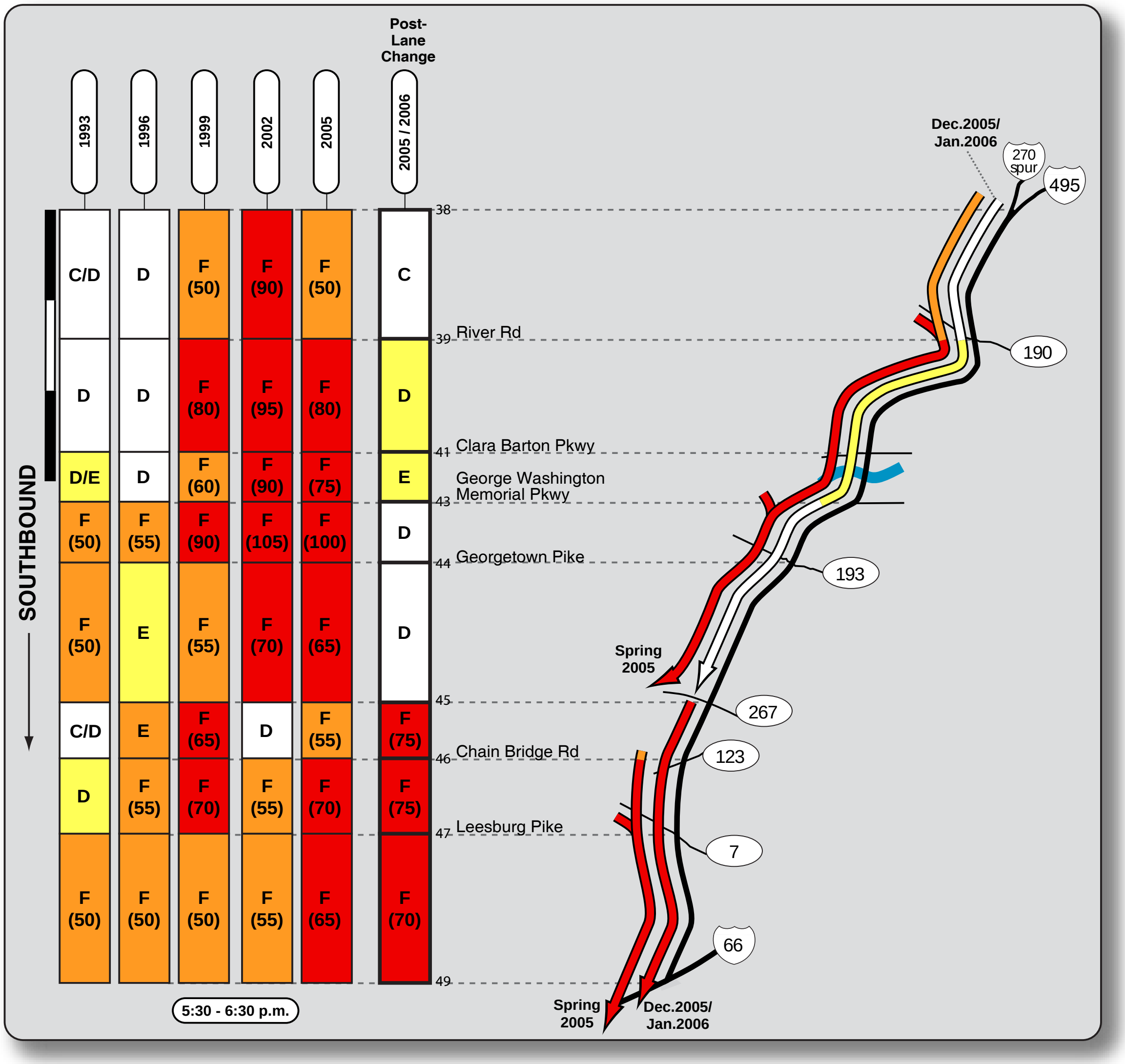
Time Period: Evening (5:30 - 6:30 p.m.)

Type of Change: **Improved**

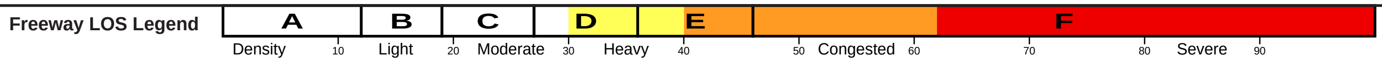
Potential Cause of Trend: Widened exit ramp

As discussed in greater detail on the previous page, supplementary survey flights in late 2005 and early 2006 confirmed that significant beltway delays between the I-270 spur and ramp to the Dulles Toll Road were gone following the widening of the exit ramp to the Toll Road. This confirmation is shown in the graphic below. During the evening survey period, which previously was more densely congested than during the morning survey period, for the 7-mile trip between the I-270 spur and the Toll Road, what used to take 20 to 25 minutes during the peak hour now takes about 6-8 minutes.

With regard to the extensive zone of downstream congestion previously found during the evening survey period, the elimination of this bottleneck caused downstream conditions to become significantly worse only for a short distance approaching VA 123; apparently, the volume of traffic exiting to the Toll Road was great enough that traffic remaining on the beltway stayed reasonably in balance with downstream capacity.



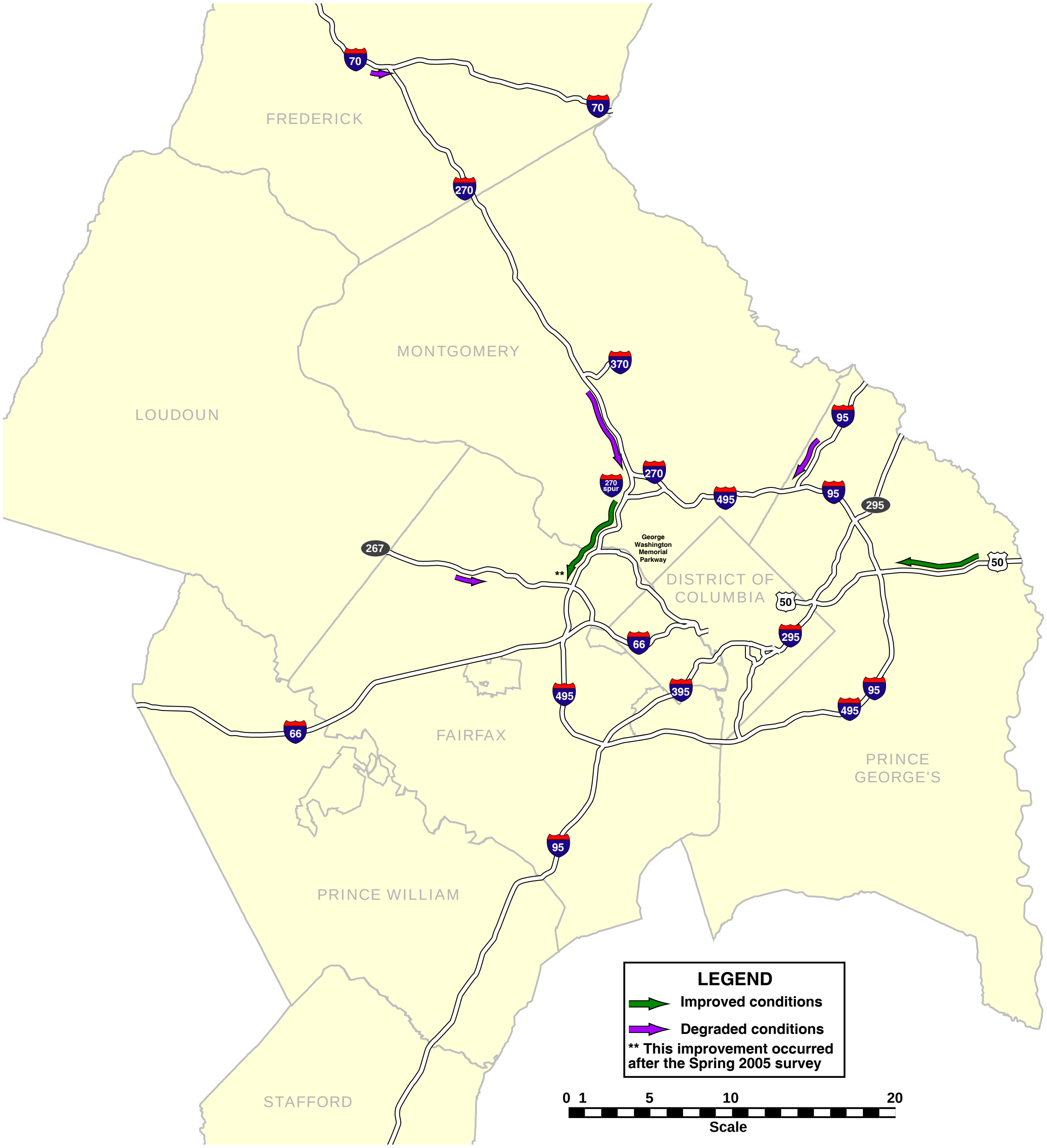
	1993	1996	1999	2002	2005	2005 / 2006
38	C/D	D	F (50)	F (90)	F (50)	C
39 River Rd	D	D	F (80)	F (95)	F (80)	D
41 Clara Barton Pkwy	D/E	D	F (60)	F (90)	F (75)	E
43 George Washington Memorial Pkwy	F (50)	F (55)	F (90)	F (105)	F (100)	D
44 Georgetown Pike	F (50)	E	F (55)	F (70)	F (65)	D
45	C/D	E	F (65)	D	F (55)	F (75)
46 Chain Bridge Rd	D	F (55)	F (70)	F (55)	F (70)	F (75)
47 Leesburg Pike	F (50)	F (50)	F (50)	F (55)	F (65)	F (70)
49						



SIGNIFICANT CHANGES (2002 - 2005) - MORNING

Route and Direction	From	To	LOS / Density Change *	% Change	Improvement (I) or Degradation (D)
EB VA 267 (7 to 8 AM)	Fairfax County Pkwy	Reston Pkwy	E to F/(40 to 70)	75%	D
WB US 50 (6 to 7 AM)	MD 197	Martin Luther King Jr. Blvd.	F to B/(70 to 20)	70%	I
EB VA 267 (7 to 8 AM)	Wiehle Ave	Hunter Mill Rd	F to F/(50 to 80)	60%	D
SB I-270 (7 to 8 AM)	Shady Grove Rd	Montrose Rd	F to F/(50 to 75)	50%	D
EB I-70 (7 to 8 AM)	US 15	I-270	C to E/ (30 to 45)	50%	D
SB I-95 (MD) (7 to 8 AM)	Sandy Spring Rd	Powder Mill Rd	C to E/(30 to 45)	50%	D

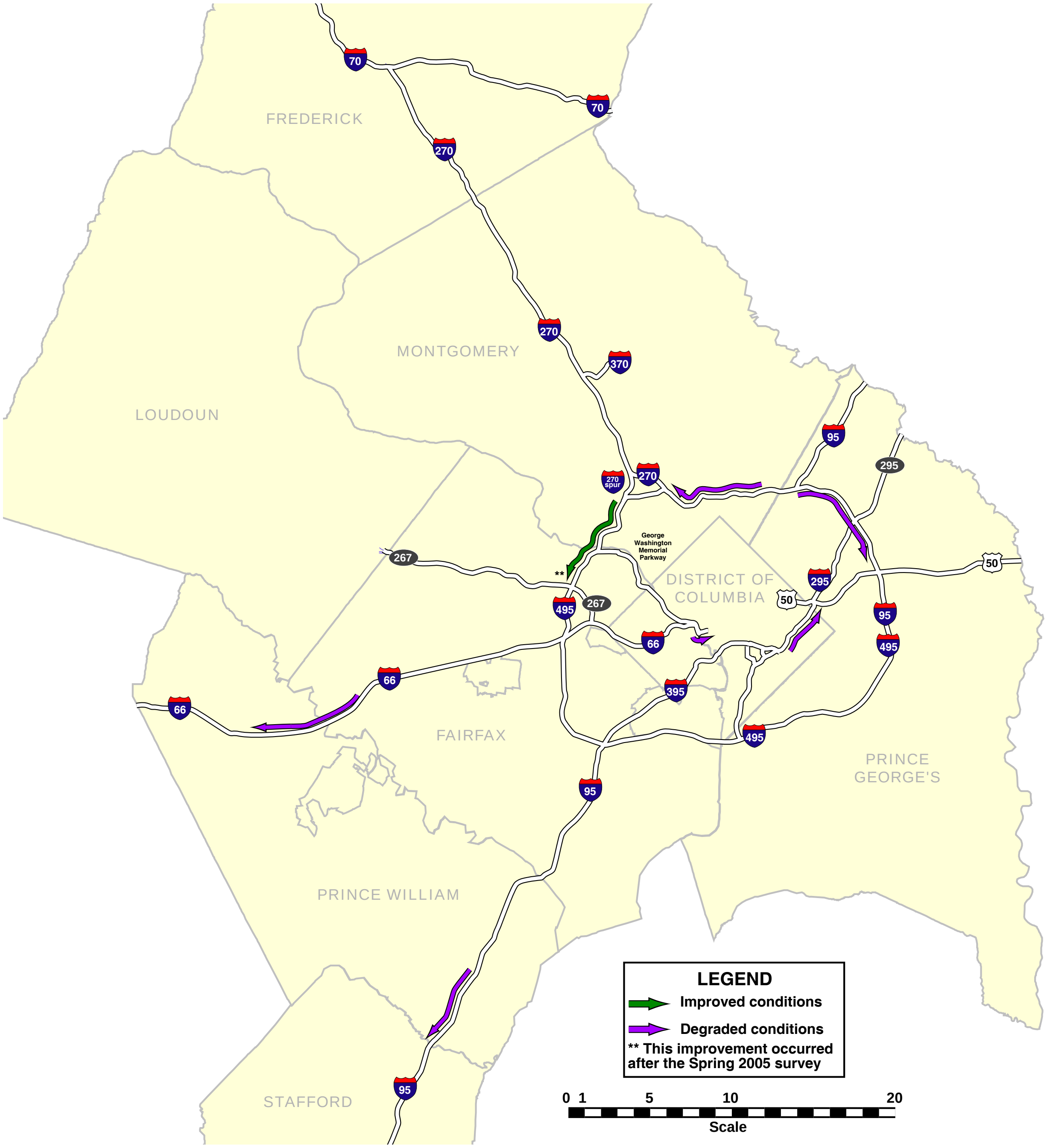
*** Density measured in passenger cars per mile per lane**



SIGNIFICANT CHANGES (2002 - 2005) - EVENING

Route and Direction	From	To	LOS / Density Change *	% Change	Improvement (I) or Degradation (D)
WB I-66 (4:30 to 5:30 PM)	Lee Hwy	Sudley Rd	F to F/(45 to 90)	100%	D
SB I-95 (4:30 to 5:30 PM)	Dumfries Blvd	Russell Rd	D to F/(30 to 60)	100%	D
EB I-66 (6 to 7 PM)	Jefferson Davis Hwy	Rock Creek Pkwy	C to F/(30 to 55)	80%	D
NB DC 295 (5 to 7 PM)	Pennsylvania Rd	US 50	D to F/(40 to 70)	75%	D
IL I-495 (4:30 to 5:30 PM)	I-95	Annapolis Rd	E to F/(40 to 70)	75%	D
OL I-495 (4:30 to 5:30 PM)	New Hampshire	I-270	E to F/(45 to 70)	55%	D
OL I-495** (8 to 9 AM and 5:30 to 6:30 PM))	I-270	Dulles Toll Rd	F to D/(80 to 40) and F to D (100 to 40)	50% and 60%	I

*** Density measured in passenger cars per mile per lane**
**** This improvement occurred after the Spring survey**



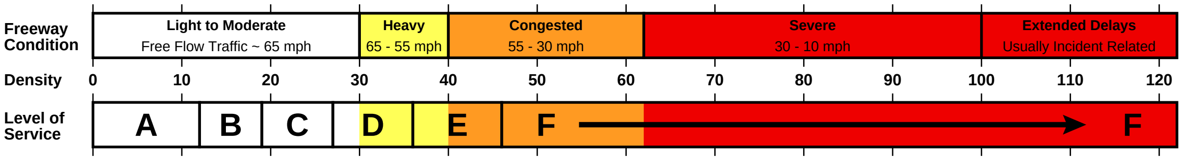
Part Two

Metropolitan Washington Area Surveyed Highways - Spring 2005

Traffic Quality Rating Tables

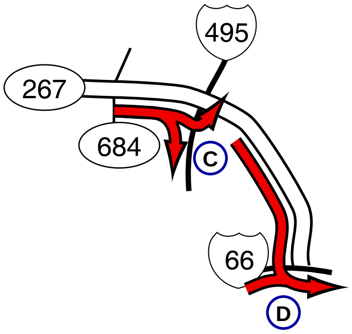
The following pages contain morning and evening traffic quality rating tables for all highways surveyed in the spring of 2005. Traffic quality ratings are presented by segment, hour and direction. Each rating is a composite reflecting all ratings for that hour – usually four –derived from survey flights on four different days, except that ratings affected by incidents or other unusual events were segregated and excluded from consideration.

TRAFFIC QUALITY RATINGS:



CONGESTED LOCATIONS

Each level-of-service table includes arrowheads that depict locations where congestion was found. A narrative that clarifies the frequency and severity of the congestion accompanies each arrowhead; where evident, apparent causes of the problems are also described. See example below:



C
During the peak period, eastbound congestion was found on VA 267 approaching the Beltway; congestion on the Beltway exit ramps extended back into the right lane of VA 267 (thru-traffic on VA 267 was typically able to bypass the queue).

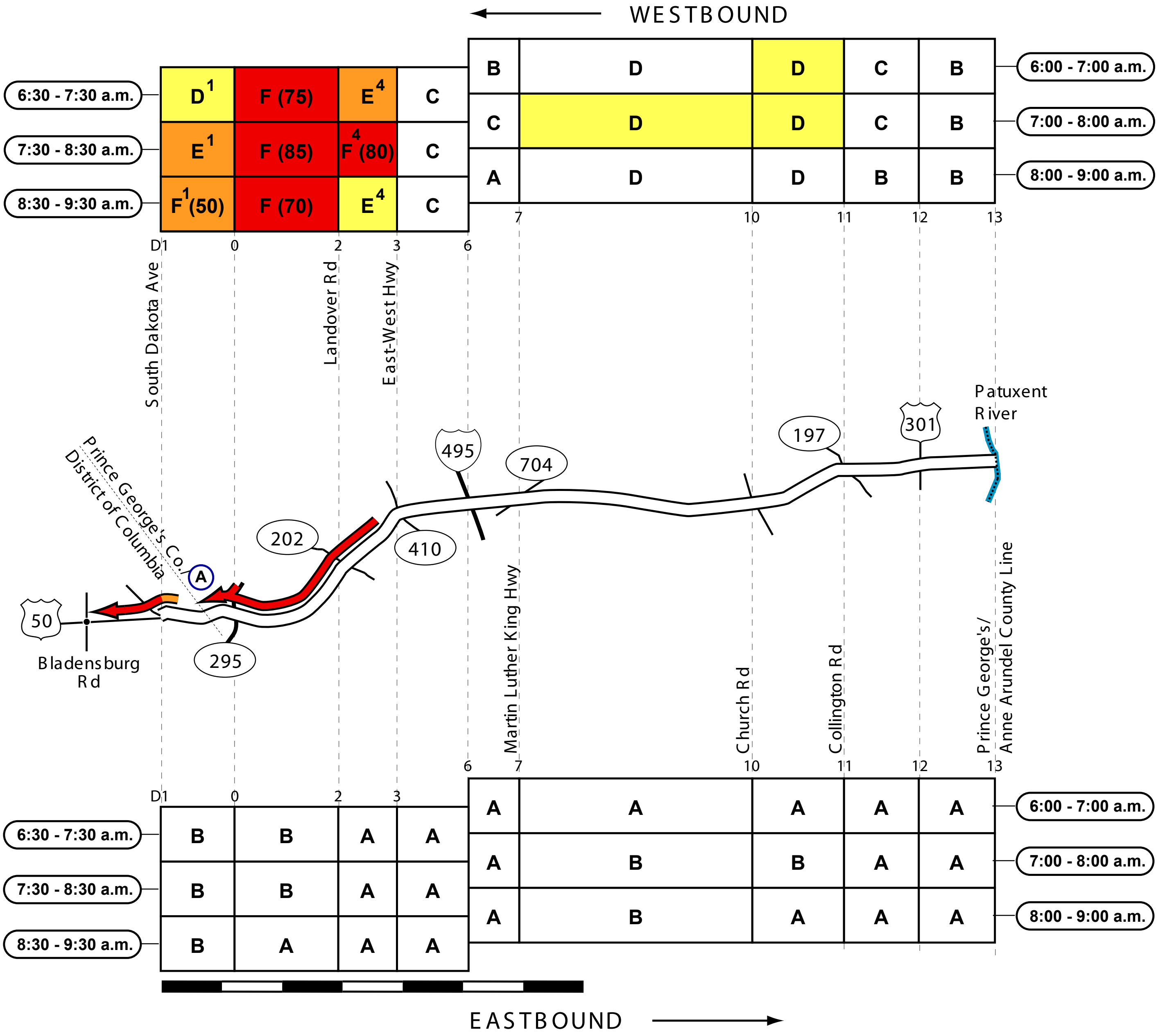
A scale accompanies each rating table in this section of the report.

NESTED CONGESTION

Level-of-Service data for some highway segments represent the mathematical average of densities that varied widely; these data have been tagged with a superscript number in the LOS tables. Four types of "nested" congestion that contributes to the variability have been identified as follows:

Descriptions	Type
Type 1 - Congestion present on some days, but not others.	1
Type 2 - Congestion more severe in left or right-hand lanes.	2
Type 3 - Congestion present only in the first or second half-hour (hourly averages).	3
Type 4 - The length of the congested zone within the segment varies.	4

US 50 (MARYLAND) - MORNING



WESTBOUND

6:30 - 7:30 a.m.	D[1]	F (75)	E[4]	C
7:30 - 8:30 a.m.	E[1]	F (85)	F[4] (80)	C
8:30 - 9:30 a.m.	F[1](50)	F (70)	E[4]	C

6:00 - 7:00 a.m.	B	D	D	C	B
7:00 - 8:00 a.m.	C	D	D	C	B
8:00 - 9:00 a.m.	A	D	D	B	B

EASTBOUND

6:30 - 7:30 a.m.	B	B	A	A
7:30 - 8:30 a.m.	B	B	A	A
8:30 - 9:30 a.m.	B	A	A	A

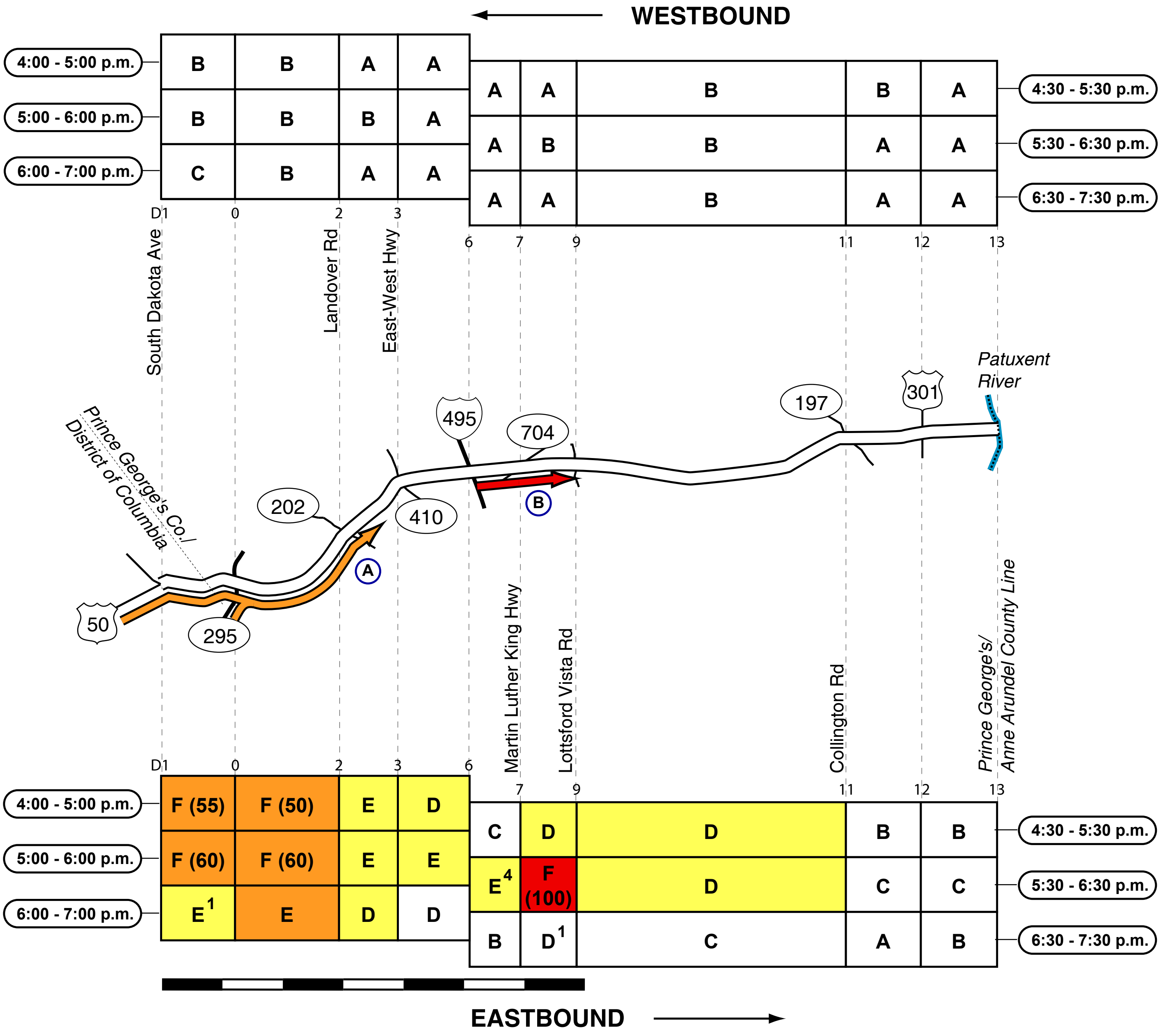
6:00 - 7:00 a.m.	A	A	A	A	A
7:00 - 8:00 a.m.	A	B	B	A	A
8:00 - 9:00 a.m.	A	B	A	A	A

A
Throughout the morning survey period, a three to four mile zone of westbound congestion was found on US 50 between the vicinity of East-West Highway and MD 295; average estimated speeds typically ranged from 15 to 25 mph. Congestion appeared to be caused by traffic entering at MD 295. On some days but not others, the signal queue at Bladensburg Rd extended back into the mainline of US 50 to MD 295 (creating a continuous zone of westbound congestion between East-West Highway and Bladensburg Rd).

Freeway LOS Legend

A	B	C	D	E	F
Density 10	Light 20	Moderate 30	Heavy 40	50 Congested 60	70 80 Severe 90

US 50 (Maryland) - Evening



WESTBOUND

4:00 - 5:00 p.m.	B	B	A	A
5:00 - 6:00 p.m.	B	B	B	A
6:00 - 7:00 p.m.	C	B	A	A

A	A	B	B	A	4:30 - 5:30 p.m.
A	B	B	A	A	5:30 - 6:30 p.m.
A	A	B	A	A	6:30 - 7:30 p.m.

EASTBOUND

4:00 - 5:00 p.m.	F (55)	F (50)	E	D
5:00 - 6:00 p.m.	F (60)	F (60)	E	E
6:00 - 7:00 p.m.	E[1]	E	D	D

C	D	D	B	B	4:30 - 5:30 p.m.
E[4]	F (100)	D	C	C	5:30 - 6:30 p.m.
B	D[1]	C	A	B	6:30 - 7:30 p.m.

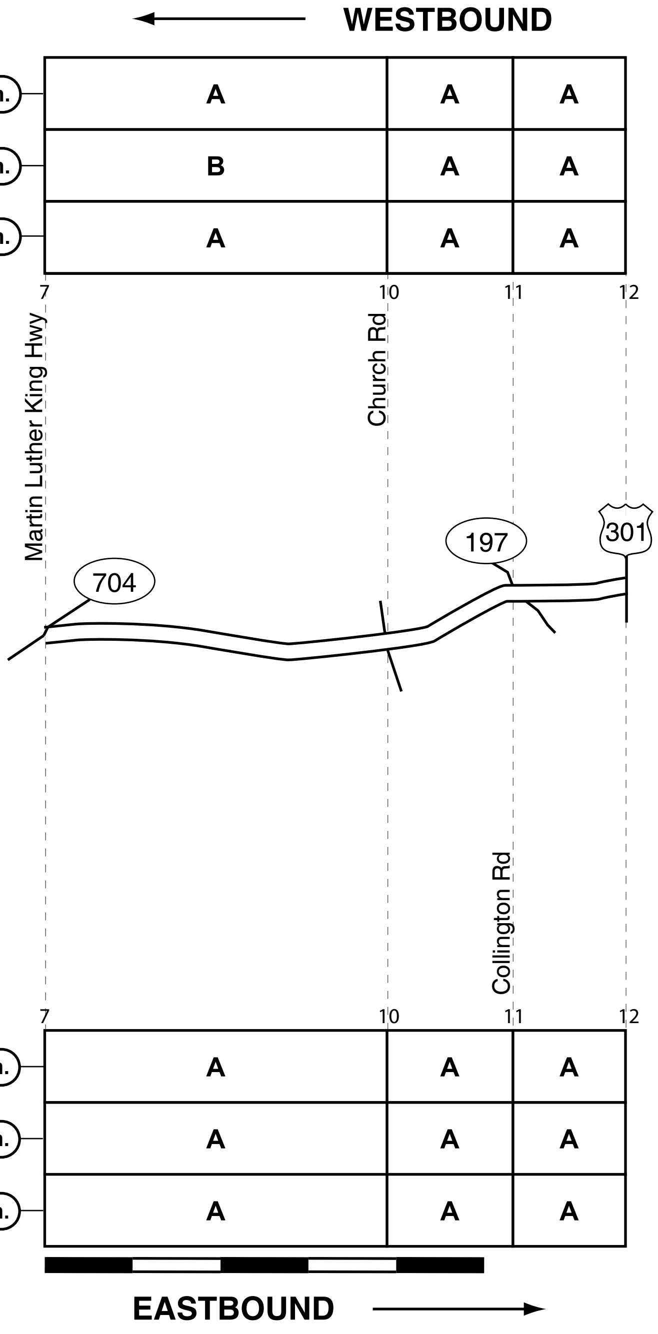
A
During most observations, eastbound congestion was found on US 50 between South Dakota Ave and MD 202; average estimated speeds typically ranged from 30 to 50 mph. Factors contributing to the congestion were: 1) the lane drop (3 lanes to 2) in the vicinity of MD 295; 2) the absence of an acceleration lane on the ramp to MD 295 (southbound), which sometimes caused congestion to extend back into the mainline of US 50 and 3) traffic entering from the MD 295.

B
During the peak period, eastbound congestion was found on US 50 between the Beltway and Lottsford Vista Rd; average estimated speeds ranged from 10 to 20 mph. The primary bottleneck was found at the lane drop (4 lanes to 3) in the vicinity of the Lottsford Vista Rd overpass; east of the lane drop, traffic flow gradually improved.

Freeway LOS Legend A B C D E F
Density 10 Light 20 Moderate 30 Heavy 40 50 Congested 60 70 80 Severe 90

US 50 HOV (Maryland) - Morning

HOV OPERATIONS
HOV 2
24 HOUR



WESTBOUND

6:00 - 7:00 a.m.	A	A	A
7:00 - 8:00 a.m.	B	A	A
8:00 - 9:00 a.m.	A	A	A

EASTBOUND

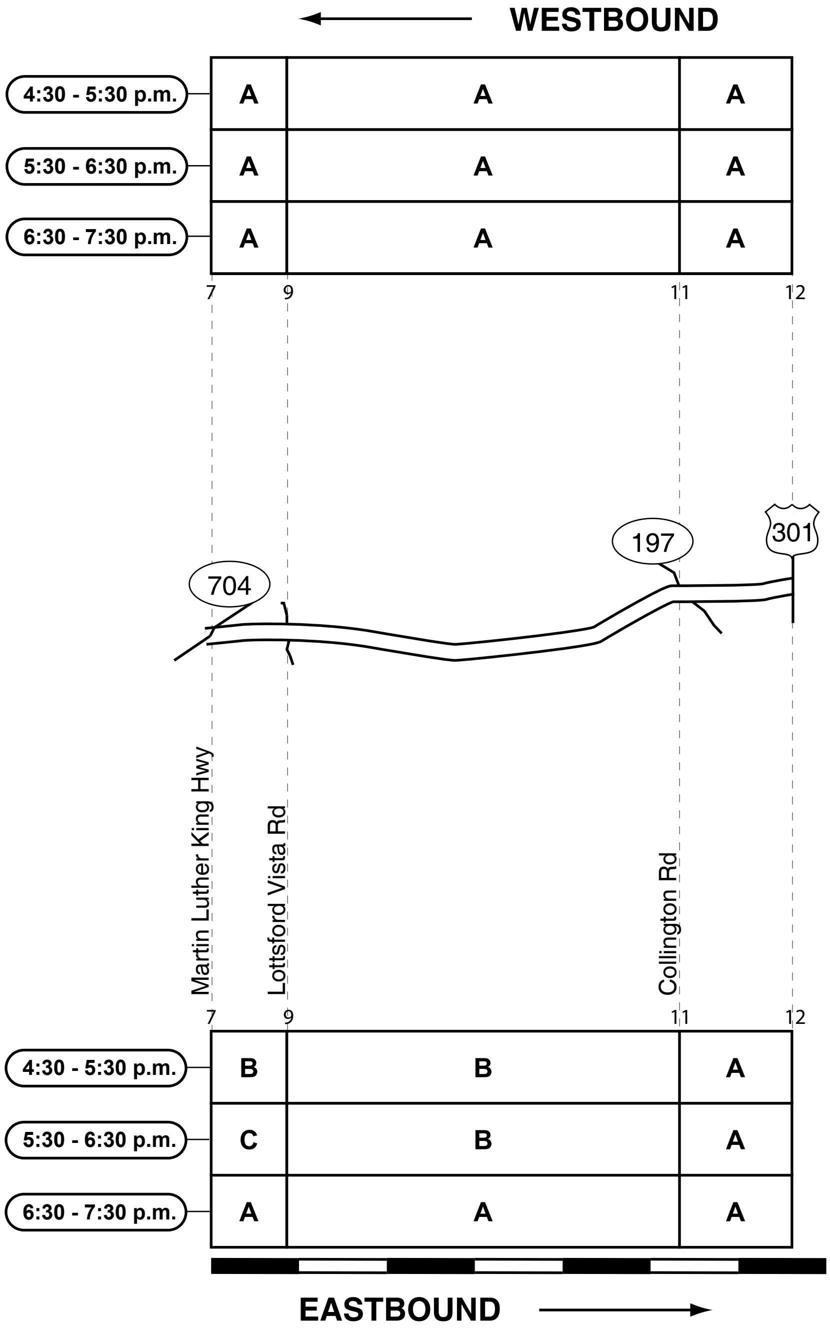
6:00 - 7:00 a.m.	A	A	A
7:00 - 8:00 a.m.	A	A	A
8:00 - 9:00 a.m.	A	A	A

Freeway LOS Legend

A	B	C	D	E	F
Density 10	Light 20	Moderate 30	Heavy 40	50 Congested 60	70 80 Severe 90

US 50 HOV (MARYLAND) - EVENING

HOV OPERATIONS
HOV 2
24 HOUR



WESTBOUND

4:30 - 5:30 p.m.	A	A	A
5:30 - 6:30 p.m.	A	A	A
6:30 - 7:30 p.m.	A	A	A

EASTBOUND

4:30 - 5:30 p.m.	B	B	A
5:30 - 6:30 p.m.	C	B	A
6:30 - 7:30 p.m.	A	A	A

Freeway LOS Legend

A	B	C	D	E	F
Density 10	Light 20	Moderate 30	Heavy 40	50 Congested 60	70 80 Severe 90

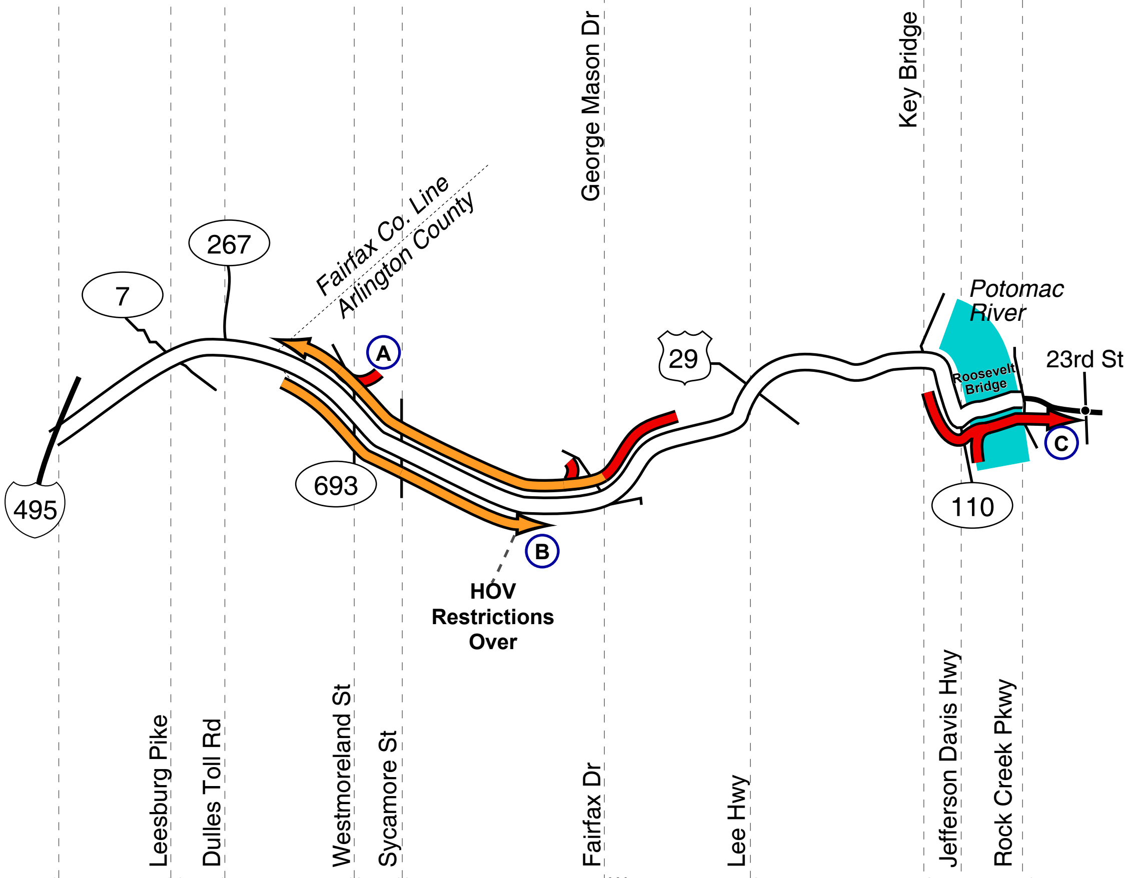
I-66 Inside Beltway (Virginia) - Morning

HOV OPERATIONS
HOV 2
6:30 - 9:00 A.M.
EASTBOUND

WESTBOUND ←

6:30 - 7:30 a.m.	A	B	C	C	C	C	C	A	B
7:30 - 8:30 a.m.	B	C	E	E[1]	F (60)	F (70)	C	B	B
8:30 - 9:30 a.m.	B	C	E	F 50	F (55)	F (55)	C	A	B

64 66 67 68 69 71W 72 73 75 76



64 66 67 68 69 71W 72 73 75 76

6:30 - 7:30 a.m.	A	C	D[3]	E[3]	D[3]	C	C	B	C	HOV All Lanes
7:30 - 8:30 a.m.	B	A	C	C	D	C	C	E[4]	F[3] (65)	
8:30 - 9:00 a.m.	A	A	C	E	C	B	C	46	70	
9:00 - 9:30 a.m.	B	A	F (55)	55[1]	F (46)	D	E	95	95	NON-HOV

EASTBOUND →

Freeway LOS Legend

A	B	C	D	E	F
Density	Light	Moderate	Heavy	Congested	Severe

10 20 30 40 50 60 70 80 90

I-66 INSIDE BELTWAY (VIRGINIA) - MORNING

A

During most observations after 7:30 a.m., a four to five-mile zone of westbound congestion was found on I-66 between Lee Highway and Westmoreland St (VA 693); average estimated speeds ranged widely, from 15 to 50 mph. Traffic entering at Fairfax Dr and Westmoreland St appeared to cause or exacerbate the congestion. Traffic flow typically improved west of Westmoreland St where the roadway widens from two to three lanes.

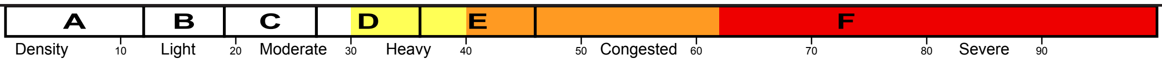
B

Prior to 6:40 a.m. and after 9:00 a.m.), eastbound congestion was found on I-66 between VA 267 and Fairfax Dr; when congested, average estimated speeds typically ranged from 30 to 50 mph. The primary bottleneck was found at the lane drop (3 lanes to 2) in the vicinity of Westmoreland St.

C

During most observations after 8:00 a.m., inbound congestion was found on I-66 approaching and across the Roosevelt Bridge; the head of the queue was found at the signalized intersection at 23rd St. Congestion on the bridge also typically extended back onto Arlington Blvd and the George Washington Memorial Parkway.

Freeway LOS Legend



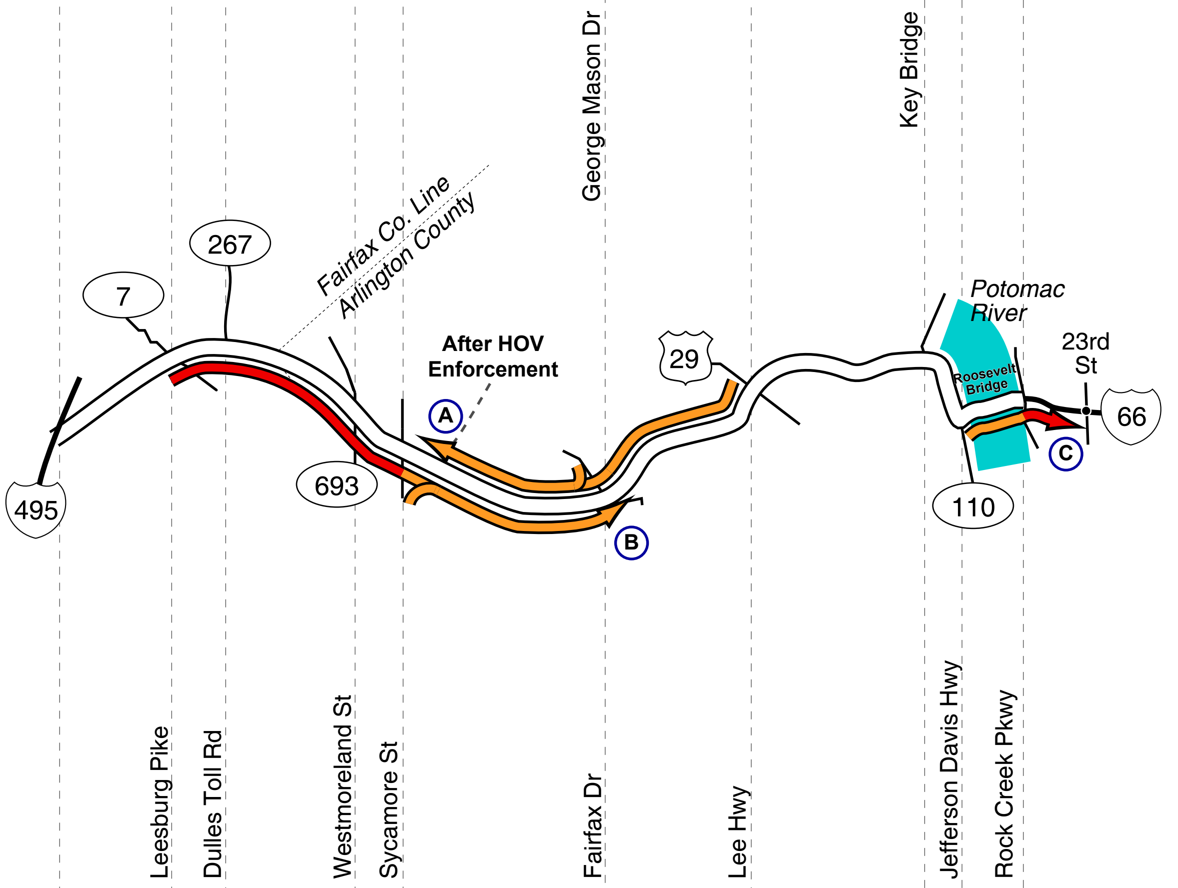
I-66 INSIDE BELTWAY (VIRGINIA) - EVENING

HOV OPERATIONS
HOV 2
4:00 - 6:30 P.M.
WESTBOUND

← **WESTBOUND**

4:00 - 5:00 p.m.	A	A	C	C	C	B	B	B	D	HOV All Lanes
5:00 - 6:00 p.m.	B	B	C	D	D	C	C	B	D	
6:00 - 6:30 p.m.	D	C	C	D	D	C	C	B	D	
6:30 - 7:00 p.m.	C	C	D	E	F (55)	F (55)	C	C	C	NON-HOV

64 66 67 68 69 71W 72 73 75 76



64 66 67 68 69 71W 72 73 75 76

4:00 - 5:00 p.m.	B	B	F (60)	F 70	F (46)	C	C	A	A
5:00 - 6:00 p.m.	C	F (80)	F (95)	F 75	F (55)	C	C	C	D
6:00 - 7:00 p.m.	D[1]	F (80)	F (100)	F 90	F (50)	C	C	D	F (55)

EASTBOUND →

Freeway LOS Legend A B C D E F

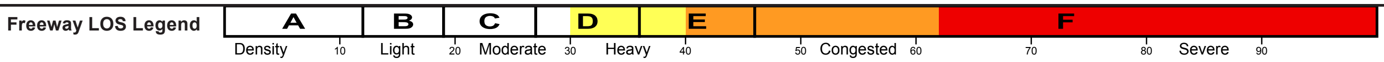
Density 10 Light 20 Moderate 30 Heavy 40 50 Congested 60 70 80 Severe 90

I-66 INSIDE BELTWAY (VIRGINIA) - EVENING

A
During most observations after 6:30 p.m. (HOV restrictions end), westbound congestion was found on I-66 between Lee Highway and Sycamore St; average estimated speeds typically ranged from 35 to 45 mph. Traffic entering at Fairfax Drive appeared to cause or exacerbate the congestion.

B
Throughout the morning survey period, eastbound congestion was found on I-66 between the Beltway and Fairfax Dr; average estimated speeds ranged widely, from 5 to 30 mph. Factors contributing to the congestion were: 1) the series of lane drops (4 lanes to 3 and 3 lanes to 2) in the vicinity of Westmoreland St and 2) traffic entering at Sycamore St.

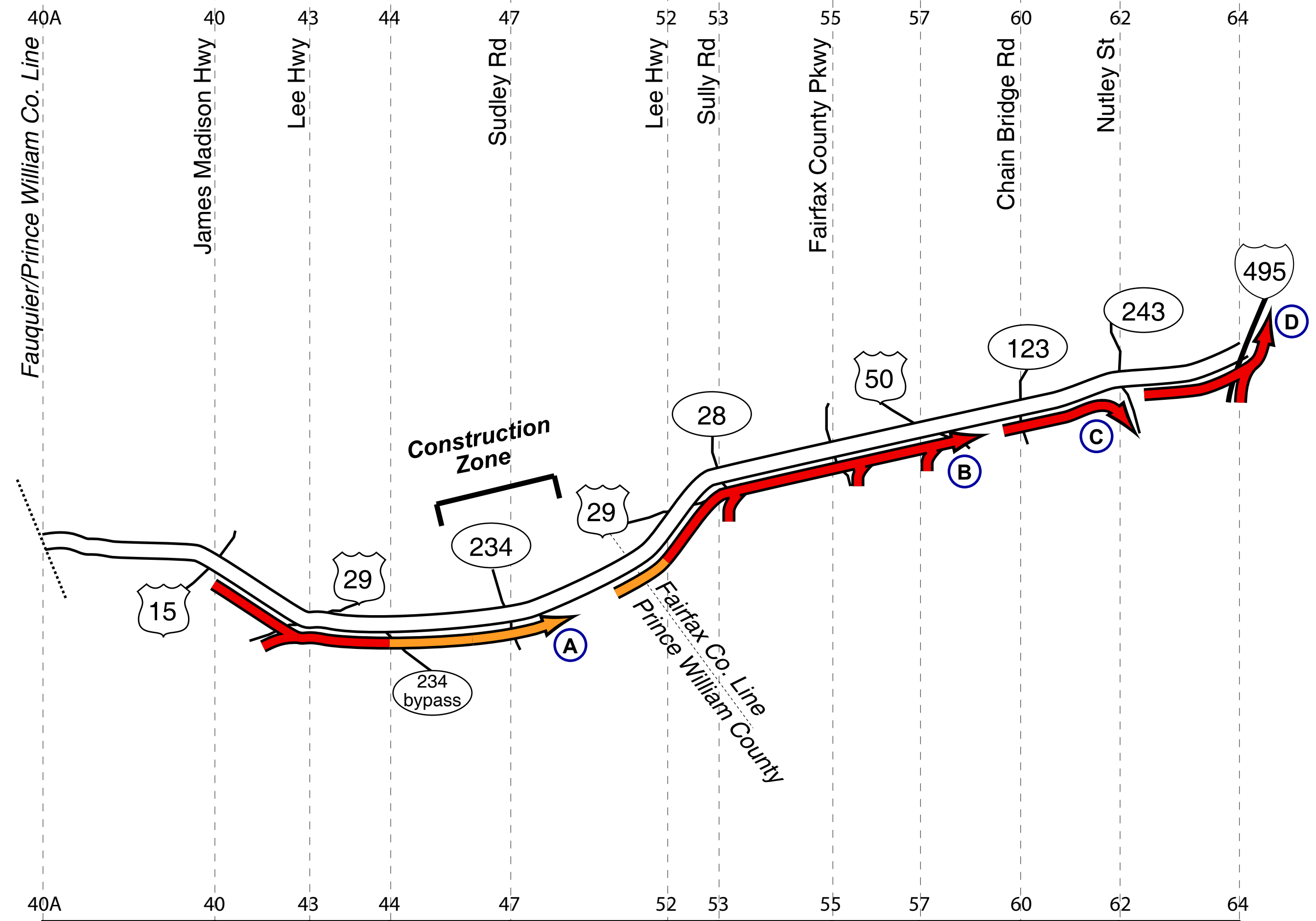
C
On some days but not others, inbound congestion was found approaching and across the Roosevelt Bridge; the head of the queue was found at the signalized intersection at 23rd St.



I-66 Outside Beltway (Virginia) - Morning

← **WESTBOUND**

6:00 - 7:00 a.m.	A	A	A	C	A	A	B	A	C	D	C
7:00 - 8:00 a.m.	A	A	B	C	A	A	B	A	C	D	C
8:00 - 9:00 a.m.	A	A	A	B	A	A	A	A	C	C	C



6:00 - 7:00 a.m.	C	F (85)	F (75)	F (55)	D	F[1] (55)	E[1]	F[1](50)	F (55)	E	F[1](50)
7:00 - 8:00 a.m.	C	F (95)	F (65)	F (60)	E[4]	F[1] (75)	F (65)	F (90)	F (65)	F[1](50)	F (55)
8:00 - 9:00 a.m.	A[4]	F (60)	F (75)	F (50)	D[4]	F[1] (46)	F[1](46)	F[1](55)	F (70)	F (65)	F[1](80)

EASTBOUND →

Freeway LOS Legend

A	B	C	D	E		F
Density 10	Light 20	Moderate 30	Heavy 40		50 Congested 60	70 Severe 80 90

I-66 Outside Beltway (Virginia) - Morning

A

Throughout the morning survey period, a seven to eight-mile zone of eastbound congestion was found on I-66 between the vicinity of US 15 and VA 234; average estimated speeds ranged widely, from 10 to 40 mph. Traffic entering at US 29 and the VA 234 Bypass appeared to cause or exacerbate the congestion; ongoing construction at the VA 234 interchange may also have contributed to the congestion. Traffic flow typically improved east of VA 234 where the roadway widens from two lanes to four (3 general-purpose and 1 HOV).

B

During most observations, a five to seven-mile zone of eastbound congestion was found on I-66 between US 29 in Centreville and US 50; when congested, average estimated speeds typically ranged from 15 to 45 mph. Congestion appeared to be caused or exacerbated by traffic entering at the interchanges along this corridor.

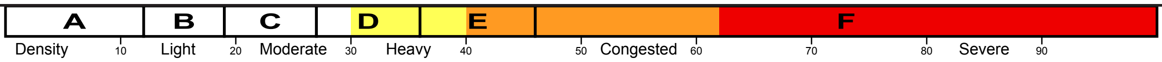
C

During most observations after 7:00 a.m., eastbound congestion was found on I-66 approaching Nutley St. The head of the queue was found on the exit ramp at Nutley St; congestion on the ramp typically extended back into the right lane and eventually across all lanes of I-66.

D

During most observations, a three to four-mile zone of eastbound congestion was found on I-66 between Nutley St and the Beltway; when congested, average estimated speeds ranged widely, from 15 to 50 mph. The head of the queue was found on the exit ramp to the inner loop of the Beltway.

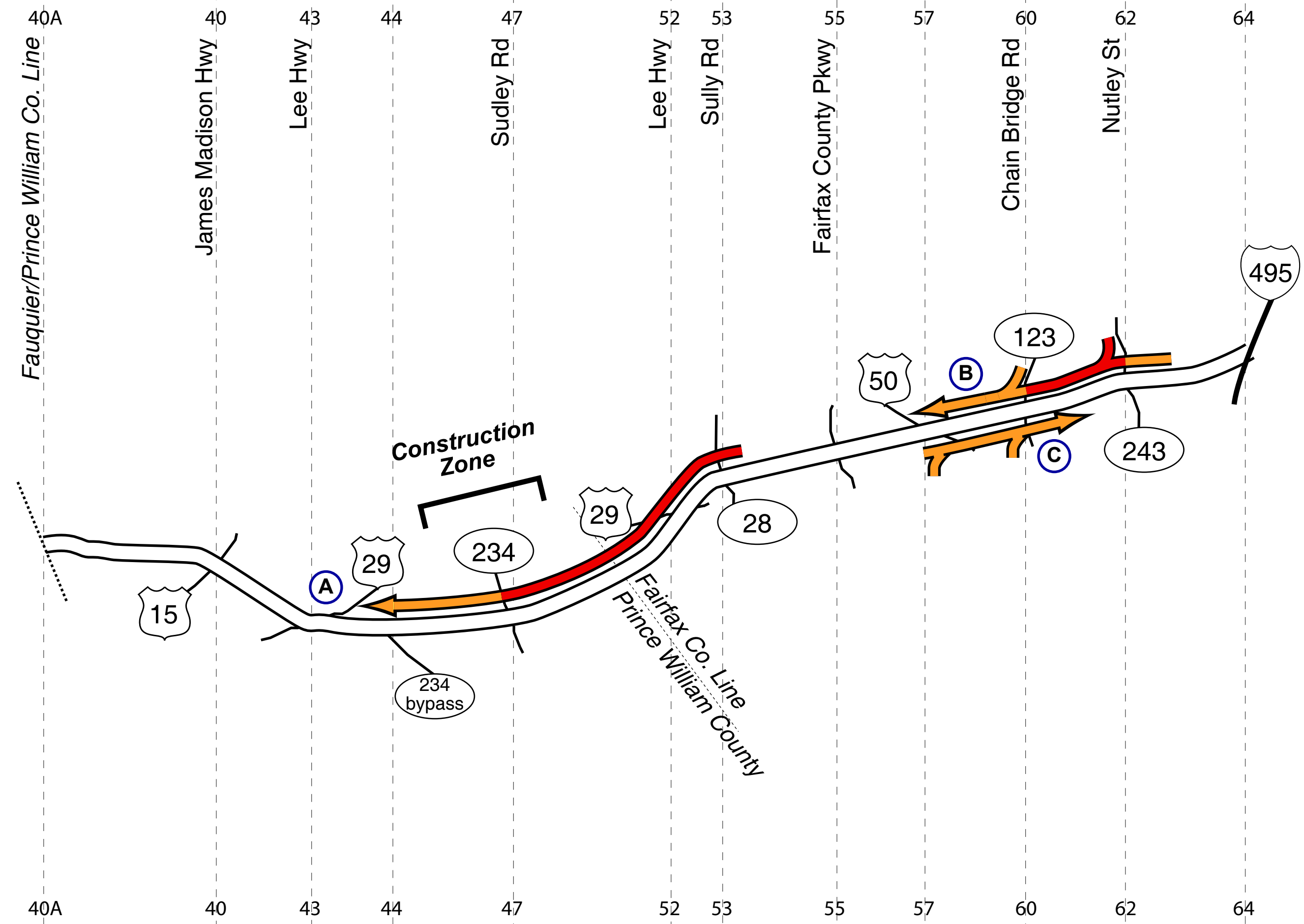
Freeway LOS Legend



I-66 Outside Beltway (Virginia) - Evening

← **WESTBOUND**

4:30 - 5:30 p.m.	B	C	D	F (55)	F (90)	F (80)	E[4]	D	E[1]	F[1] (55)	D
5:30 - 6:30 p.m.	A	C	D	F (60)	F (85)	F[3] (65)	E[4]	D	F (50)	F (70)	D
6:30 - 7:30 p.m.	A	A	C	F[3] (46)	F[3] (46)	C	D	C	E[3]	E[3]	C



4:30 - 5:30 p.m.	A	A	C	C	A	B	B	B	E[1]	E[1]	D
5:30 - 6:30 p.m.	A	A	B	C	B	B	B	B	E[1]	E[1]	D
6:30 - 7:30 p.m.	A	A	B	B	A	A	B	A	B	D	D

EASTBOUND →

Freeway LOS Legend

A	B	C	D	E	F
Density 10	Light 20	Moderate 30	Heavy 40	50 Congested 60	70 80 Severe 90

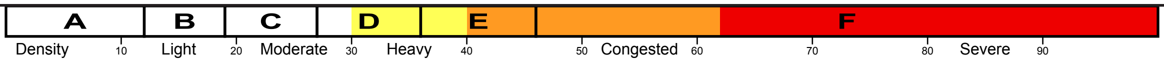
I-66 Outside Beltway (Virginia) - Evening

A
During most observations before 7:00 p.m., a six to seven-mile zone of westbound congestion was found on I-66 between VA 28 and VA 234; average estimated speeds typically ranged from 10 to 30 mph. The primary bottleneck was the series of lane drops (4 lanes to 3 and 3 lanes to 2) at VA 234 (HOV terminus); ongoing construction in the vicinity of VA 234 (roadway widening) may have contributed to the congestion. While congestion persisted west of VA 234, traffic flow typically improved.

B
During most observations before 7:00 p.m., a three to four-mile zone of westbound congestion was found on I-66 between Nutley St and US 50; when congested, average estimated speeds typically ranged from 25 to 50 mph. Traffic entering at Nutley St and Chain Bridge Rd appeared to cause or exacerbate the congestion.

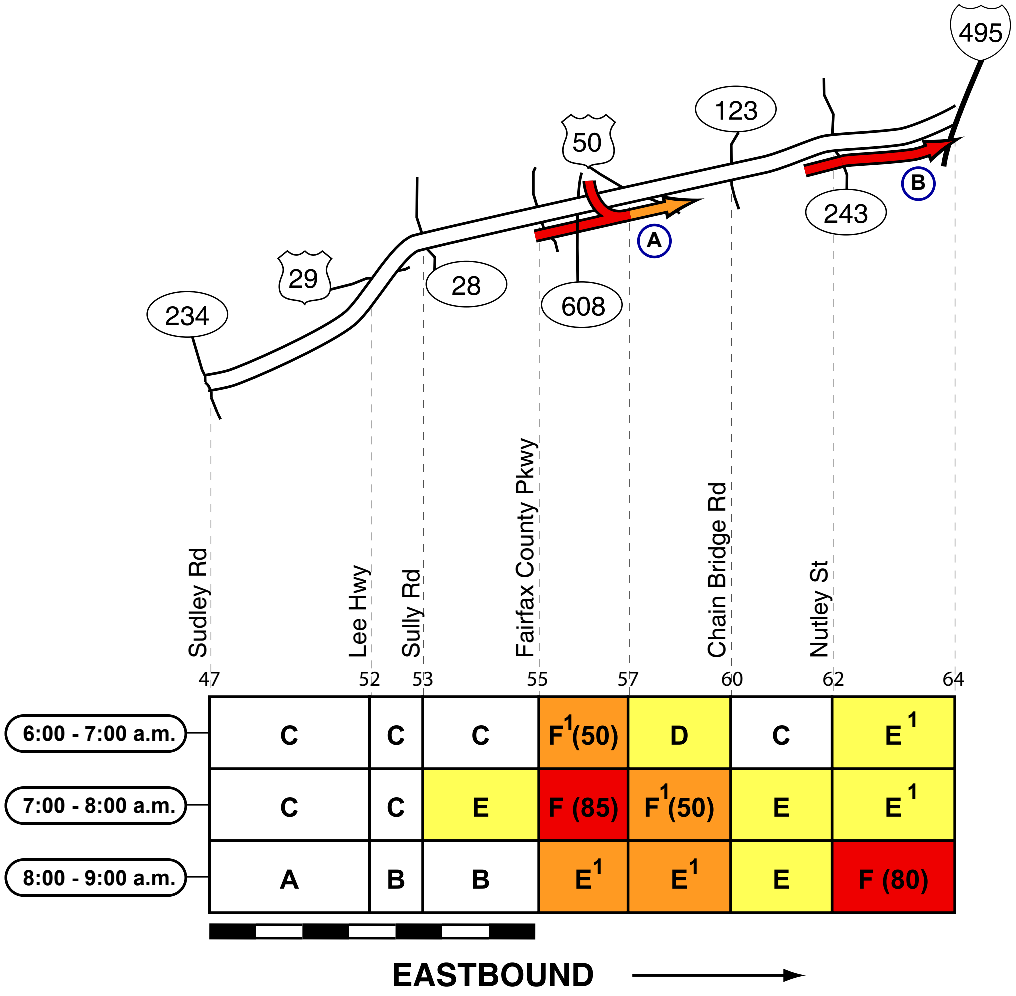
C
On some days but not others, a three to four-mile zone of eastbound congestion was found on I-66 between US 50 and Nutley St; when congested, average estimated speeds typically ranged from 30 to 50 mph. Traffic entering at US 50 and Chain Bridge Rd appeared to cause or exacerbate the congestion.

Freeway LOS Legend



I-66 (OUTSIDE BELTWAY) LEFT LANE / CONCURRENT FLOW HOV - MORNING

HOV OPERATIONS
HOV 2
5:30 - 9:30 A.M.
EASTBOUND



6:00 - 7:00 a.m.	C	C	C	F^1(50)	D	C	E^1
7:00 - 8:00 a.m.	C	C	E	F (85)	F^1(50)	E	E^1
8:00 - 9:00 a.m.	A	B	B	E^1	E^1	E	F (80)

A
After 6:30 a.m., eastbound congestion was typically found on the I-66 HOV facility between Fairfax County Parkway and VA 123; average estimated speeds ranged from 15 to 45 mph. Traffic entering from the center of the roadway at VA 608 may have contributed to the congestion.

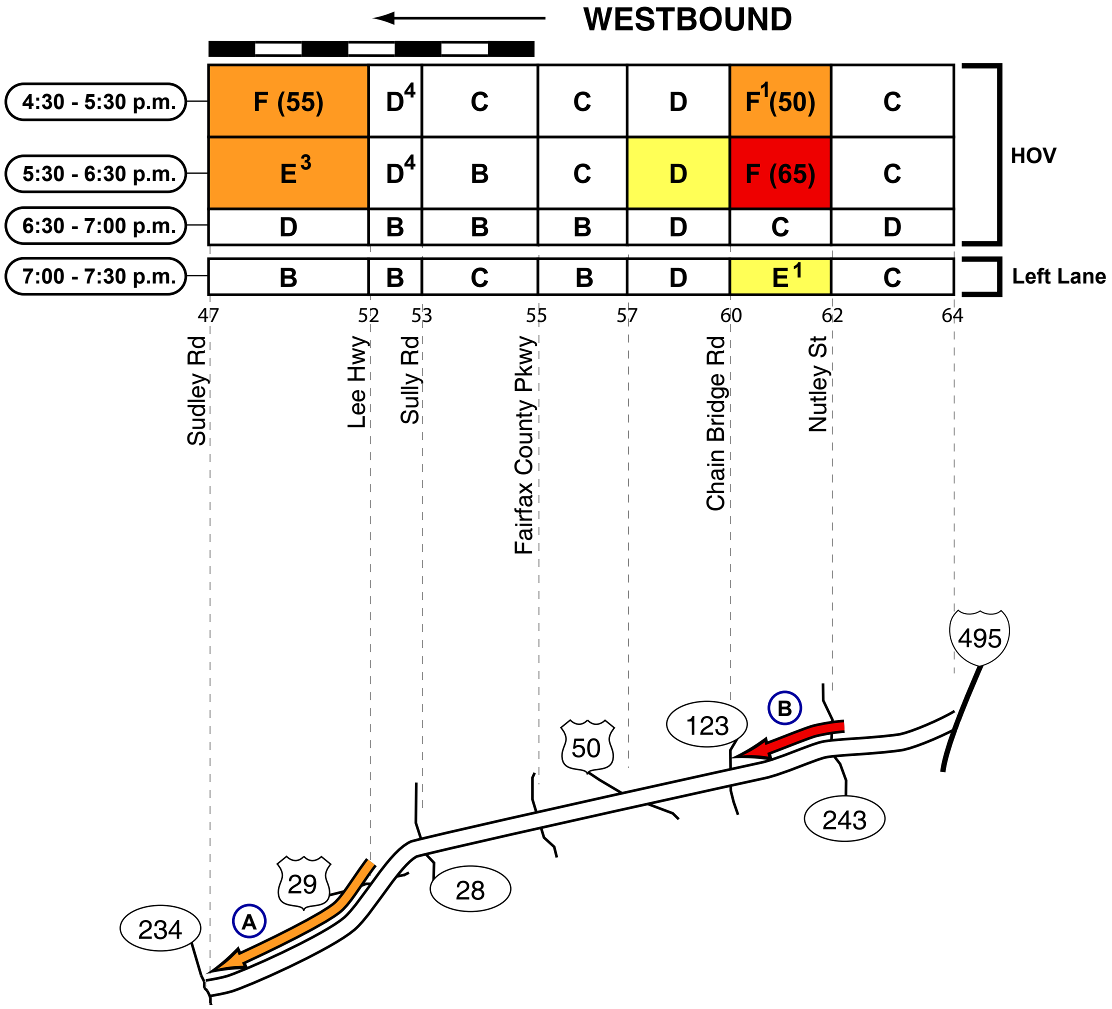
B
During most observations, eastbound congestion was found on the I-66 HOV facility approaching the Beltway; when congested, average estimated speeds typically ranged from 15 to 35 mph.

Freeway LOS Legend

A	B	C	D	E	F
Density 10	Light 20	Moderate 30	Heavy 40	50 Congested 60	70 80 Severe 90

I-66 (OUTSIDE BELTWAY) LEFT LANE / CONCURRENT FLOW HOV - EVENING

HOV OPERATIONS
HOV 2
3:00 - 7:00 P.M.
WESTBOUND



4:30 - 5:30 p.m.	F (55)	D^4	C	C	D	F^1(50)	C
5:30 - 6:30 p.m.	E^3	D^4	B	C	D	F (65)	C
6:30 - 7:00 p.m.	D	B	B	B	D	C	D
7:00 - 7:30 p.m.	B	B	C	B	D	E^1	C

A
During most observations before 6:00 p.m., westbound congestion was found on the I-66 HOV facility between US 29 in Centreville and VA 234 (HOV terminus); when congested, average estimated speeds typically ranged from 30 to 50 mph.

B
During most observations, westbound congestion was found on the I-66 HOV facility between Nutley St and Chain Bridge Rd; average estimated speeds typically ranged from 30 to 50 mph. Traffic entering at Nutley St and Chain Bridge Rd may have contributed to the congestion.

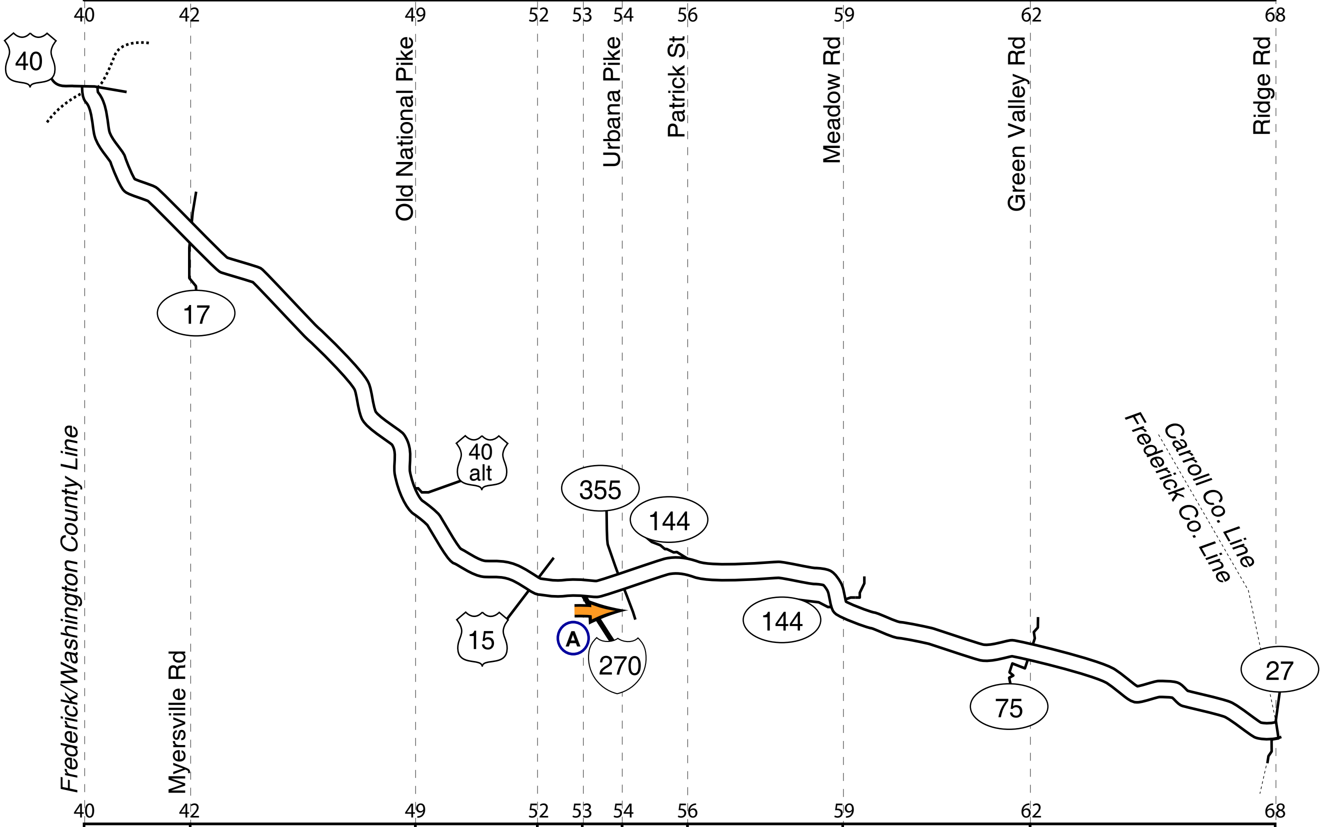
Freeway LOS Legend

A		B		C		D		E		F	
Density	10	Light	20	Moderate	30	Heavy	40	50	Congested 60	70	80 Severe 90

I-70 (MARYLAND) - MORNING

← **WESTBOUND**

	40–42	42–49	49–52	52–53	53–54	54–56	56–59	59–62	62–68
6:00 - 7:00 a.m.	A	A	A	A	A	B	A	A	A
7:00 - 8:00 a.m.	A	A	A	A	B	C	A	A	A
8:00 - 9:00 a.m.	A	A	A	A	B	C	B	B	A



	40–42	42–49	49–52	52–53	53–54	54–56	56–59	59–62	62–68
6:00 - 7:00 a.m.	B	B	D	C	C	C	A	A	B
7:00 - 8:00 a.m.	B	C	C	D	E[3]	C	A	A	A
8:00 - 9:00 a.m.	B	B	C	D	E[3]	C	A	A	B

EASTBOUND →

A
Between 7:30 and 8:30 a.m., a short zone of eastbound congestion was found on I-70 between US 15 and MD 355; average estimated speeds typically ranged from 30 to 50 mph. Congestion appeared to be caused or exacerbated by traffic entering at the I-270 interchange.

Freeway LOS Legend

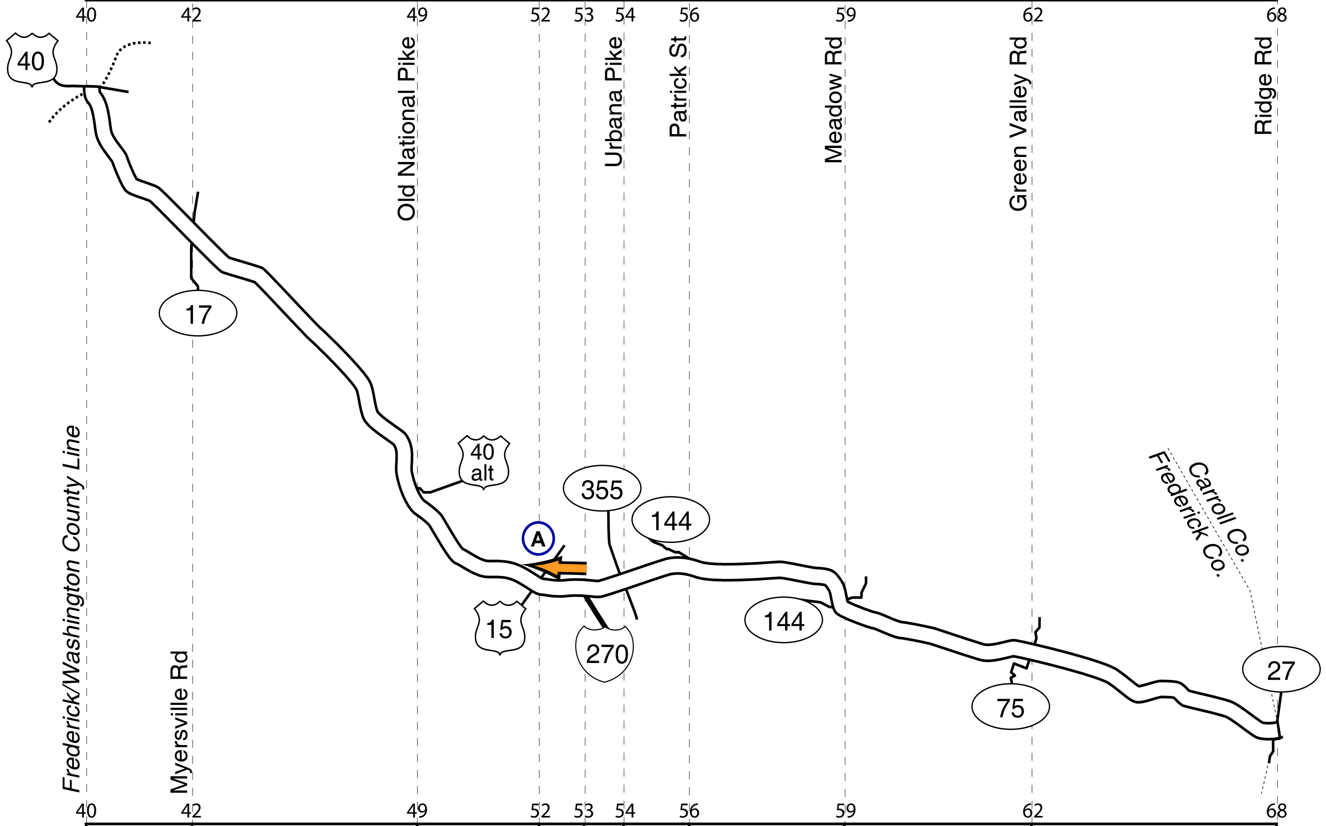
A	B	C	D	E	F
Density	Light	Moderate	Heavy	Congested	Severe

10 20 30 40 50 60 70 80 90

I-70 (MARYLAND) - EVENING

WESTBOUND ←

4:30 - 5:30 p.m.	A	C	E	E[1]	D	C	A	B	B
5:30 - 6:30 p.m.	A	C	D	E[3]	C	C	A	B	B
6:30 - 7:30 p.m.	A	B	B	B	B	B	A	A	A



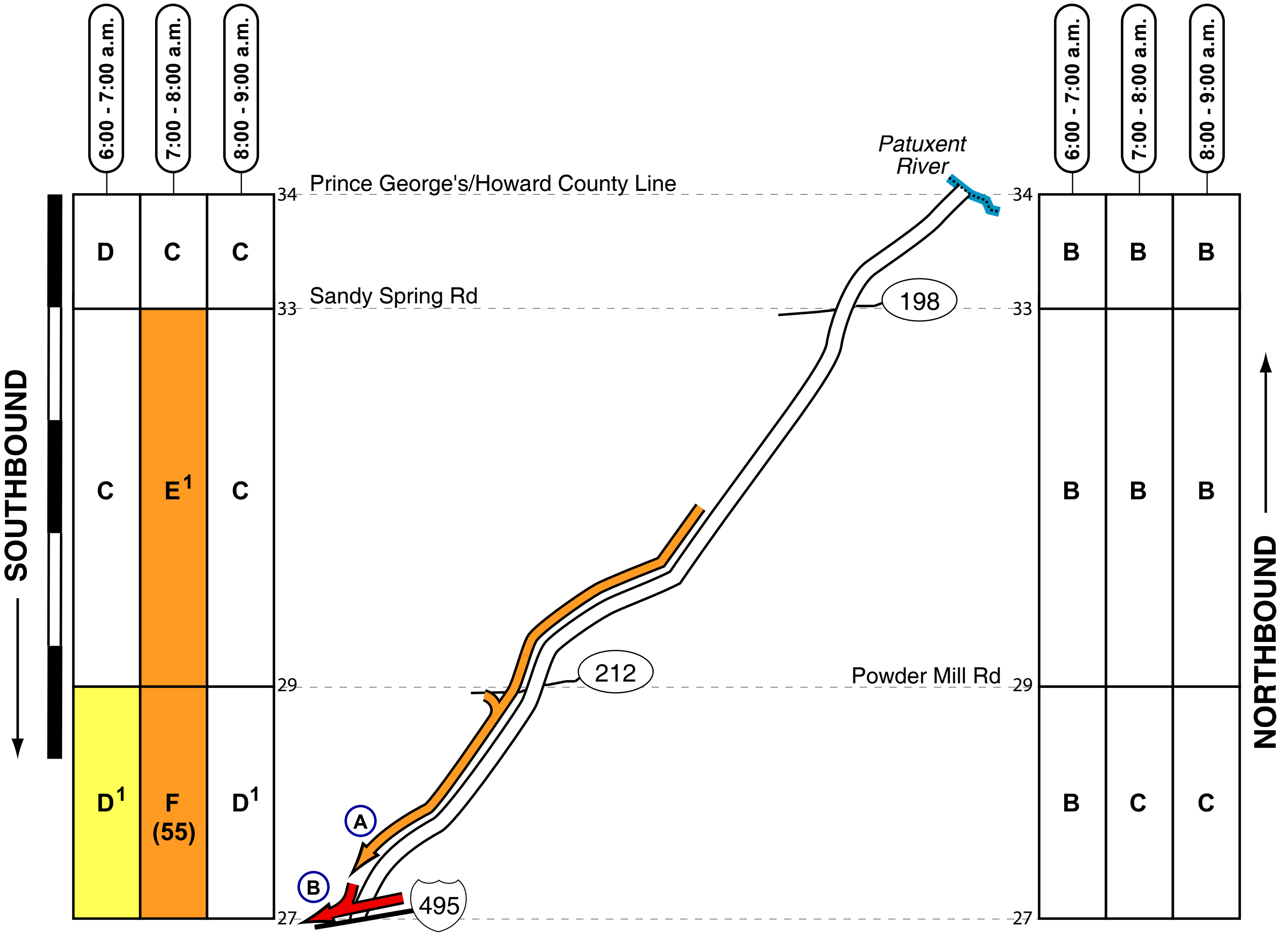
4:30 - 5:30 p.m.	A	A	B	B	C	C	B	B	A
5:30 - 6:30 p.m.	A	A	A	A	B	C	A	A	A
6:30 - 7:30 p.m.	A	A	A	A	B	B	A	A	A

EASTBOUND →

A
During most observations before 6:00 p.m., a short zone of westbound congestion was found on I-70 between I-270 and US 15 (southbound); average estimated speeds typically ranged from 30 to 50 mph. Congestion appeared to be caused or exacerbated by the merge at the US 15/I-270 interchange.

Freeway LOS Legend A B C D E F
Density 10 Light 20 Moderate 30 Heavy 40 50 Congested 60 70 80 Severe 90

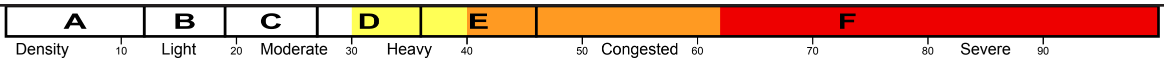
I-95 (MARYLAND) - MORNING



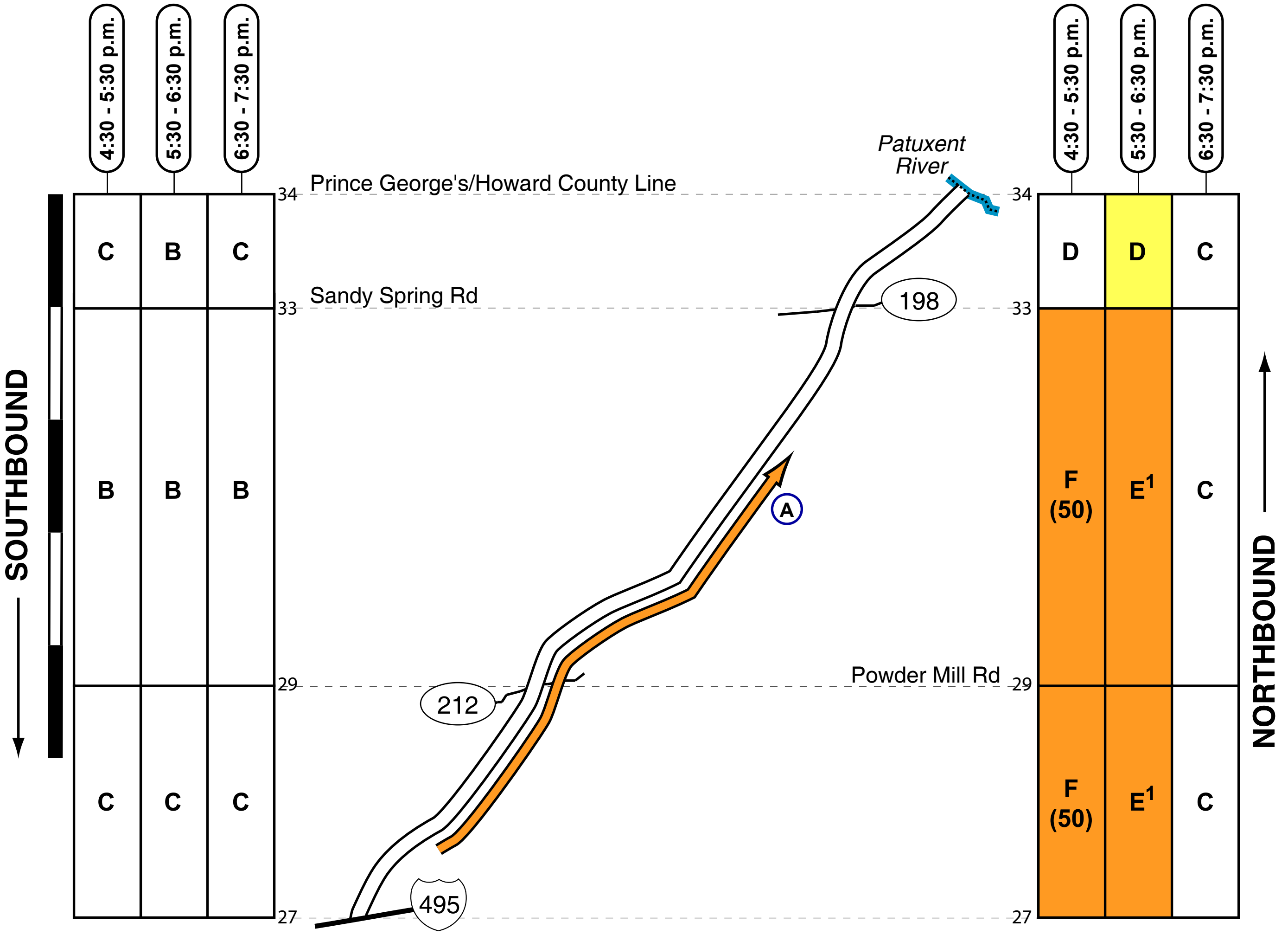
A
On some days but not others, a two to four-mile zone of southbound congestion was found on I-95 approaching the Beltway; when congested, average estimated speeds typically ranged from 30 to 50 mph. Factors that appeared to contribute to the congestion were: 1) traffic entering at Powder Mill Rd and 2) weaving associated with the I-95/I-495 split.

B
During most observations, westbound congestion on the Beltway extended back onto the I-95 ramp; however, the queue typically did not extend back onto the mainline of I-95.

Freeway LOS Legend

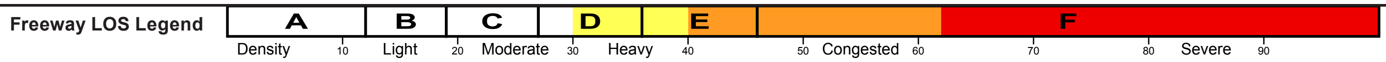


I-95 (MARYLAND) - EVENING

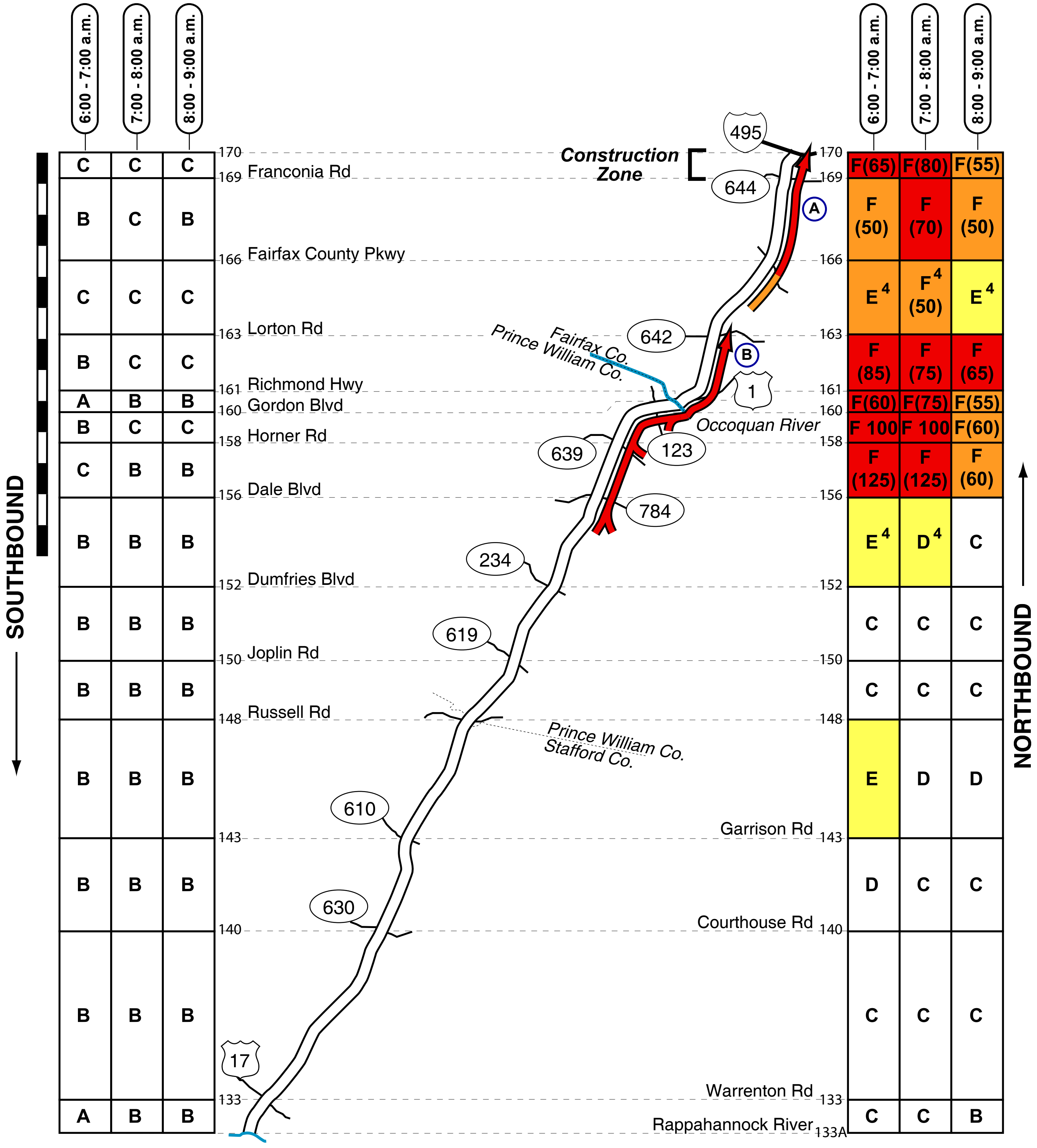


A

During most observations before 6:30 p.m., northbound congestion was found on I-95 between the Beltway and MD 198; average estimated speeds typically ranged from 35 to 50 mph.



I-95 (VIRGINIA) - MORNING



SOUTHBOUND

	6:00 - 7:00 a.m.	7:00 - 8:00 a.m.	8:00 - 9:00 a.m.
170–169	C	C	C
169–166	B	C	B
166–163	C	C	C
163–161	B	C	C
161–160	A	B	B
160–158	B	C	C
158–156	C	B	B
156–152	B	B	B
152–150	B	B	B
150–148	B	B	B
148–143	B	B	B
143–140	B	B	B
140–133	B	B	B
133–133A	A	B	B

NORTHBOUND

	6:00 - 7:00 a.m.	7:00 - 8:00 a.m.	8:00 - 9:00 a.m.
170–169	F(65)	F(80)	F(55)
169–166	F (50)	F (70)	F (50)
166–163	E^4	F^4 (50)	E^4
163–161	F (85)	F (75)	F (65)
161–160	F(60)	F(75)	F(55)
160–158	F 100	F 100	F(60)
158–156	F (125)	F (125)	F (60)
156–152	E^4	D^4	C
152–150	C	C	C
150–148	C	C	C
148–143	E	D	D
143–140	D	C	C
140–133	C	C	C
133–133A	C	C	B

Freeway LOS Legend

A	B	C	D	E	F
Density 10	Light 20	Moderate 30	Heavy 40	50 Congested 60	70 80 Severe 90

I-95 (VIRGINIA) - MORNING

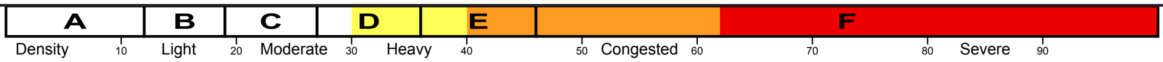
A

During most observations, an extended zone of northbound congestion was typically found on I-95 approaching the Capital Beltway; average estimated speeds typically ranged from 10 to 30 mph. The head of the queue was found on I-395, five miles north of the Beltway in the vicinity of VA 7.

B

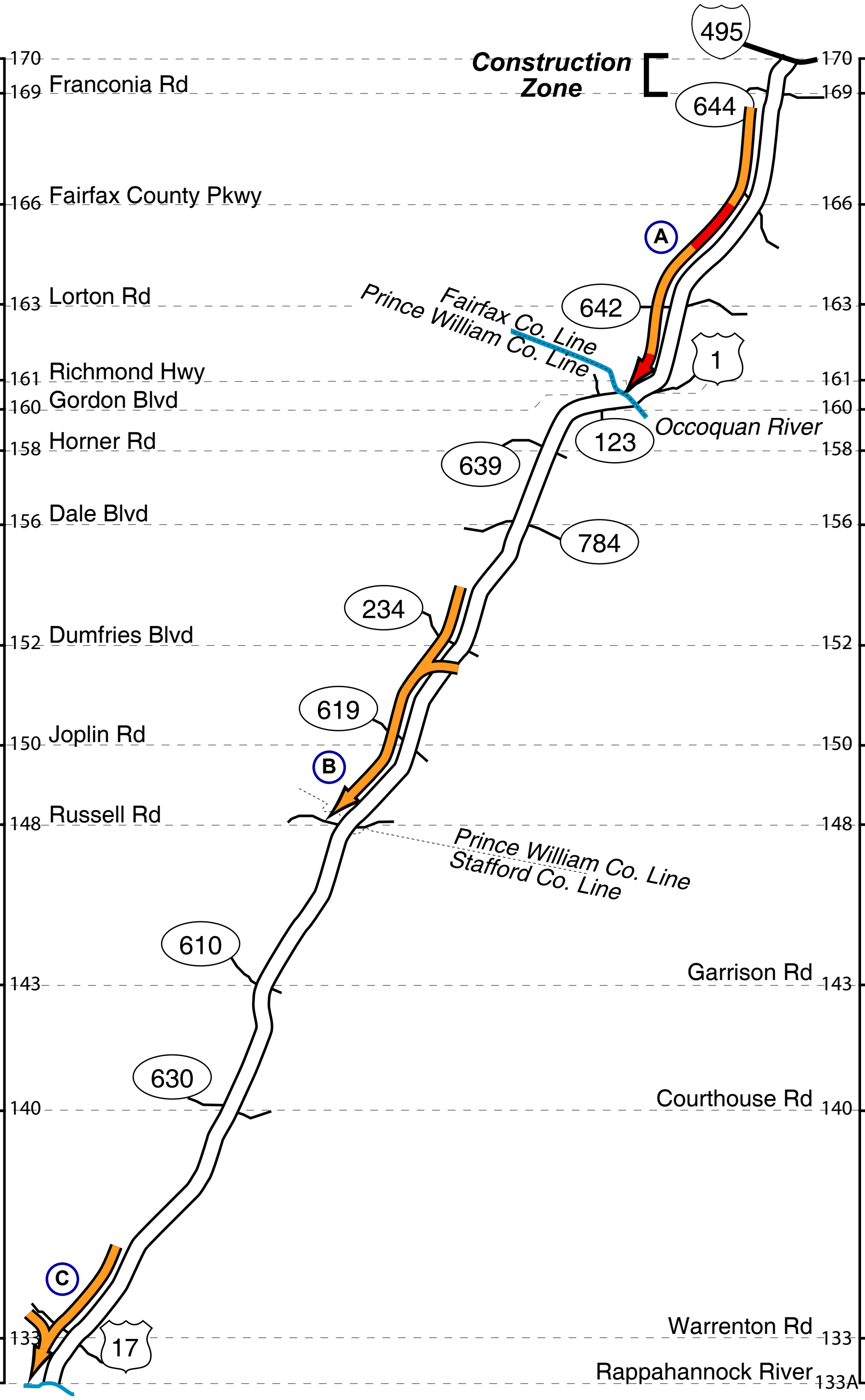
During most observations, a five to six mile zone of northbound congestion was found on I-95 between Dale Blvd and Lorton Rd; average estimated speeds typically ranged from 15 to 45 mph. Congestion appeared to be caused or exacerbated by traffic entering at the interchanges along this corridor; traffic flow typically improved north of Lorton Rd where the roadway widens from 3 lanes to 4.

Freeway LOS Legend



I-95 (VIRGINIA) - EVENING

	SOUTHBOUND 4:30 - 5:30 p.m.	SOUTHBOUND 5:30 - 6:30 p.m.	SOUTHBOUND 6:30 - 7:30 p.m.	NORTHBOUND 4:30 - 5:30 p.m.	NORTHBOUND 5:30 - 6:30 p.m.	NORTHBOUND 6:30 - 7:30 p.m.
170 - 169	D	D	C	C	C	B
169 Franconia Rd - 166	F[4] (55)	D[4]	B	C	C	C
166 Fairfax County Pkwy - 163	F (65)	E[3]	C	B	C	B
163 Lorton Rd - 161	F (50)	E[3]	C	D	B	C
161 Richmond Hwy - 160	F(46)	F[3] (65)	C	B	B	B
160 Gordon Blvd - 158	E	D	C	C	C	B
158 Horner Rd - 156	C	D	C	C	C	C
156 Dale Blvd - 152	E[4]	D[3,4]	B	C	B	B
152 Dumfries Blvd - 150	F (60)	E[3]	C	C	B	B
150 Joplin Rd - 148	E[3]	E[3]	C	C	B	B
148 Russell Rd - 143	D	D	C	C	C	B
143 Garrison Rd - 140	C	C	B	B	B	B
140 Courthouse Rd - 133	D	D	C	B	B	B
133 Warrenton Rd - 133A Rappahannock River	E[3]	E[3]	B	B	B	B



Freeway LOS Legend

A		B		C		D		E			F		
Density	10	Light	20	Moderate	30	Heavy	40		50	Congested 60	70	80 Severe	90

I-95 (VIRGINIA) - EVENING

A

During most observations before 6:00 p.m., an extended zone of southbound congestion was found on I-95 between Franconia Rd and the Occoquan River; average estimated speeds ranged widely, from 20 to 40 mph. Factors contributing to the congestion were: 1) the lane drop (4 lanes to 3) at Fairfax County Parkway and 2) the Occoquan River crossing (traffic entering at US 1 and weaving on the bridge). After 6:00 p.m. (when HOV restrictions end) congestion typically dissipated.

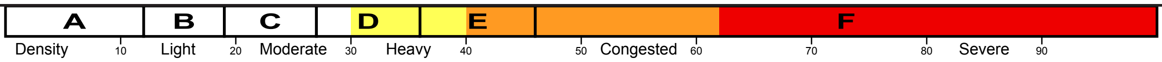
B

During most observations before 6:00 p.m., southbound congestion was found on I-95 between Dale Blvd and Russell Rd; when congested, average estimated speeds typically ranged from 25 to 50 mph. The primary bottleneck appeared to be the merge at the barrier-separated HOV terminus; south of the merge, traffic flow gradually improved.

C

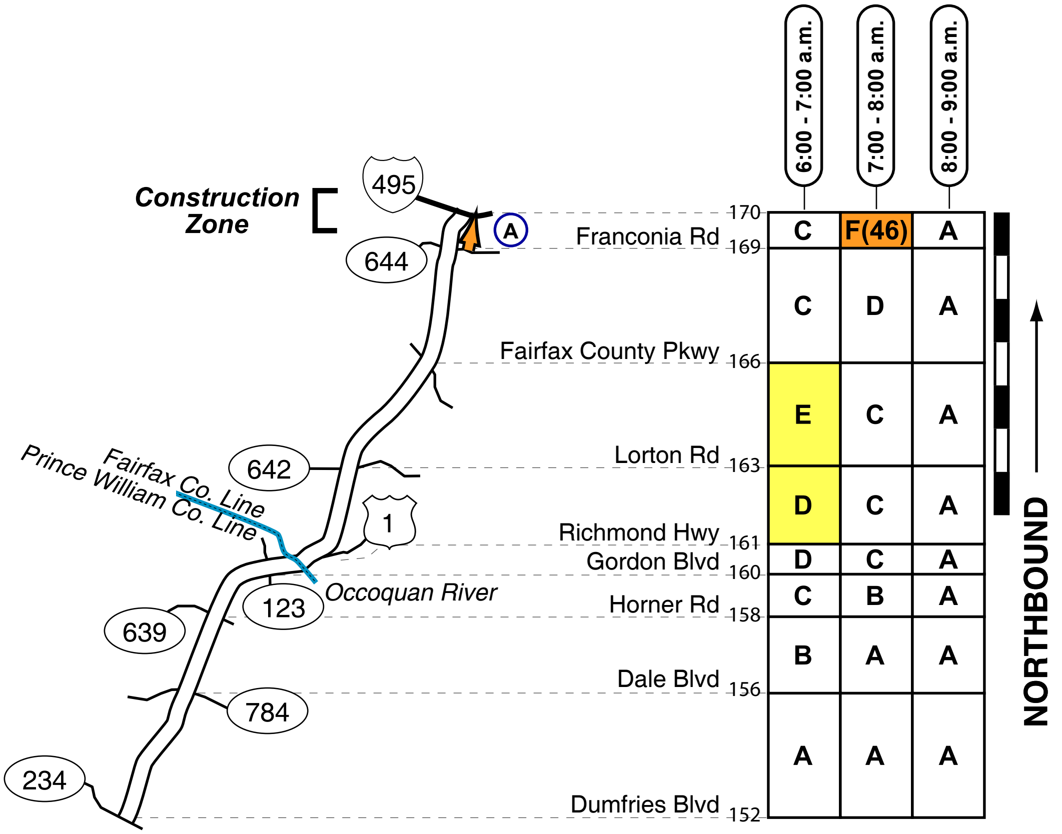
On some days but not others, a two to three-mile zone southbound congestion was found on I-95 approaching the Rappahannock River; when congested, average estimated speeds typically ranged from 40 to 50 mph. Congestion appeared to be caused or exacerbated by traffic entering at US 17.

Freeway LOS Legend



I-95 BARRIER SEPARATED HOV (VIRGINIA) - MORNING

HOV OPERATIONS
HOV 3
6:00 - 9:00 A.M.
NORTHBOUND



6:00 - 7:00 a.m.	7:00 - 8:00 a.m.	8:00 - 9:00 a.m.
C	F(46)	A
C	D	A
E	C	A
D	C	A
D	C	A
C	B	A
B	A	A
A	A	A

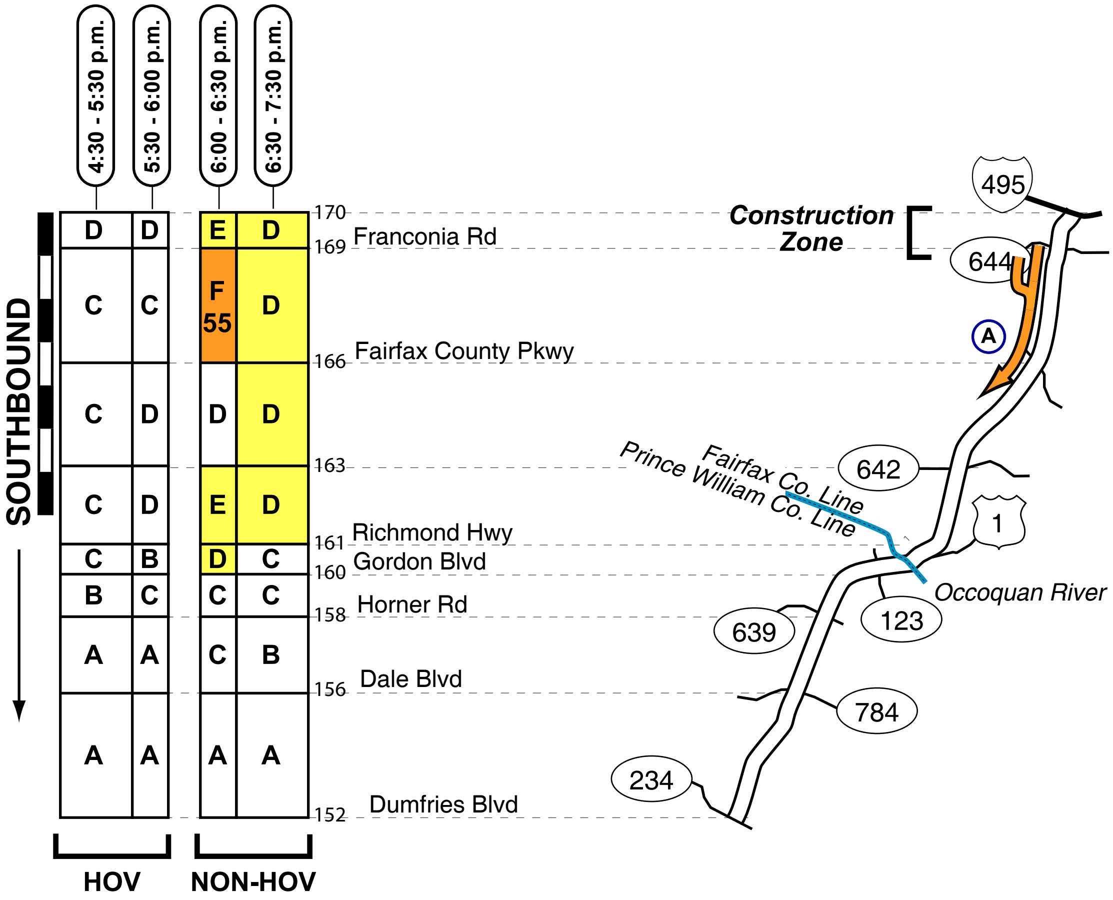
A
On some days but not others, northbound congestion was found on the HOV roadway between Fairfax County Parkway and the Beltway; when congested, average estimated speeds typically ranged from 25 to 35 mph. Factors contributing to the congestion were: 1) construction at the Springfield Interchange and 2) traffic entering at Franconia/Old Keene Mill Rd.

Freeway LOS Legend

A	B	C	D	E	F
Density 10	Light 20	Moderate 30	Heavy 40	50 Congested 60	70 80 Severe 90

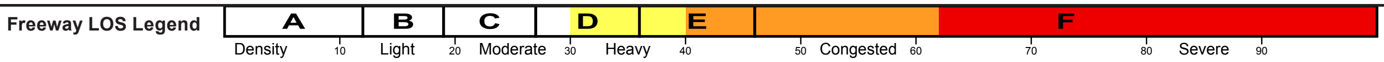
I-95 Barrier Separated HOV (Virginia) - Evening

HOV OPERATIONS
HOV 3
3:30 - 6:00 P.M.
SOUTHBOUND

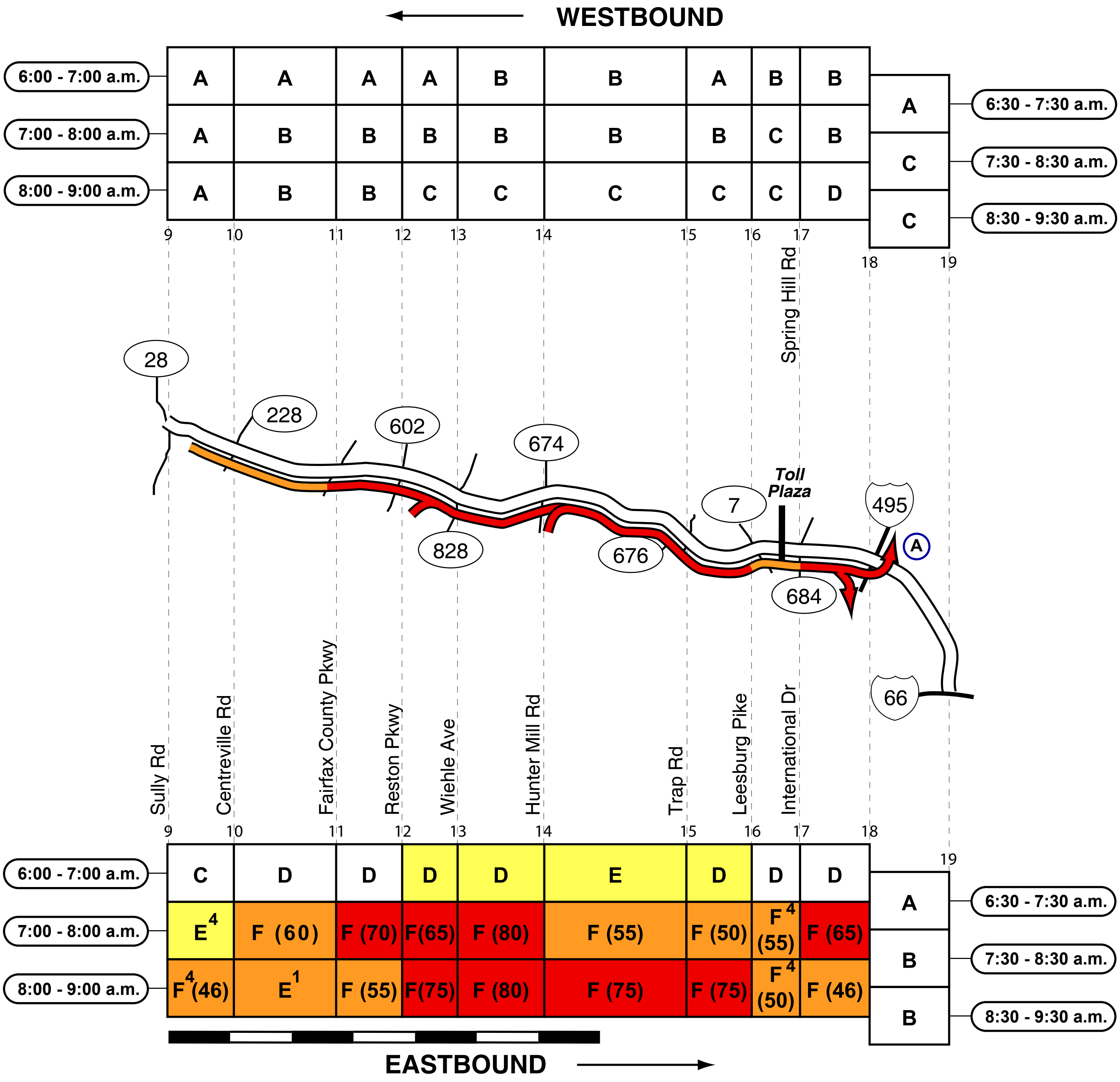


4:30 - 5:30 p.m.	5:30 - 6:00 p.m.	6:00 - 6:30 p.m.	6:30 - 7:30 p.m.
D	D	E	D
C	C	F 55	D
C	D	D	D
C	D	E	D
C	B	D	C
B	C	C	C
A	A	C	B
A	A	A	A

A
After 6:00 p.m., the left general-purpose lane typically became congested in the vicinity of Franconia-Springfield Parkway as drivers waited to cross over into the HOV roadway. Vehicles entering the HOV roadway at this location caused upstream congestion to develop. South of the HOV entrance ramp, traffic flow on the HOV roadway gradually improved.



VA 267 (Dulles Toll Road) - Morning



WESTBOUND

6:00 - 7:00 a.m.	A	A	A	A	B	B	A	B	B
7:00 - 8:00 a.m.	A	B	B	B	B	B	B	C	B
8:00 - 9:00 a.m.	A	B	B	C	C	C	C	C	D

6:30 - 7:30 a.m.	A
7:30 - 8:30 a.m.	C
8:30 - 9:30 a.m.	C

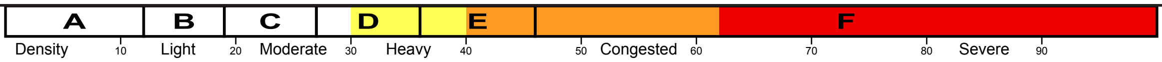
EASTBOUND

6:00 - 7:00 a.m.	C	D	D	D	D	E	D	D	D
7:00 - 8:00 a.m.	E^4	F (60)	F (70)	F(65)	F (80)	F (55)	F (50)	F^4 (55)	F (65)
8:00 - 9:00 a.m.	F^4(46)	E^1	F (55)	F(75)	F (80)	F (75)	F (75)	F^4 (50)	F (46)

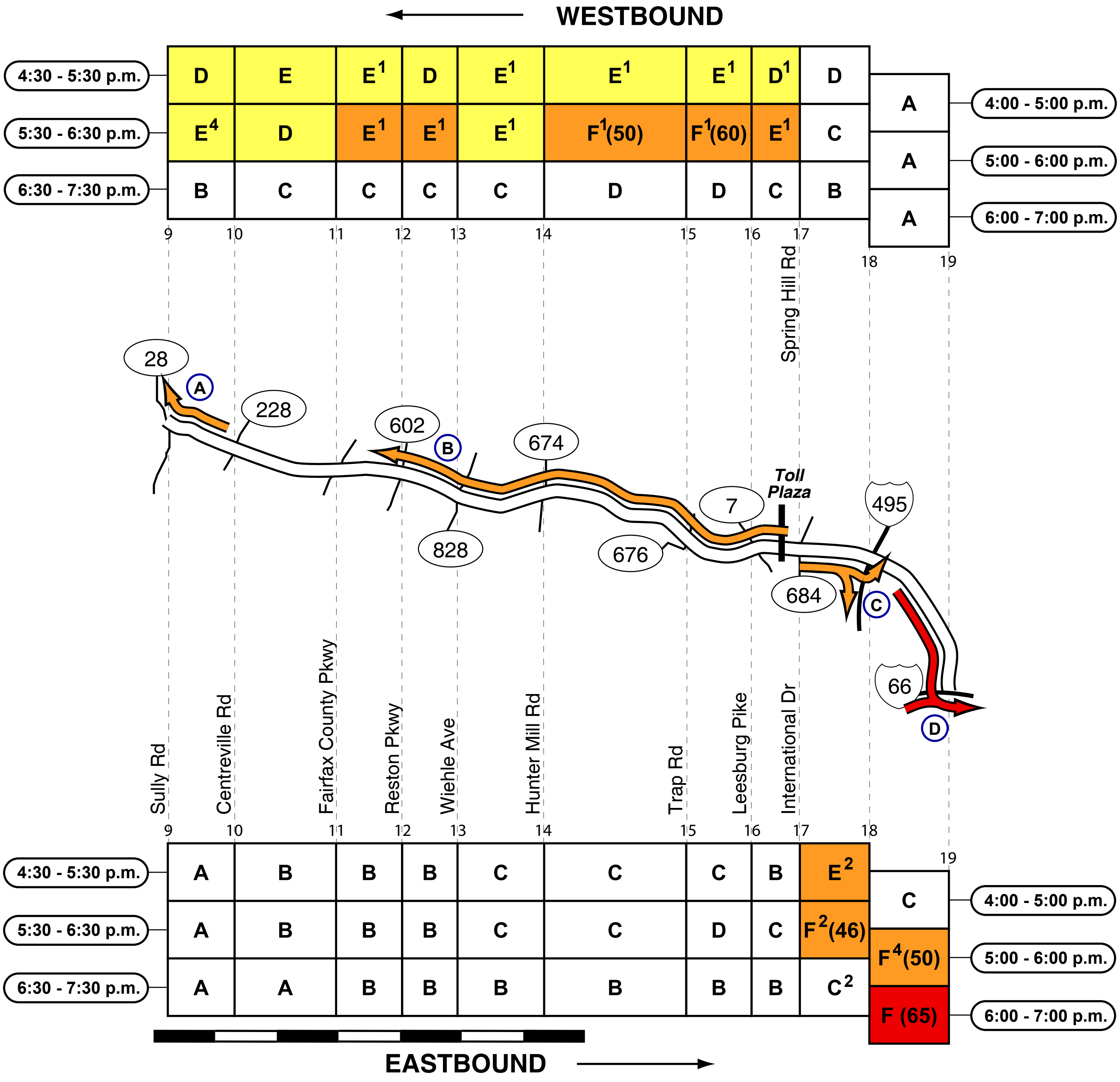
6:30 - 7:30 a.m.	A
7:30 - 8:30 a.m.	B
8:30 - 9:30 a.m.	B

A
During most observations after 7:00 a.m., an extended zone of eastbound congestion was found on VA 267 between VA 28 and the Beltway; average estimated speeds ranged widely, from 10 to 40 mph. Factors contributing to the congestion were: 1) traffic entering at Reston Parkway and Hunter Mill Rd 2) weaving associated with the high-speed EZPass lanes at the mainline toll plaza and 3) congestion on the Beltway exit ramps, that backed into the mainline of VA 267. During the peak period, congestion approaching the Beltw□
(and eventually across all lanes) of VA 267. Vehicles in the right lanes of VA 267 approaching the toll plaza typically traveled at near free-flow speeds.

Freeway LOS Legend



VA 267 (DULLES TOLL ROAD) - EVENING



WESTBOUND

4:30 - 5:30 p.m.	D	E	E[1]	D	E[1]	E[1]	E[1]	D[1]	D
5:30 - 6:30 p.m.	E[4]	D	E[1]	E[1]	E[1]	F[1](50)	F[1](60)	E[1]	C
6:30 - 7:30 p.m.	B	C	C	C	C	D	D	C	B

4:00 - 5:00 p.m.	A
5:00 - 6:00 p.m.	A
6:00 - 7:00 p.m.	A

EASTBOUND

4:30 - 5:30 p.m.	A	B	B	B	C	C	C	B	E[2]
5:30 - 6:30 p.m.	A	B	B	B	C	C	D	C	F[2](46)
6:30 - 7:30 p.m.	A	A	B	B	B	B	B	B	C[2]

4:00 - 5:00 p.m.	C
5:00 - 6:00 p.m.	F[4](50)
6:00 - 7:00 p.m.	F (65)

Freeway LOS Legend

A	B	C	D	E		F		
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80	Severe 90

VA 267 (Dulles Toll Road) - Evening

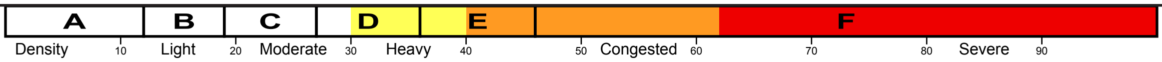
A
On some days but not others, a short zone of westbound congestion was found on VA 267 approaching VA 28. Factors contributing to the congestion were: 1) the lane drop (3 lanes to 2) in the vicinity of VA 28 and 2) congestion on the exit ramp at VA 28 (northbound), that extended back through the toll plaza and into the mainline of VA 267.

B
During most observations, westbound congestion was found on VA 267 between the mainline toll plaza and Reston Parkway; when congested, average estimated speeds typically ranged from 35 to 50 mph. Congestion was most severe approaching the lane drop (4 lanes to 3) in the vicinity of VA 7; during the peak period, average estimated speeds approaching the lane drop ranged from 15 to 25 mph.

C
During the peak period, eastbound congestion was found on VA 267 approaching the Beltway; congestion on the Beltway exit ramps extended back into the right lane of VA 267 (thru-traffic on VA 267 was typically able to bypass the queue).

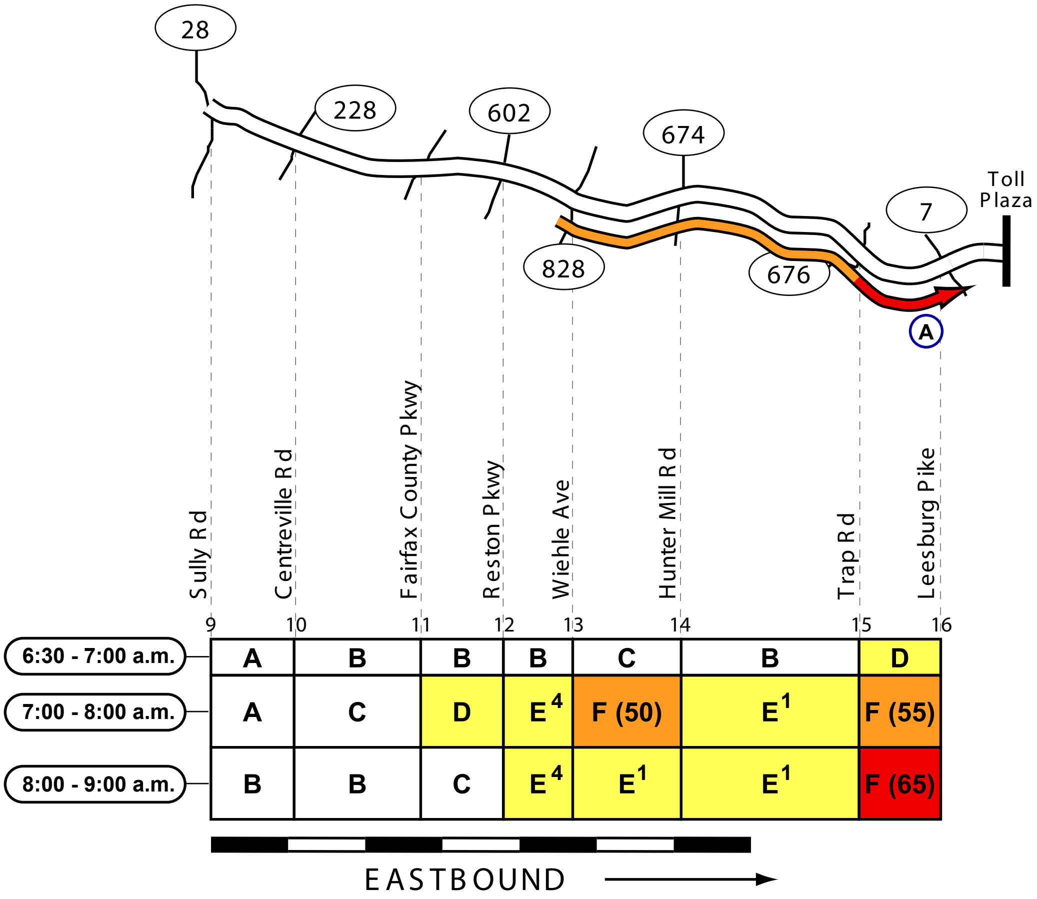
D
During most observations between 5:30 and 7:00 p.m., eastbound congestion was found on VA 267 approaching the terminus at I-66; average estimated speeds ranged from 10 to 30 mph. Congestion was caused by the merge into congested eastbound flow on I-66.

Freeway LOS Legend



VA 267 (DULLES TOLL ROAD) LEFT LANE CONCURRENT HOV - MORNING

HOV OPERATIONS
HOV 2
6:30 - 9:00 A.M.
EASTBOUND



6:30 - 7:00 a.m.	A	B	B	B	C	B	D
7:00 - 8:00 a.m.	A	C	D	E^4	F (50)	E^1	F (55)
8:00 - 9:00 a.m.	B	B	C	E^4	E^1	E^1	F (65)

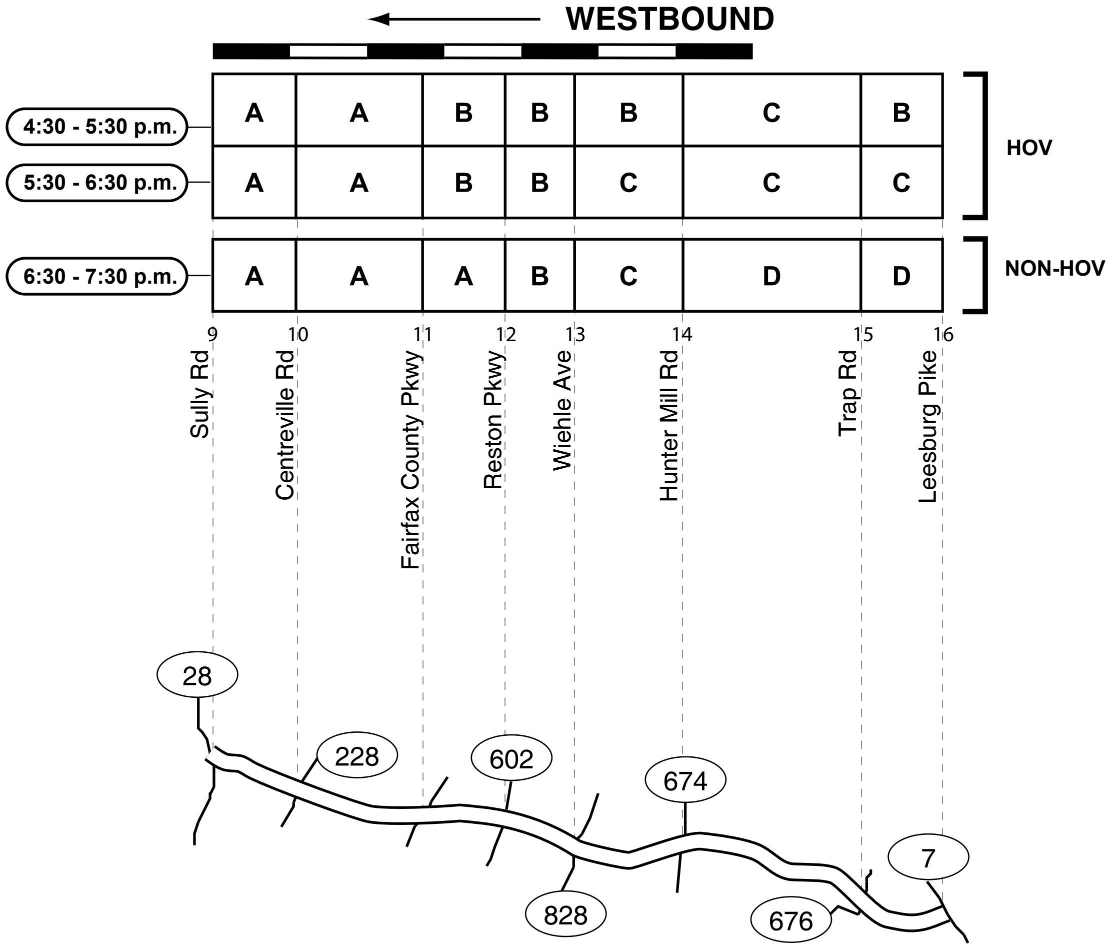
A
During most observations between 7:30 and 8:30 a.m., eastbound congestion was found in the VA 267 HOV facility (left lane) between the vicinity of Reston Parkway and the mainline toll plaza; average estimated speeds typically ranged from 20 to 40 mph. The head of the queue was found where HOV users encountered congestion in the dedicated EZPass lanes at the mainline toll plaza.

Freeway LOS Legend

A	B	C	D	E	F
Density 10	Light 20	Moderate 30	Heavy 40	50 Congested 60	70 80 Severe 90

VA 267 (DULLES TOLL ROAD) LEFT LANE CONCURRENT HOV - EVENING

HOV OPERATIONS
HOV 2
4:00 - 6:30 P.M.
WESTBOUND



4:30 - 5:30 p.m.	A	A	B	B	B	C	B	HOV
5:30 - 6:30 p.m.	A	A	B	B	C	C	C	
6:30 - 7:30 p.m.	A	A	A	B	C	D	D	NON-HOV
	9 Sully Rd – 10 Centreville Rd	10 Centreville Rd – 11 Fairfax County Pkwy	11 Fairfax County Pkwy – 12 Reston Pkwy	12 Reston Pkwy – 13 Wiehle Ave	13 Wiehle Ave – 14 Hunter Mill Rd	14 Hunter Mill Rd – 15 Trap Rd	15 Trap Rd – 16 Leesburg Pike	

Freeway LOS Legend

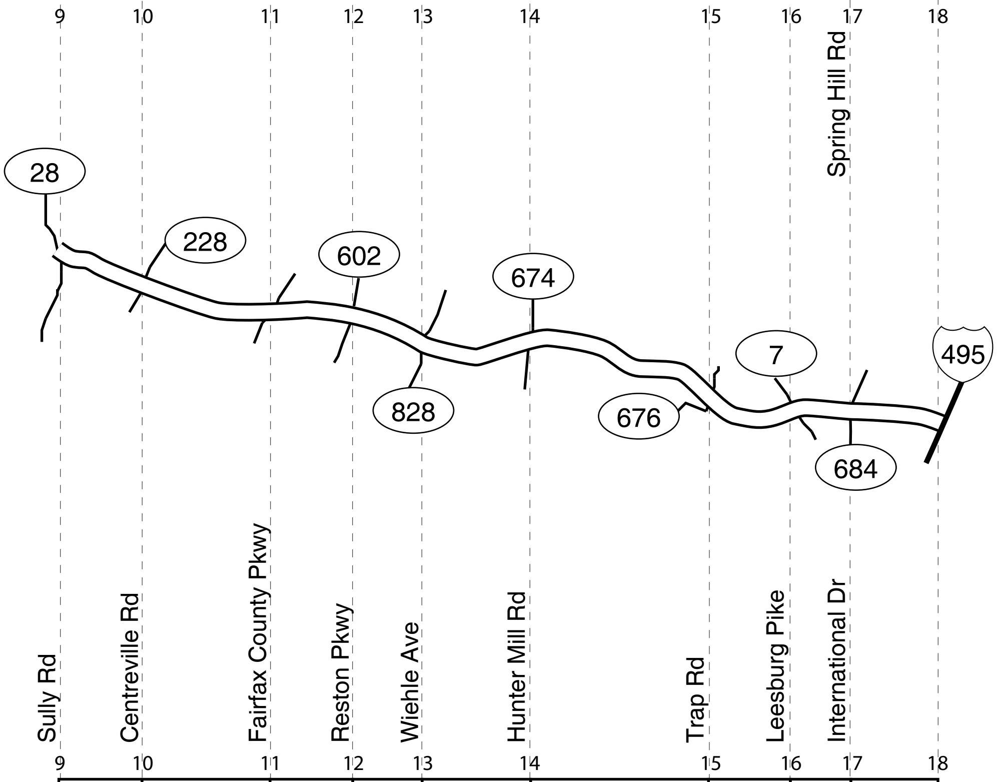
A	B	C	D	E	F

Density 10 Light 20 Moderate 30 Heavy 40 50 Congested 60 70 80 Severe 90

VA 267 (Dulles Airport Access Road) - Morning

WESTBOUND

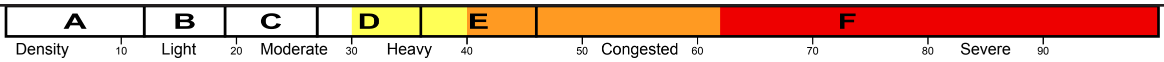
6:00 - 7:00 a.m.	B	B	A	A	A	A	A	A	A
7:00 - 8:00 a.m.	B	A	A	A	A	A	A	A	A
8:00 - 9:00 a.m.	A	A	A	A	A	A	A	A	A



6:00 - 7:00 a.m.	A	A	A	A	A	A	A	A	A
7:00 - 8:00 a.m.	B	B	B	B	A	B	A	A	A
8:00 - 9:00 a.m.	B	A	A	A	B	A	A	A	A

EASTBOUND

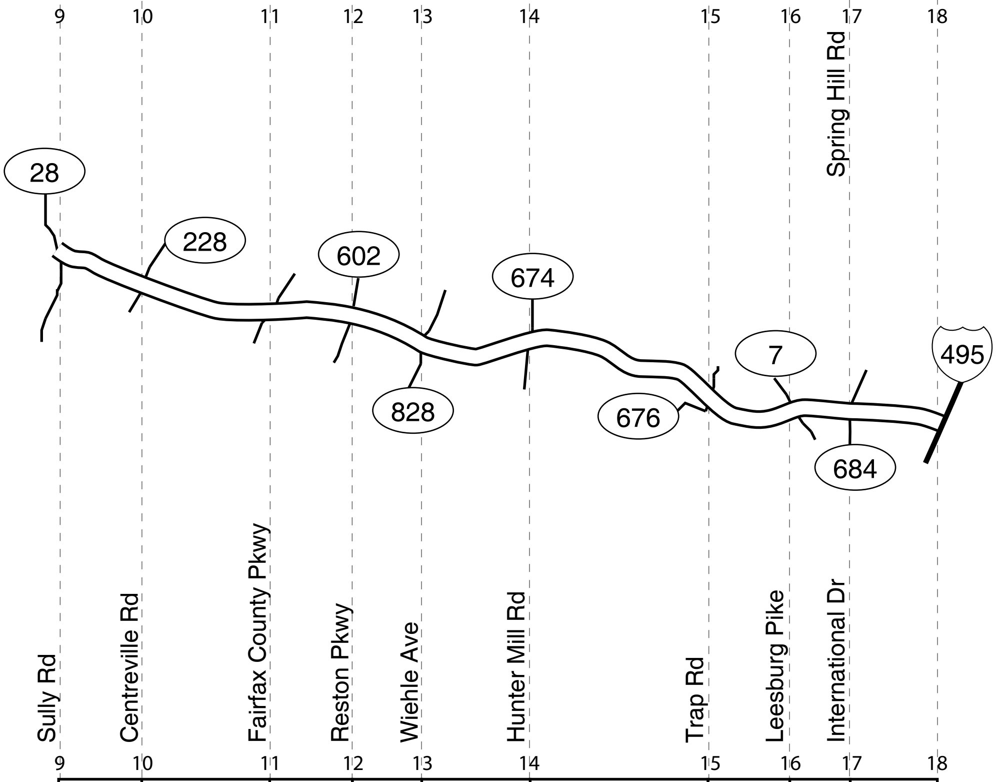
Freeway LOS Legend



VA 267 (Dulles Airport Access Road) - Evening

WESTBOUND ←

4:30 - 5:30 p.m.	B	A	B	B	A	A	A	A	A
5:30 - 6:30 p.m.	B	A	A	A	A	A	A	A	A
6:30 - 7:30 p.m.	A	A	A	A	A	A	A	A	A



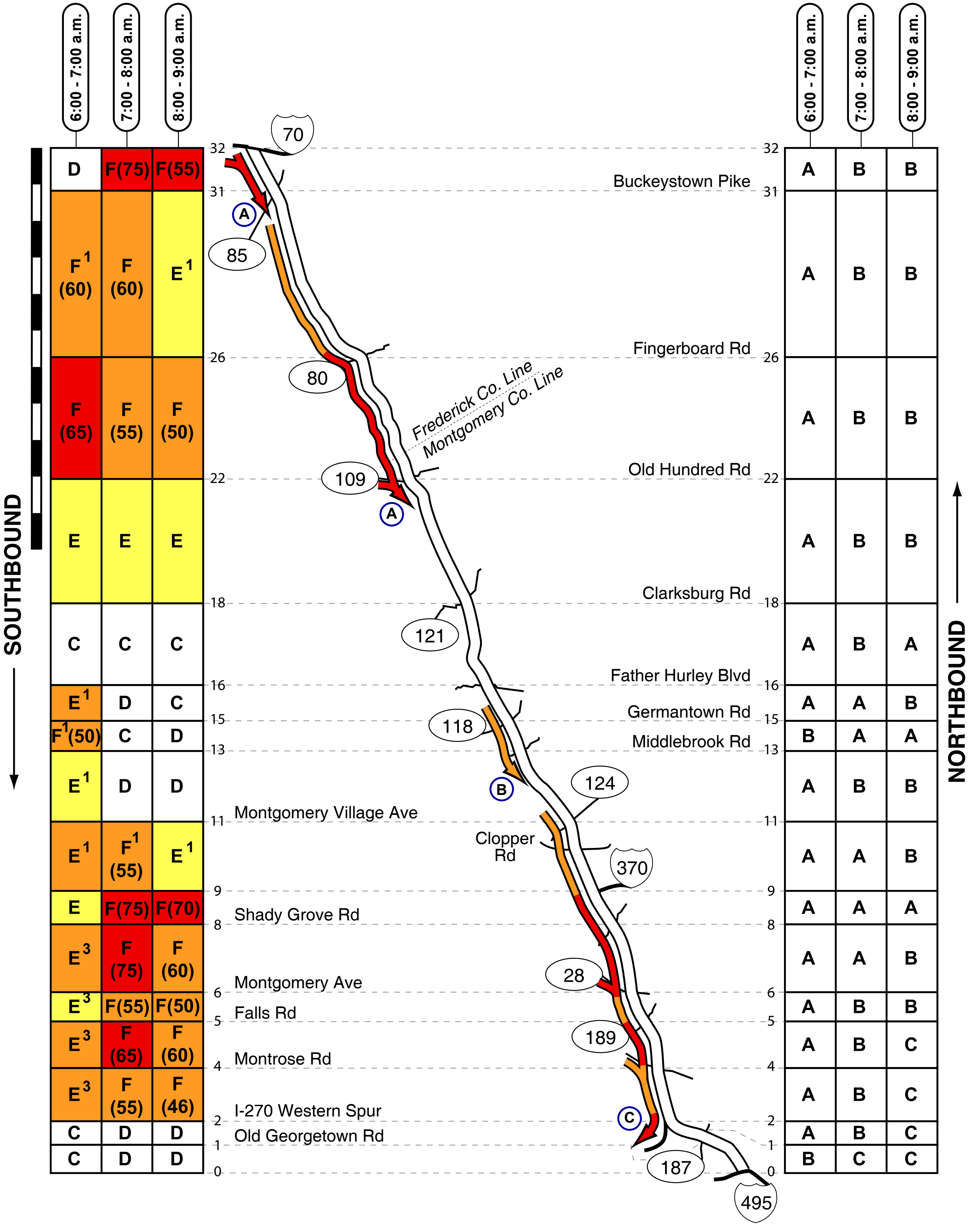
4:30 - 5:30 p.m.	B	B	B	B	B	A	B	A	A
5:30 - 6:30 p.m.	A	A	A	A	A	A	A	A	A
6:30 - 7:30 p.m.	A	A	A	A	A	A	A	A	A

EASTBOUND →

Freeway LOS Legend

A	B	C	D	E	F
Density 10	Light 20	Moderate 30	Heavy 40	50 Congested 60	70 80 Severe 90

I-270 (MARYLAND) - MORNING



SOUTHBOUND

6:00 - 7:00 a.m.	7:00 - 8:00 a.m.	8:00 - 9:00 a.m.
D	F(75)	F(55)
F^1 (60)	F (60)	E^1
F (65)	F (55)	F (50)
E	E	E
C	C	C
E^1	D	C
F^1(50)	C	D
E^1	D	D
E^1	F^1 (55)	E^1
E	F(75)	F(70)
E^3	F (75)	F (60)
E^3	F(55)	F(50)
E^3	F (65)	F (60)
E^3	F (55)	F (46)
C	D	D
C	D	D

NORTHBOUND

6:00 - 7:00 a.m.	7:00 - 8:00 a.m.	8:00 - 9:00 a.m.
A	B	B
A	B	B
A	B	B
A	B	B
A	B	A
A	A	B
B	A	A
A	B	B
A	A	B
A	A	A
A	A	B
A	B	B
A	B	C
A	B	C
A	B	C
B	C	C

Freeway LOS Legend

A	B	C	D	E	F
Density 10	Light 20	Moderate 30	Heavy 40	50 Congested 60	70 80 Severe 90

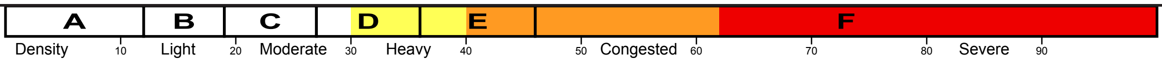
I-270 (Maryland) - Morning

A
Throughout most of the morning survey period, southbound congestion was found on I-270 between I-70 and MD 109; average estimated speeds typically ranged from 20 to 50 mph. Congestion was most severe where traffic entered at I-70; the presence of heavy commercial vehicles climbing the series of steep grades between MD 85 and MD 121 may have exacerbated the congestion.

B
On some days but not others, a short zone of southbound congestion was found on I-270 between Father Hurley Blvd and Middlebrook Rd; when congested, average estimated speeds ranged from approximately 30 to 50 mph. Congestion appeared to be caused or exacerbated by traffic entering at Germantown Rd.

C
During most observations after 6:30 a.m., a nine to eleven-mile zone of southbound congestion was found on I-270 between Montgomery Village Ave and the I-270/I-270 spur split; average estimated speeds ranged widely, from 15 to 50 mph. The primary bottleneck was found at the entrance ramp from the local lanes in the vicinity of MD 28.

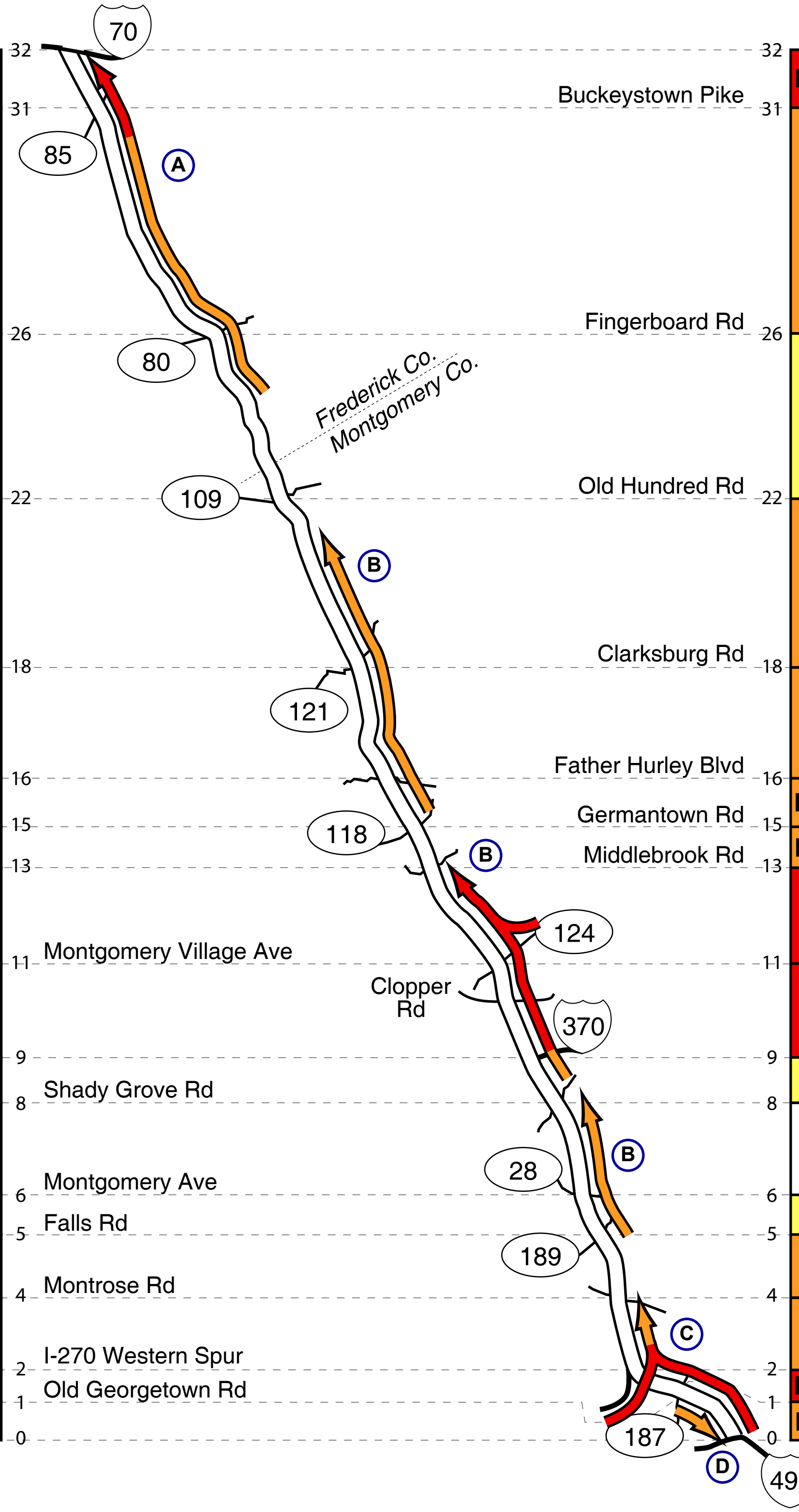
Freeway LOS Legend



I-270 (MARYLAND) - EVENING

SOUTHBOUND

	4:30 - 5:30 p.m.	5:30 - 6:30 p.m.	6:30 - 7:30 p.m.
32	C	B	B
31	B	B	B
26	B	B	A
22	B	B	B
18	B	A	A
16	B	B	B
15	B	B	A
13	B	B	A
11	C	B	B
9	B	B	B
8	B	B	B
6	B	B	B
5	B	B	B
4	C	C	B
2	C	C	B
1	F[1](55)	F[1](50)	B



NORTHBOUND

	4:30 - 5:30 p.m.	5:30 - 6:30 p.m.	6:30 - 7:30 p.m.
32	F(65)	E[1]	C
31	F[3] (46)	E[3]	C
26	D	E[3]	C
22	F (46)	E[3]	C
18	F (60)	E[3]	B
16	F(60)	C	B
15	F(50)	D	C
13	F (65)	F (55)	C
11	F (65)	F (70)	C
9	E	F[3](46)	C
8	D	E[3]	C
6	E	E[3]	D
5	E	E[3]	D
4	F (46)	F (50)	E
2	F(65)	F(90)	D
1	F(60)	F(70)	C

Freeway LOS Legend

A	B	C	D	E	F
Density	Light	Moderate	Heavy	Congested	Severe

10 20 30 40 50 60 70 80 90

I-270 (MARYLAND) - EVENING

A

During most observations before 6:00 p.m., northbound congestion was found on I-270 between MD 80 and I-70; average estimated speeds typically ranged from 20 to 40 mph. The primary bottleneck was found at the entrance ramp from I-70 (westbound); the presence of heavy commercial vehicles climbing the series of steep grades between MD 80 and MD 85 may have exacerbated the congestion.

B

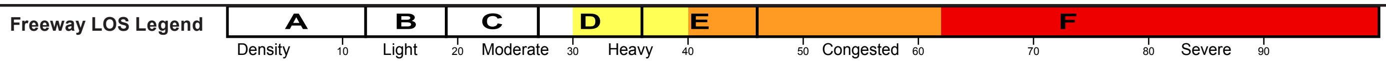
During most observations before 6:30 p.m., northbound congestion was found along the I-270 corridor between the vicinity of Falls Rd and MD 109; average estimated speeds ranged widely, from 15 to 50 mph. Factors contributing to the congestion were: 1) traffic entering at the terminus of the local lanes at Montgomery Village Ave and 2) the lane drop (3 lanes to 2) at the HOV terminus north of Clarksburg Road.

C

During most observations before 6:30 p.m., a one to three-mile zone of northbound congestion was found on I-270 between the Beltway and Montrose Rd; average estimated speeds typically ranged from 10 and 40 mph. Factors contributing to the congestion were: 1) traffic entering at Old Georgetown Rd and 2) the merge with the I-270 western spur.

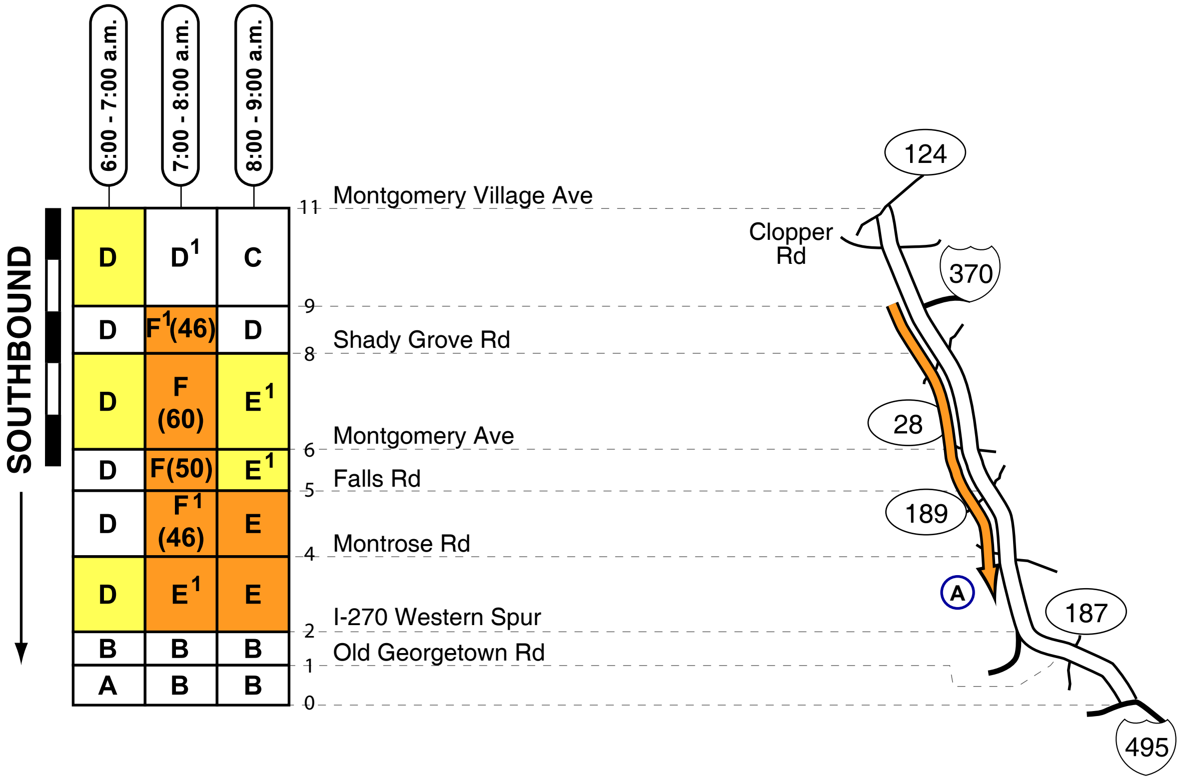
D

On some days but not others, southbound congestion was found on I-270 between Old Georgetown Rd and the Beltway; when congested, average estimated speeds typically ranged from 10 to 30 mph. Congestion was caused by the merge into congested flow on the inner loop of the Beltway.



I-270 (MARYLAND) LEFT LANE / CONCURRENT FLOW HOV - MORNING

HOV OPERATIONS
HOV 2
6:00 - 9:00 A.M.
SOUTHBOUND



	6:00 - 7:00 a.m.	7:00 - 8:00 a.m.	8:00 - 9:00 a.m.
11–9	D	D[1]	C
9–8	D	F[1](46)	D
8–6	D	F (60)	E[1]
6–5	D	F(50)	E[1]
5–4	D	F[1] (46)	E
4–2	D	E[1]	E
2–1	B	B	B
1–0	A	B	B

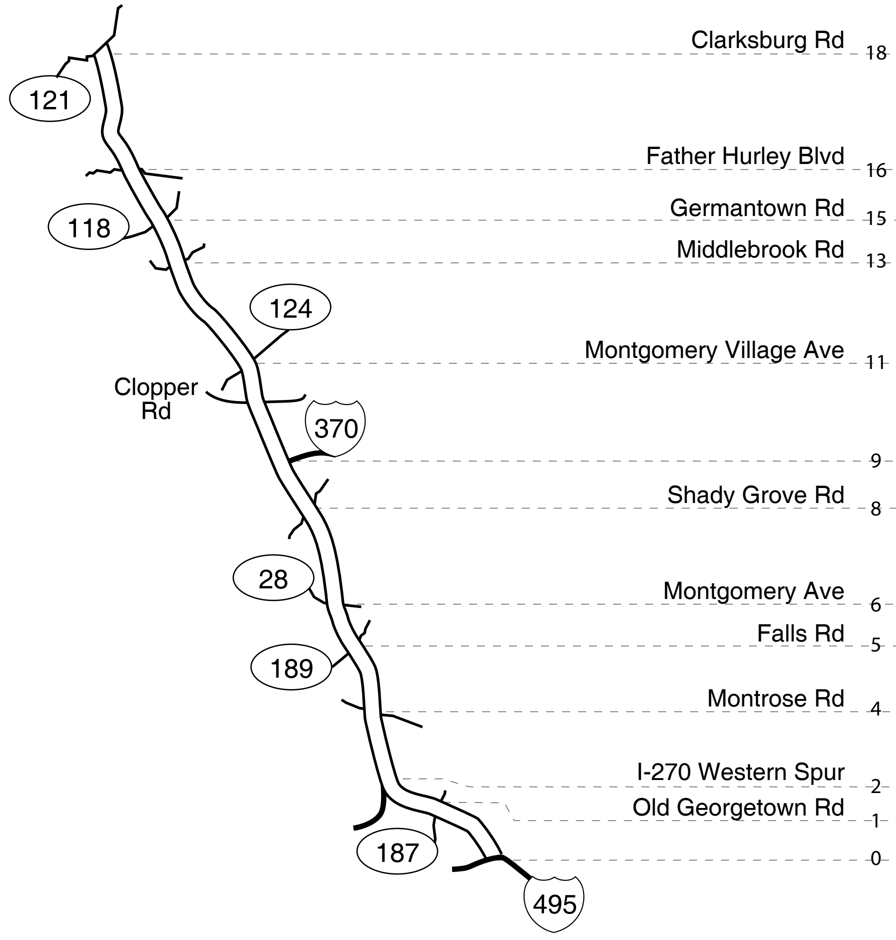
A
During most observations after 7:00 a.m., southbound congestion was found on the I-270 HOV facility (left lane) between the vicinity of I-370 and the I-270 western spur; average estimated speeds typically ranged from 25 to 50 mph. Vehicles entering the express lanes in the vicinity of MD 28 appeared to exacerbate the congestion.

Freeway LOS Legend

A	B	C	D	E	F
Density 10	Light 20	Moderate 30	Heavy 40	50 Congested 60	70 80 Severe 90

I-270 (MARYLAND) LEFT LANE / CONCURRENT FLOW HOV - EVENING

HOV OPERATIONS
HOV 2
3:30 - 6:30 P.M.
NORTHBOUND



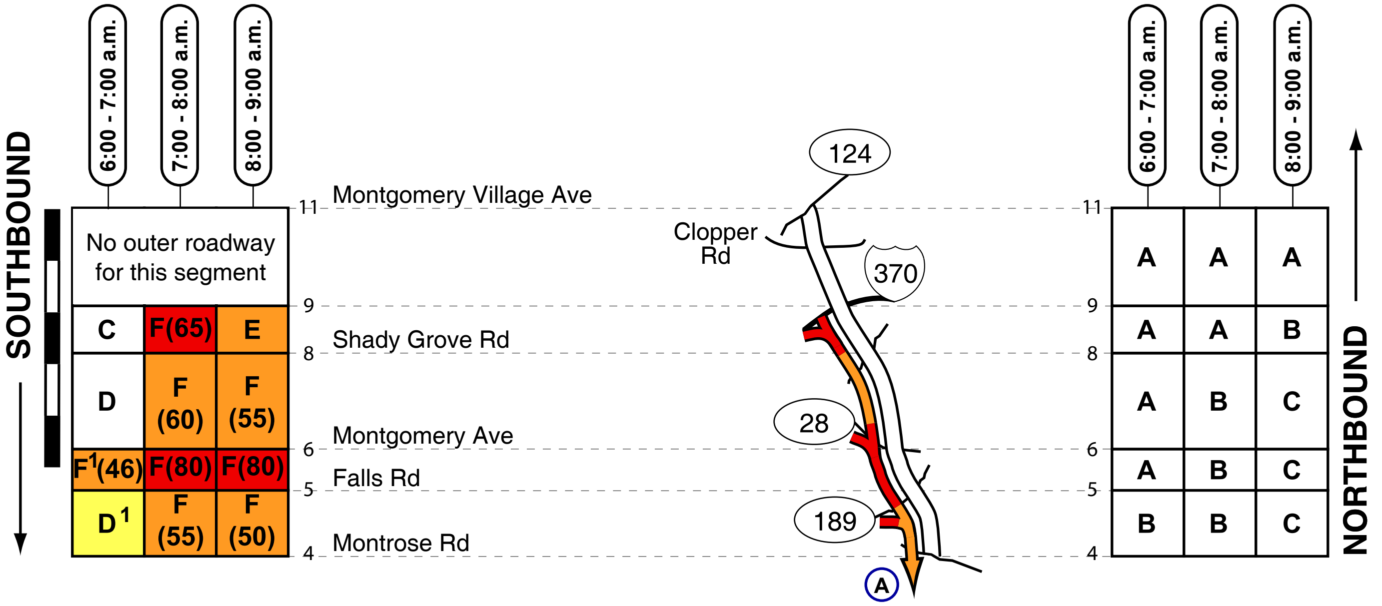
	HOV		NON-HOV
	4:30 - 5:30 p.m.	5:30 - 6:30 p.m.	6:30 - 7:30 p.m.
18	D	C	B
16	B	A	B
15	B	A	C
13	D	C	C
11	D	C	B
9	C	C	B
8	C	B	C
6	C	C	D
5	D	C	D
4	D	C	D
2	B	C	C
1	B	C	C
0			

NORTHBOUND

Freeway LOS Legend

A	B	C	D	E	F
Density 10	Light 20	Moderate 30	Heavy 40	50 Congested 60	70 80 Severe 90

I-270 LOCAL LANES - MORNING



SOUTHBOUND

	6:00 - 7:00 a.m.	7:00 - 8:00 a.m.	8:00 - 9:00 a.m.
11–9	No outer roadway for this segment		
9–8	C	F(65)	E
8–6	D	F (60)	F (55)
6–5	F[1](46)	F(80)	F(80)
5–4	D[1]	F (55)	F (50)

NORTHBOUND

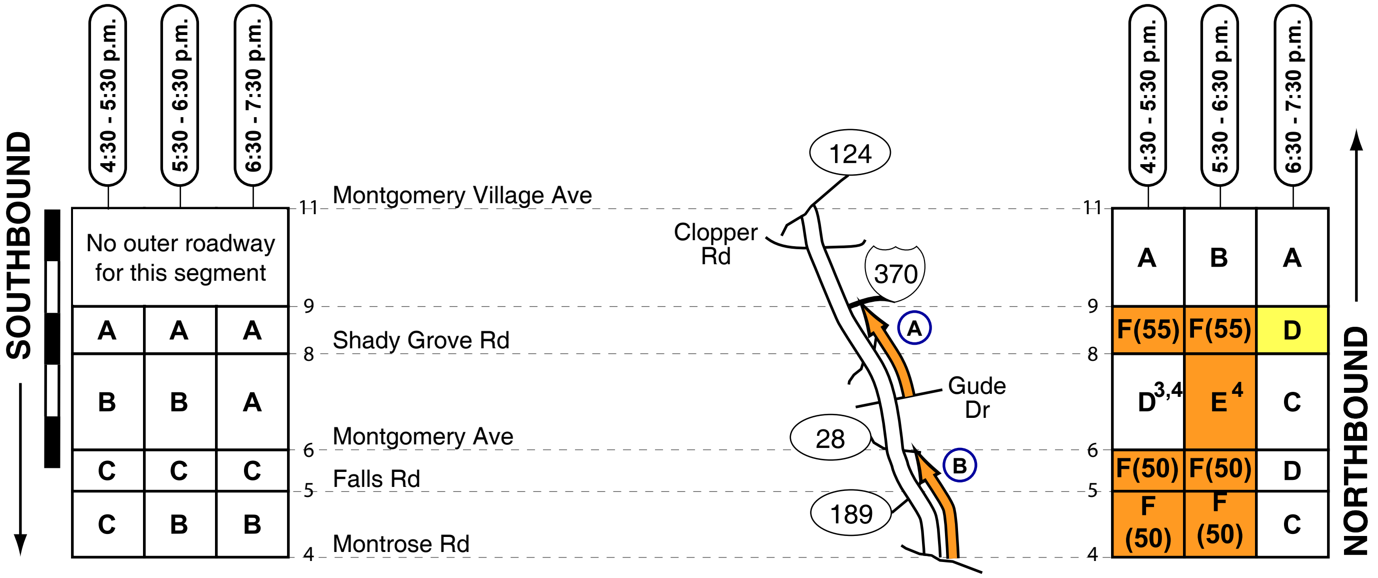
	6:00 - 7:00 a.m.	7:00 - 8:00 a.m.	8:00 - 9:00 a.m.
11–9	A	A	A
9–8	A	A	B
8–6	A	B	C
6–5	A	B	C
5–4	B	B	C

A
During most observations, an extended zone of southbound congestion was found in the I-270 local lanes between I-370 and Montrose Rd (Local Lane terminus); average estimated speeds typically ranged from 20 to 40 mph. Factors contributing to the congestion were: 1) traffic entering at the series of interchanges along this corridor and 2) weaving associated with vehicles entering and exiting the local lanes to/from the express lanes.

Freeway LOS Legend

A	B	C	D	E	F
Density 10	Light 20	Moderate 30	Heavy 40	50 Congested 60	70 80 Severe 90

I-270 LOCAL LANES - EVENING



SOUTHBOUND

4:30 - 5:30 p.m.	5:30 - 6:30 p.m.	6:30 - 7:30 p.m.
No outer roadway for this segment		
A	A	A
B	B	A
C	C	C
C	B	B

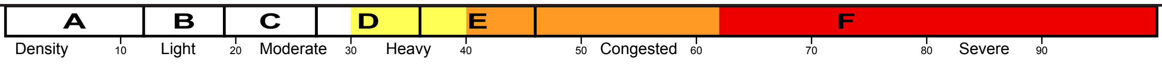
NORTHBOUND

4:30 - 5:30 p.m.	5:30 - 6:30 p.m.	6:30 - 7:30 p.m.
A	B	A
F(55)	F(55)	D
$D^{3,4}$	E^{4}	C
F(50)	F(50)	D
F (50)	F (50)	C

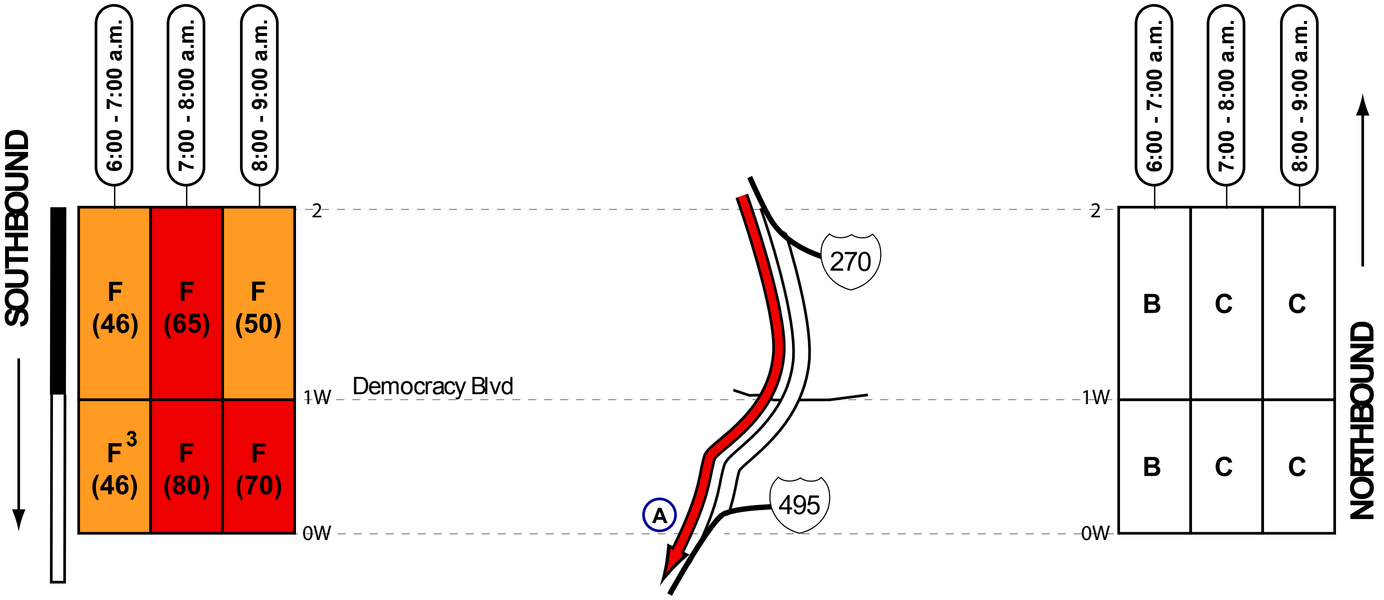
A
During most observations before 6:30 p.m., northbound congestion was found in the I-270 local lanes between Gude Dr and I-370; average estimated speeds typically ranged from 25 to 50 mph. Traffic entering from Shady Grove Rd and the mainline of I-270 appeared to cause or exacerbate the congestion.

B
During most observations before 6:30 p.m., northbound congestion was found in the I-270 local lanes between Montrose Rd and MD 28; average estimated speeds typically ranged from 30 to 50 mph. Traffic entering from Falls Rd and the mainline of I-270 appeared to cause or exacerbate the congestion.

Freeway LOS Legend



I-270 WESTERN SPUR (MARYLAND) - MORNING



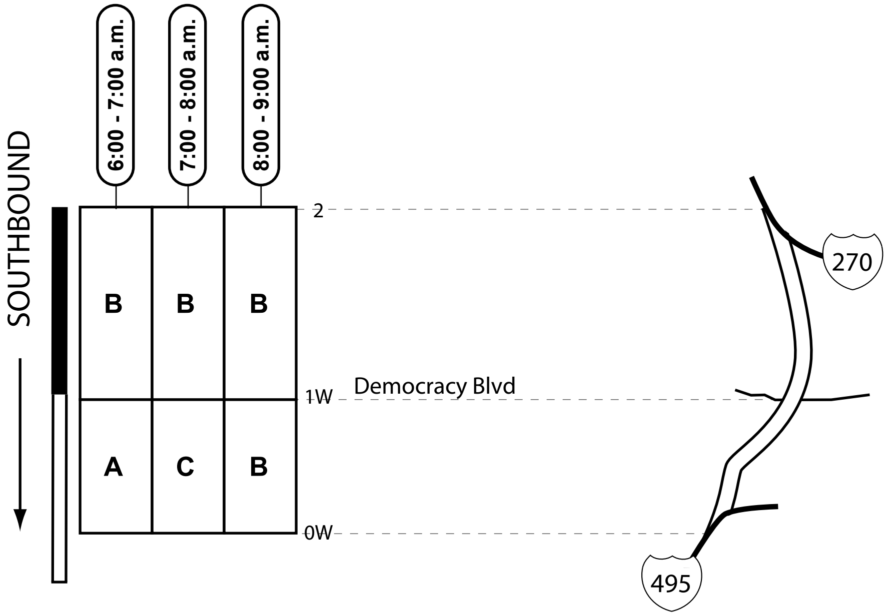
6:00 - 7:00 a.m.	7:00 - 8:00 a.m.	8:00 - 9:00 a.m.
F (46)	F (65)	F (50)
F[3] (46)	F (80)	F (70)

6:00 - 7:00 a.m.	7:00 - 8:00 a.m.	8:00 - 9:00 a.m.
B	C	C
B	C	C

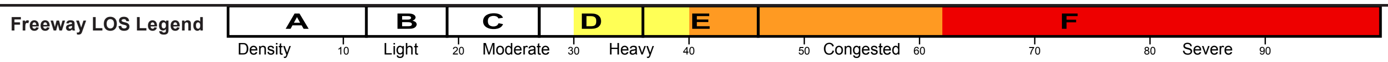
A
During most observations after 6:30 a.m., southbound congestion was found on the I-270 western spur; average estimated speeds typically ranged from 20 to 40 mph. The head of the queue was found at the merge at the Beltway.

I-270 WESTERN SPUR (MARYLAND)
LEFT LANE / CONCURRENT FLOW HOV - MORNING

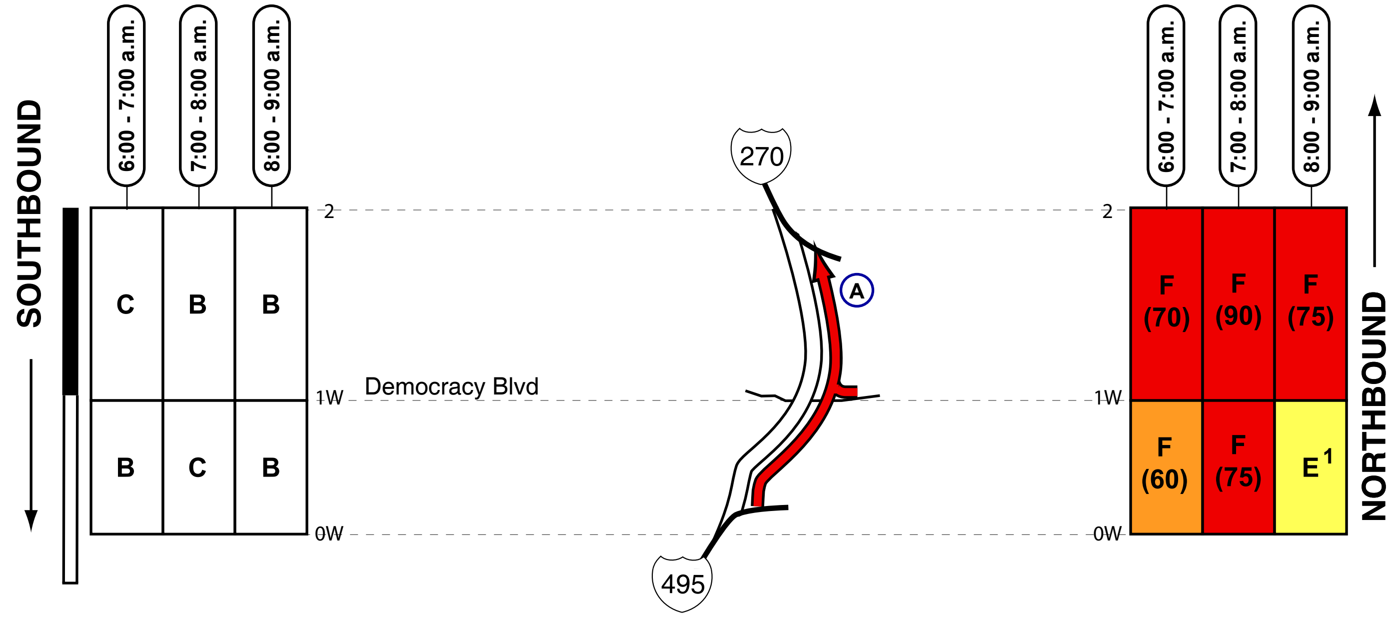
HOV OPERATIONS
HOV 2
6:00 - 9:00 A.M.
SOUTHBOUND



6:00 - 7:00 a.m.	7:00 - 8:00 a.m.	8:00 - 9:00 a.m.
B	B	B
A	C	B



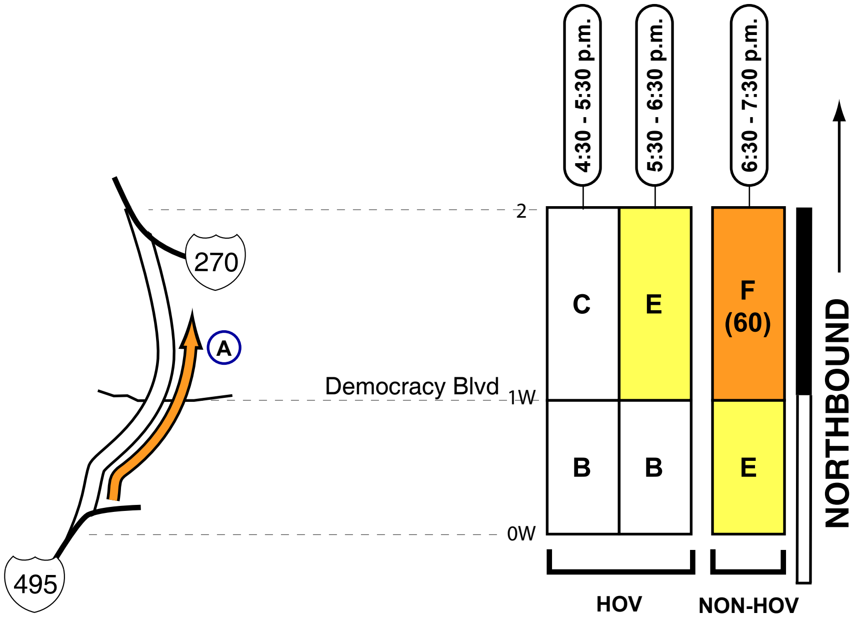
I-270 Western Spur (Maryland) - Evening



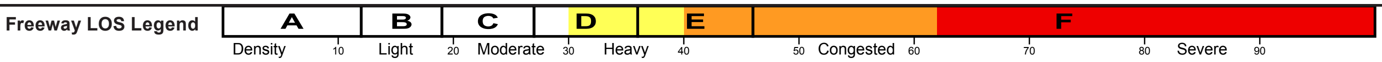
A
Throughout the evening survey period, northbound congestion was found on the I-270 western spur; average estimated speeds ty□
merge at I-270.

I-270 Western Spur (Maryland)
Left Lane / Concurrent Flow HOV - Evening

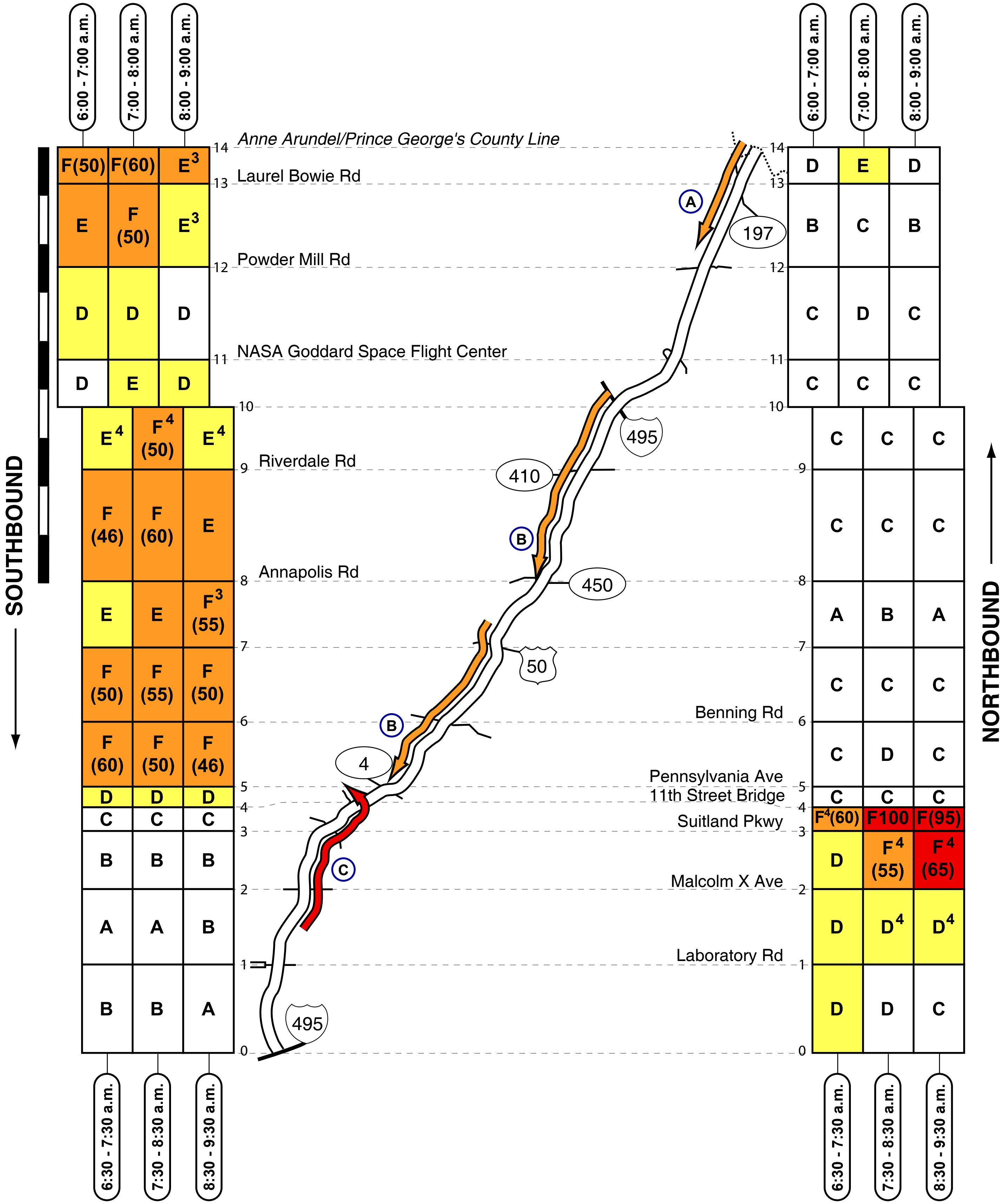
HOV OPERATIONS
HOV 2
3:30 - 6:30 P.M.
NORTHBOUND



A
After 6:30 p.m. (HOV restrictions end), northbound congestion was found in the left lane between Democracy Blvd and I-270; average estimated speeds typically ranged from 25 to 50 mph.



I-295/D.C. 295/KENILWORTH AVE/MD 295 - MORNING



SOUTHBOUND

	6:00 - 7:00 a.m.	7:00 - 8:00 a.m.	8:00 - 9:00 a.m.
14–13	F(50)	F(60)	E³
13–12	E	F (50)	E³
12–11	D	D	D
11–10	D	E	D

	6:30 - 7:30 a.m.	7:30 - 8:30 a.m.	8:30 - 9:30 a.m.
10–9	E⁴	F⁴ (50)	E⁴
9–8	F (46)	F (60)	E
8–7	E	E	F³ (55)
7–6	F (50)	F (55)	F (50)
6–5	F (60)	F (50)	F (46)
5–4	D	D	D
4–3	C	C	C
3–2	B	B	B
2–1	A	A	B
1–0	B	B	A

NORTHBOUND

	6:00 - 7:00 a.m.	7:00 - 8:00 a.m.	8:00 - 9:00 a.m.
14–13	D	E	D
13–12	B	C	B
12–11	C	D	C
11–10	C	C	C

	6:30 - 7:30 a.m.	7:30 - 8:30 a.m.	8:30 - 9:30 a.m.
10–9	C	C	C
9–8	C	C	C
8–7	A	B	A
7–6	C	C	C
6–5	C	D	C
5–4	C	C	C
4–3	F⁴(60)	F100	F(95)
3–2	D	F⁴ (55)	F⁴ (65)
2–1	D	D⁴	D⁴
1–0	D	D	C

Freeway LOS Legend

A	B	C	D	E	F
Density 10	Light 20	Moderate 30	Heavy 40	50 Congested 60	70 80 Severe 90

I-295/D.C. 295/KENILWORTH AVE/MD 295 - MORNING

A

During most observations before 8:30 a.m., southbound congestion was found on the MD 295 between the vicinity of the Anne Arundel/Prince George's County Line and Powder Mill Rd (MD 212); average estimated speeds typically ranged from 25 to 50 mph. The primary bottleneck was found where traffic entered at the MD 197.

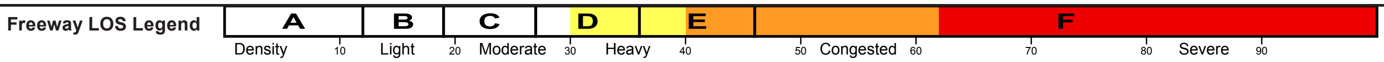
B

During most observations, a short zone of southbound congestion was found on the MD 295 between the Beltway and MD 450; when congested, average estimated speeds typically ranged from 30 to 50 mph. Traffic flow typically improved in the vicinity of MD 450 where the roadway widened from 2 lanes to 3.

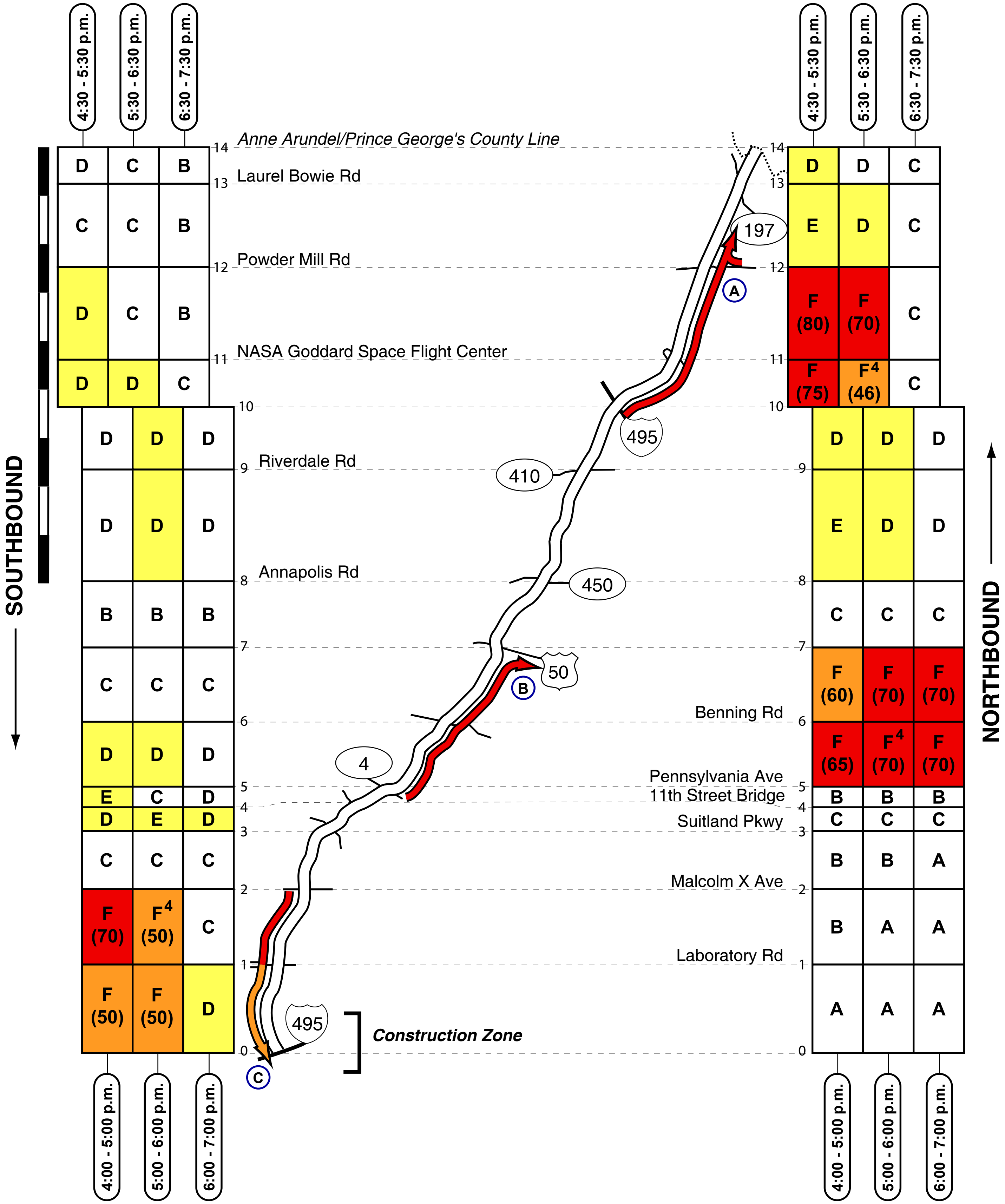
Further south, southbound congestion was found on Kenilworth Ave/DC 295 between the US 50 and Pennsylvania Ave; average estimated speeds typically ranged from 25 to 50 mph. The primary bottleneck was found at the lane drop (3 lanes to 2) at East Capitol St.

C

During most observations, stop-and-go northbound congestion was found on I-295 approaching the exit queue on the ramp to the 11th Street Bridge; average estimated speeds typically ranged from 5 to 35 mph. At its maximum observed extent, the tail of the queue was found in the vicinity of Malcolm X Ave (a distance of approximately 2 miles).



I-295/D.C. 295/KENILWORTH AVE/MD 295 - EVENING



SOUTHBOUND

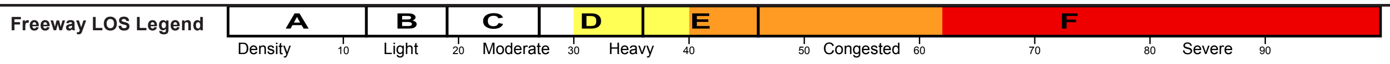
4:30 - 5:30 p.m.	5:30 - 6:30 p.m.	6:30 - 7:30 p.m.
D	C	B
C	C	B
D	C	B
D	D	C

4:00 - 5:00 p.m.	5:00 - 6:00 p.m.	6:00 - 7:00 p.m.
D	D	D
D	D	D
B	B	B
C	C	C
D	D	D
E	C	D
D	E	D
C	C	C
F (70)	F^4 (50)	C
F (50)	F (50)	D

NORTHBOUND

4:30 - 5:30 p.m.	5:30 - 6:30 p.m.	6:30 - 7:30 p.m.
D	D	C
E	D	C
F (80)	F (70)	C
F (75)	F^4 (46)	C

4:00 - 5:00 p.m.	5:00 - 6:00 p.m.	6:00 - 7:00 p.m.
D	D	D
E	D	D
C	C	C
F (60)	F (70)	F (70)
F (65)	F^4 (70)	F (70)
B	B	B
C	C	C
B	B	A
B	A	A
A	A	A



I-295/D.C. 295/Kenilworth Ave/MD 295 - Evening

A

During most observations before 6:30 p.m., northbound congestion was found on MD 295 between the Beltway and Powder Mill Rd; average estimated speeds typically ranged from 15 to 30 mph. The primary bottleneck was found where traffic entered at Powder Mill Rd; just north of Powder Mill Rd, the roadway widens from 2 to 3 lanes (up to MD 197).

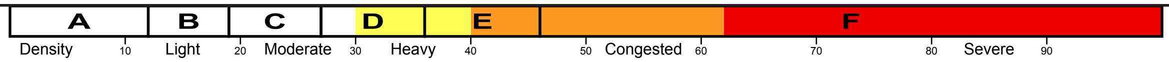
B

During most observations, a three to four-mile zone of northbound congestion was found on D.C. 295/Kenilworth Ave/MD 295 between Pennsylvania Ave and US 50; average estimated speeds ranged widely, from 15 to 45 mph. The head of the queue was found on the ramp to US 50 (eastbound).

C

During most observations before 6:00 p.m., southbound congestion was found on I-295 between South Capitol St and the Beltway; average estimated speeds ranged widely, from 20 to 50 mph. Traffic entering at South Capitol St and Laboratory Rd appeared to cause or exacerbate the congestion. Ongoing construction in the vicinity of the I-495 interchange may also have contributed to the congestion.

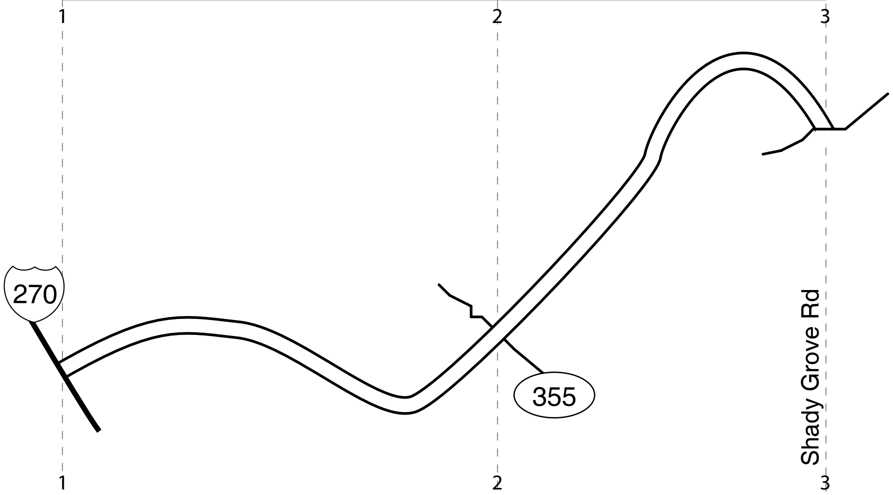
Freeway LOS Legend



I-370 - MORNING

← **WESTBOUND**

6:00 - 7:00 a.m.	B	A
7:00 - 8:00 a.m.	B	B
8:00 - 9:00 a.m.	B	B



6:00 - 7:00 a.m.	A	A
7:00 - 8:00 a.m.	B	B
8:00 - 9:00 a.m.	A	B

EASTBOUND →

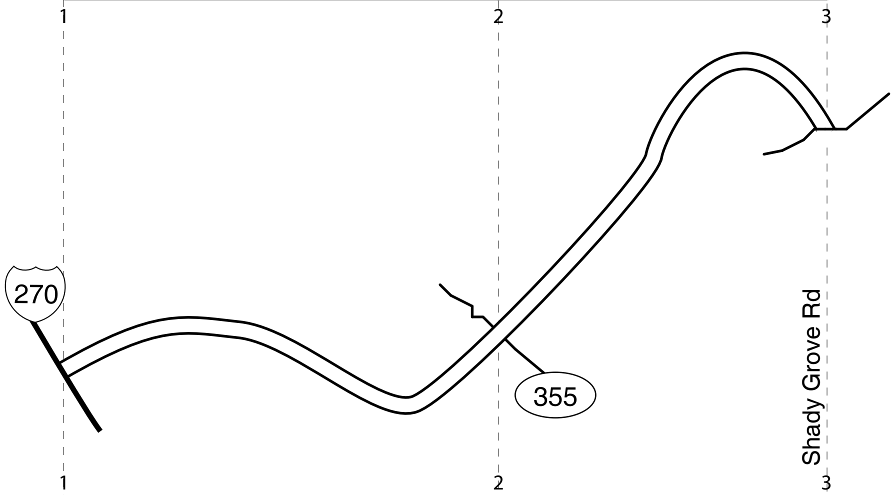
Freeway LOS Legend

A	B	C	D	E	F
Density 10	Light 20	Moderate 30	Heavy 40	50 Congested 60	70 80 Severe 90

I-370 - EVENING

← **WESTBOUND**

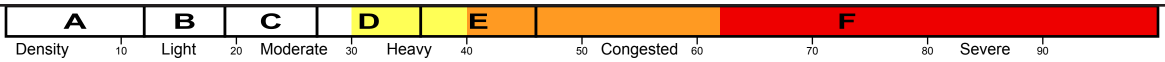
4:30 - 5:30 p.m.	B	C
5:30 - 6:30 p.m.	B	B
6:30 - 7:30 p.m.	A	C



4:30 - 5:30 p.m.	A	B
5:30 - 6:30 p.m.	A	A
6:30 - 7:30 p.m.	A	A

EASTBOUND →

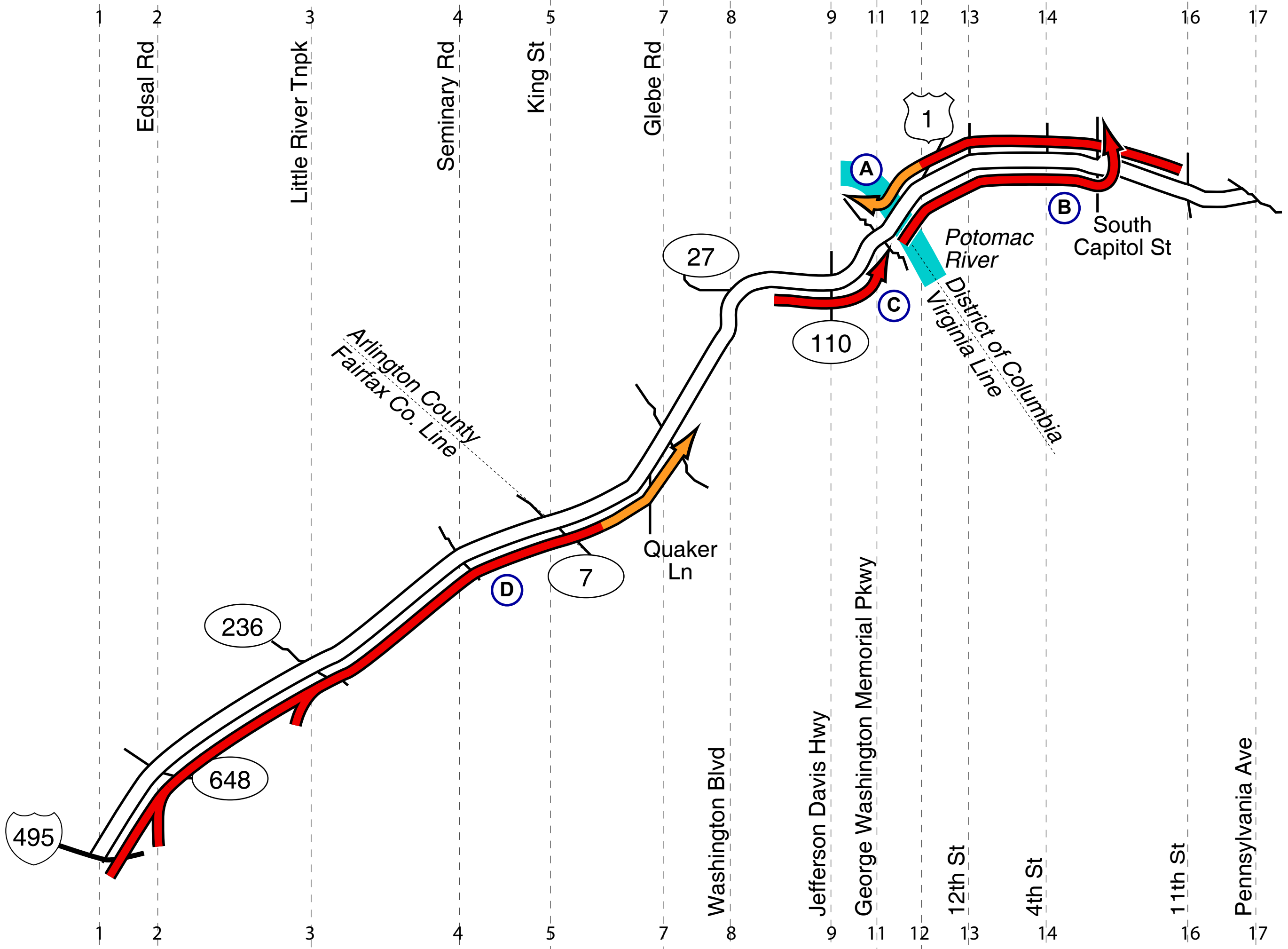
Freeway LOS Legend



I-395/SOUTHEAST/SOUTHWEST FREEWAY (VIRGINIA/DISTRICT OF COLUMBIA) - MORNING

← **SOUTHBOUND**

6:30 - 7:30 a.m.	B	B	B	B	B	B	B	C	D	F 65	F (70)	F^{4}(55)	C
7:30 - 8:30 a.m.	C	C	B	B	B	C	B	C	F 55	F 75	F (75)	F^{4}(85)	B
8:30 - 9:30 a.m.	B	B	B	A	B	B	B	B	D	F 55	F (60)	E^{4}	C



6:30 - 7:30 a.m.	F (80)	F (80)	F (75)	F^{3}(55)	E^{3}	E^{1}	C	F 50	F 50	F 55	D^{2}	B	B
7:30 - 8:30 a.m.	F (80)	F (85)	F (80)	F (80)	F (60)	F (46)	F^{4}(60)	F 105	F 55	F 55	E^{2}	B	A
8:30 - 9:30 a.m.	C	D	E	D	D	C	F^{4}(65)	F 95	F 65	F 60	E^{2}	B	A

NORTHBOUND →

Freeway LOS Legend

A	B	C	D	E	F
Density	Light	Moderate	Heavy	Congested	Severe

10 20 30 40 50 60 70 80 90

I-395/Southeast/Southwest Freeway (Virginia/District of Columbia) - Morning

A

During most observations, westbound congestion was found on the Southeast/Southwest Freeway between the vicinity of 11th St and the 14th St Bridge; during the peak period, average estimated speeds typically ranged from 15 to 30 mph. Congestion appeared to be caused or exacerbated by the two separate lane drops at 7th St (4 lanes to 3) and 14th St (3 lanes to 2).

During the middle hour, westbound congestion was found approaching and across the 14th St Bridge. The head of the queue was found on the ramp to the George Washington Memorial Parkway; congestion on the ramp typically extended back into the right lane (and eventually across all lanes) of the bridge.

B

Throughout the morning survey period, north/eastbound congestion was found on I-395 between the 14th St Bridge and the exit to the mall (I-395 terminus); average estimated speeds typically ranged from 25 to 45 mph. The head of the queue was found on the ramp to the mall; congestion typically extended back into the right lane (and eventually across all lanes) of I-395.

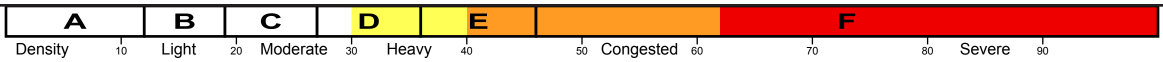
C

During most observations, a one to two-mile zone of northbound congestion was found on I-395 between VA 27 and the 14th Street Bridge; average estimated speeds ranged from 5 to 30 mph. The primary bottleneck was found at the lane drop (4 lanes to 3) located just prior to the George Washington Memorial Parkway.

D

During most observations before 8:30 a.m., a seven to eight-mile zone of northbound congestion was found on I-395 between the vicinity of the Beltway and VA 7; average estimated speeds ranged widely, from 15 to 45 mph. Congestion appeared to be caused or exacerbated by traffic entering at the interchanges along this corridor; north of VA 7, traffic flow gradually improved where the roadway widens from 3 to 4 lanes.

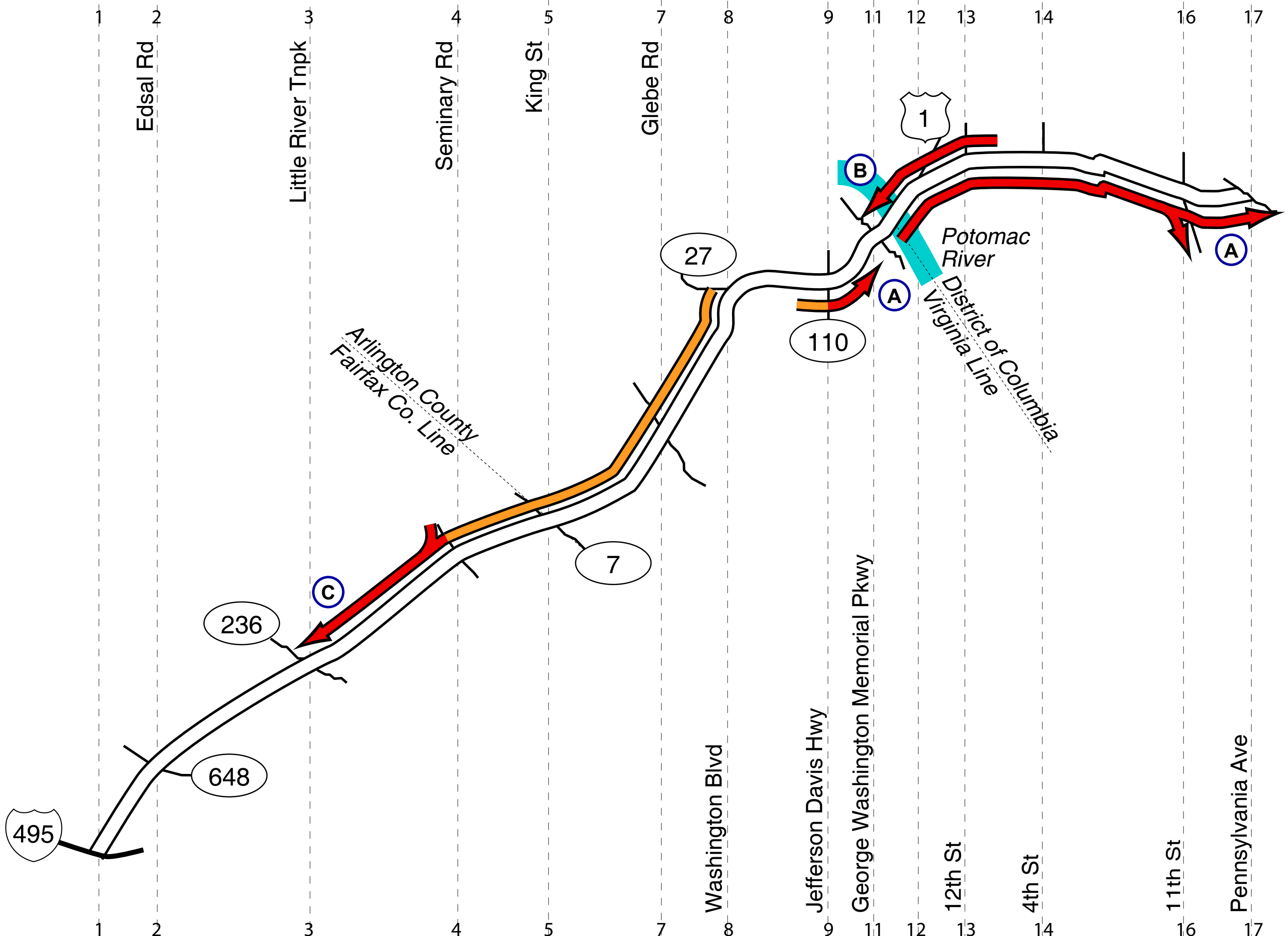
Freeway LOS Legend



I-395/SOUTHEAST/SOUTHWEST FREEWAY (VIRGINIA/DISTICT OF COLUMBIA) - EVENING

SOUTHBOUND ←

4:00 - 5:00 p.m.	C	D	F (75)	F (60)	F^1(46)	D^1	C	C	F 60	F^2 90	F (100)	D^4	A
5:00 - 6:00 p.m.	C	D	F (70)	F (60)	E^1	E^1	C	C	F 75	F^2 85	F (105)	D^4	A
6:00 - 7:00 p.m.	C	D	F^3(60)	D^1	C		D	B	C	F 65	F^2 90	F (105)	D^4	A



4:00 - 5:00 p.m.	B	D	D	C	C	C	B	F 80	F 70	F 95	F(60)	F^2(65)	F^4 (70)
5:00 - 6:00 p.m.	C	D	D	D	D	C	E	F 130	F 70	F 115	F(80)	F^2(70)	F^4 (85)
6:00 - 7:00 p.m.	C	D	C	C	C	C	C	F 85	F 55	F 70	E	E^2	F^4 (65)

NORTHBOUND →

Freeway LOS Legend

A	B	C	D	E	F
Density 10	Light 20	Moderate 30	Heavy 40	50 Congested 60	70 80 Severe 90

I-395/Southeast/Southwest Freeway (Virginia/Distict of Columbia) - Evening

A
During most observations before 6:30 p.m., a four to five-mile zone of north-eastbound congestion was found on the Southwest/Southeast Freeway between VA 110 and the Southeast Freeway terminus (signal at the Sousa Bridge); average estimated speeds ranged widely, from 5 to 30 mph. Factors contributing to the congestion were: 1) the lane drop (4 lanes to 3) in the vicinity of the George Washington Memorial Parkway; 2) HOV traffic entering the mainline after crossing the 14th St Bridge (HOV terminus); 3) the two lane exit queue at 11th St and 4) the signal at Pennsylvania Ave (Sousa Bridge).

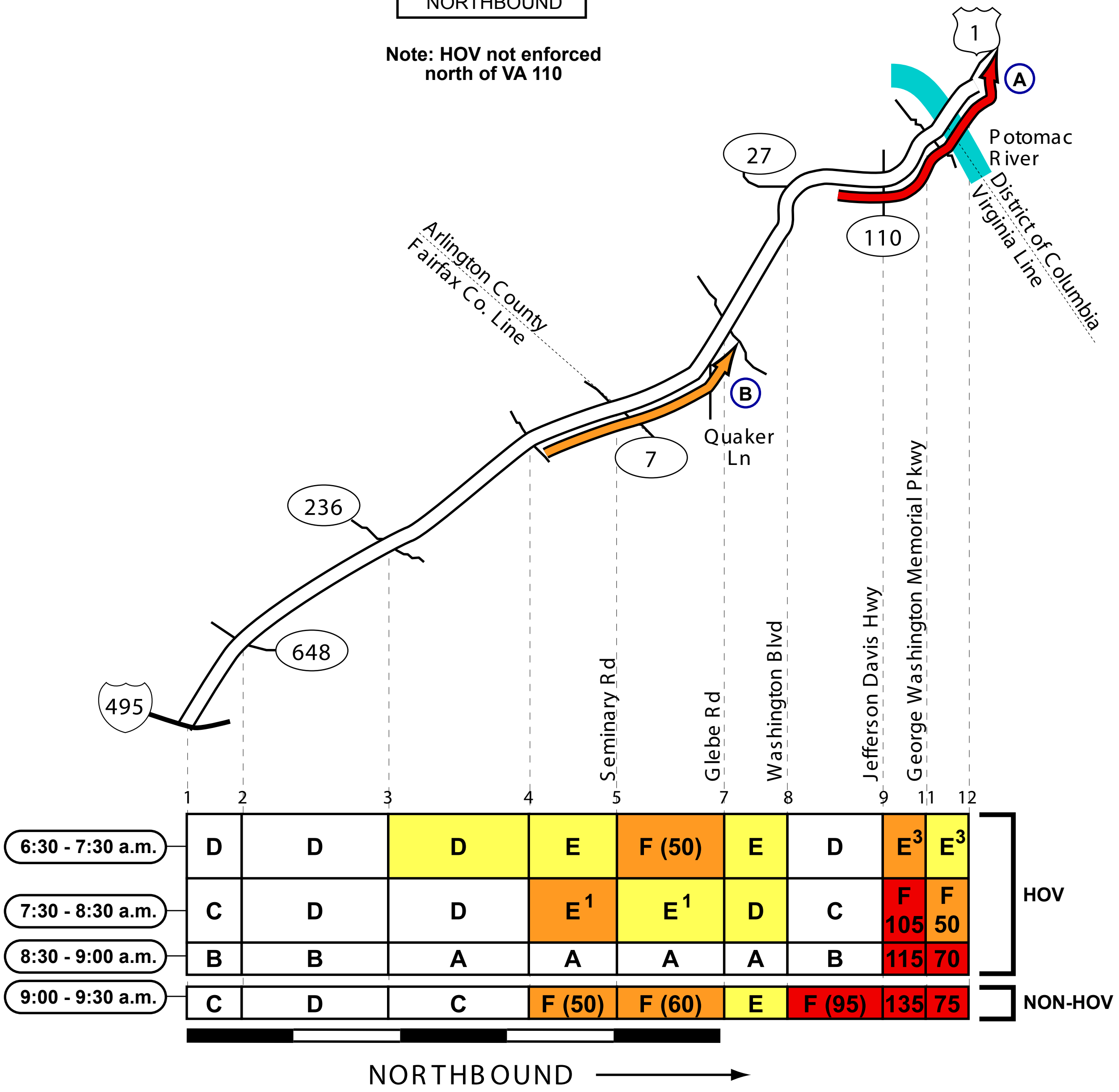
B
Throughout the evening survey period, a two to three-mile zone of south-westbound congestion was found on the Southwest Freeway between South Capitol St and the George Washington Memorial Parkway; average estimated speeds ranged widely, from 10 to 25 mph. Factors contributing to the congestion were: 1) the lane drop (3 lanes to 2) where the HOV roadway begins (in the vicinity of US 1) and 2) congestion on the ramp to George Washington Memorial Parkway, that extended back onto the 14th Street Bridge.

C
During most observations before 6:30 p.m., a three to five-mile zone of southbound congestion was found on I-395 between VA 27 and Little River Turnpike (VA 236); when congested, average estimated speeds typically ranged from 15 to 45 mph.
F□
River Turnpike.

I-395/SE FWY (VIRGINIA/DISTICT OF COLUMBIA) BARRIER SEPARATED HOV - MORNING

HOV OPERATIONS
HOV 3
6:00 - 9:00 A.M.
NORTHBOUND

Note: HOV not enforced north of VA 110

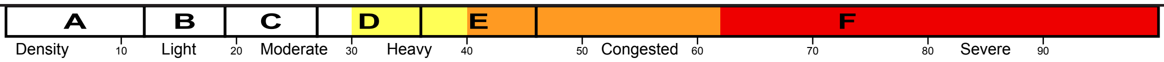


6:30 - 7:30 a.m.	D	D	D	E	F (50)	E	D	E[3]	E[3]
7:30 - 8:30 a.m.	C	D	D	E[1]	E[1]	D	C	F 105	F 50
8:30 - 9:00 a.m.	B	B	A	A	A	A	B	115	70
9:00 - 9:30 a.m.	C	D	C	F (50)	F (60)	E	F (95)	135	75

A
During most observations after 7:00 a.m., stop-and-go northbound congestion was found on the HOV roadway approaching and across the 14th Street Bridge (Note: HOV not enforced north of VA 110). Factors contributing to the congestion were: 1) the queue generated by the pair of signals on US Rte 1 at C St and Independence Ave (this queue typically extended back onto the HOV roadway) and 2) congestion on the ramp where HOV traffic merges with the non HOV vehicles at the Case Bridge.

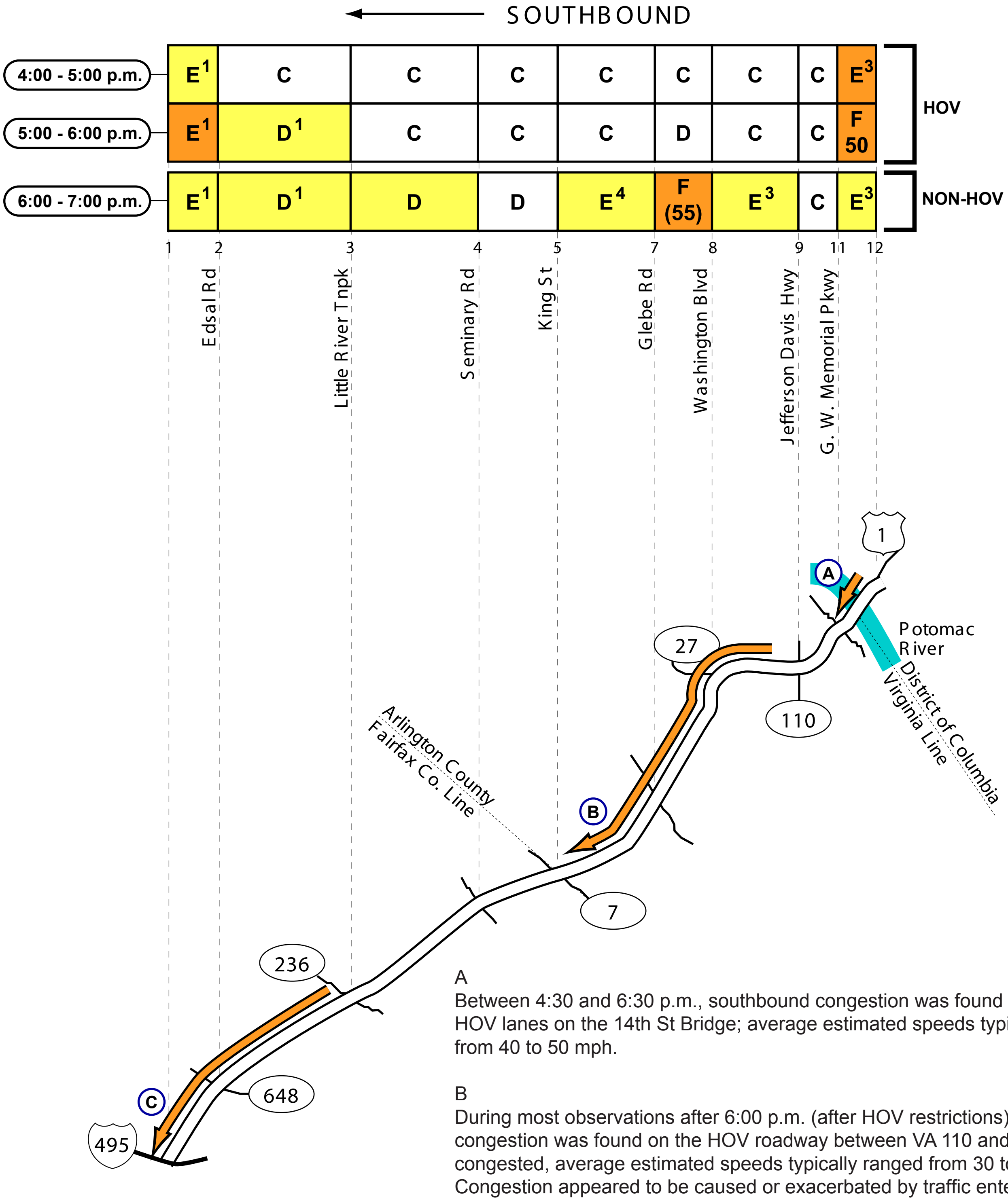
B
On some days but not others, a two to three-mile zone of northbound congestion was found on the HOV roadway between Seminary Rd and Glebe Rd (during HOV restriction period); when congested, average estimated speeds ranged from 25 to 45 mph.

Freeway LOS Legend



I-395/SE Fwy (Virginia/Distict of Columbia) Barrier Separated HOV - Evening

HOV OPERATIONS
HOV 3
3:30 - 6:00 P.M.
SOUTHBOUND



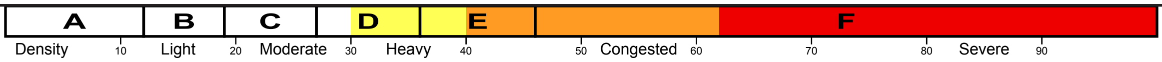
4:00 - 5:00 p.m.	E[1]	C	C	C	C	C	C	C	E[3]	HOV
5:00 - 6:00 p.m.	E[1]	D[1]	C	C	C	D	C	C	F 50	
6:00 - 7:00 p.m.	E[1]	D[1]	D	D	E[4]	F (55)	E[3]	C	E[3]	NON-HOV

A
Between 4:30 and 6:30 p.m., southbound congestion was found in the I-395 HOV lanes on the 14th St Bridge; average estimated speeds typically ranged from 40 to 50 mph.

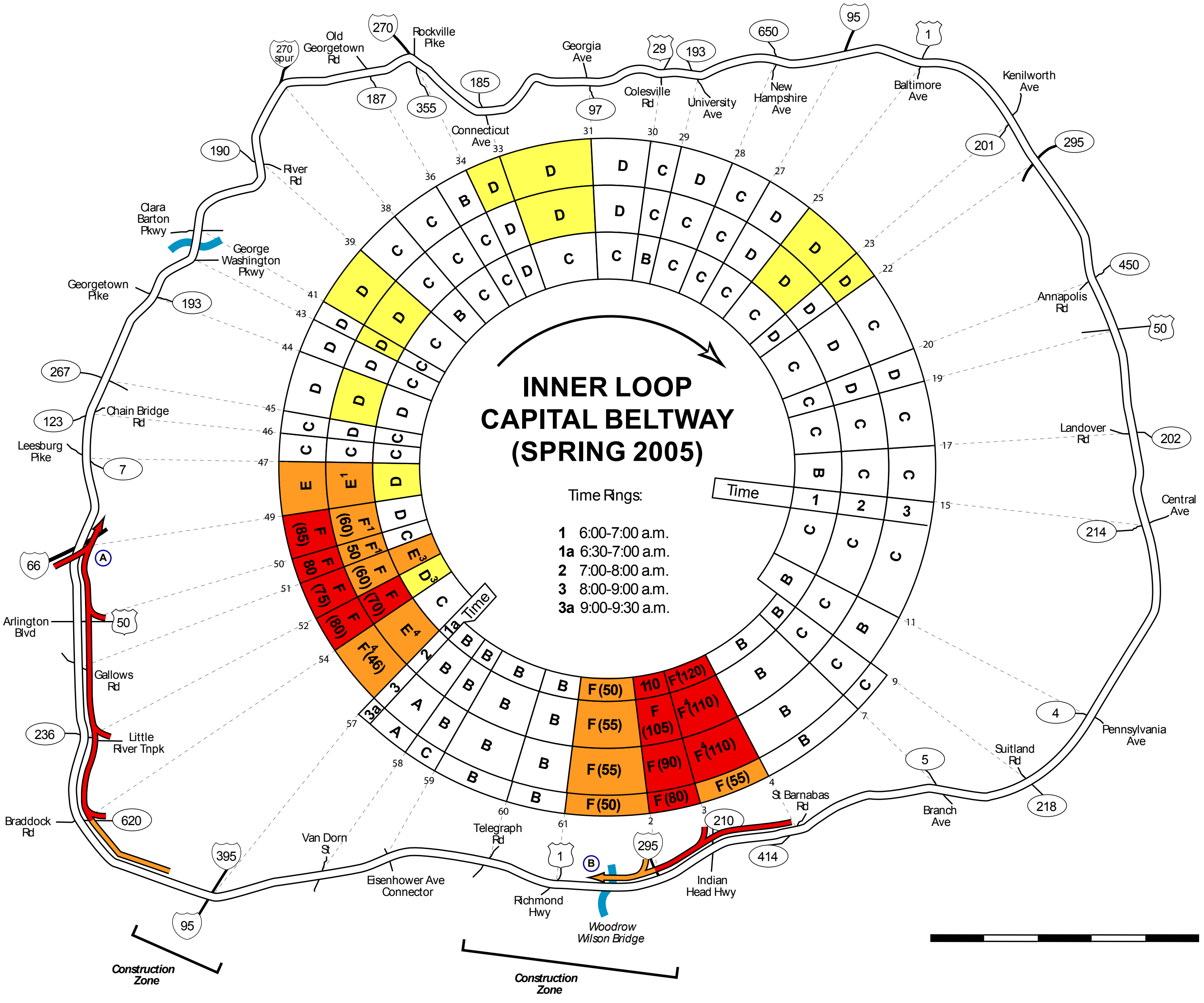
B
During most observations after 6:00 p.m. (after HOV restrictions), southbound congestion was found on the HOV roadway between VA 110 and VA 7; when congested, average estimated speeds typically ranged from 30 to 50 mph. Congestion appeared to be caused or exacerbated by traffic entering the roadway from the general-purpose lanes.

C
On some days but not others, southbound congestion was found on the HOV roadway between VA 236 and the Beltway (during and after HOV restrictions); when congested, average estimated speeds typically range from 40 to 50 mph. Ongoing construction in the vicinity of the Springfield Interchange may have contributed to the congestion.

Freeway LOS Legend



I-495/95 Capital Beltway (Inner Loop) - Morning



Freeway LOS Legend

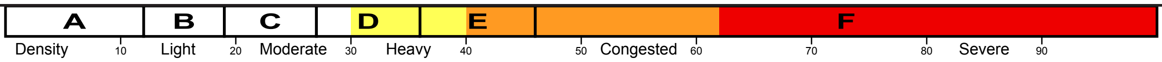
A	B	C	D	E	F
Density 10	Light 20	Moderate 30	Heavy 40	50 Congested 60	70 80 Severe 90

I-495/95 CAPITAL BELTWAY (INNER LOOP) - MORNING

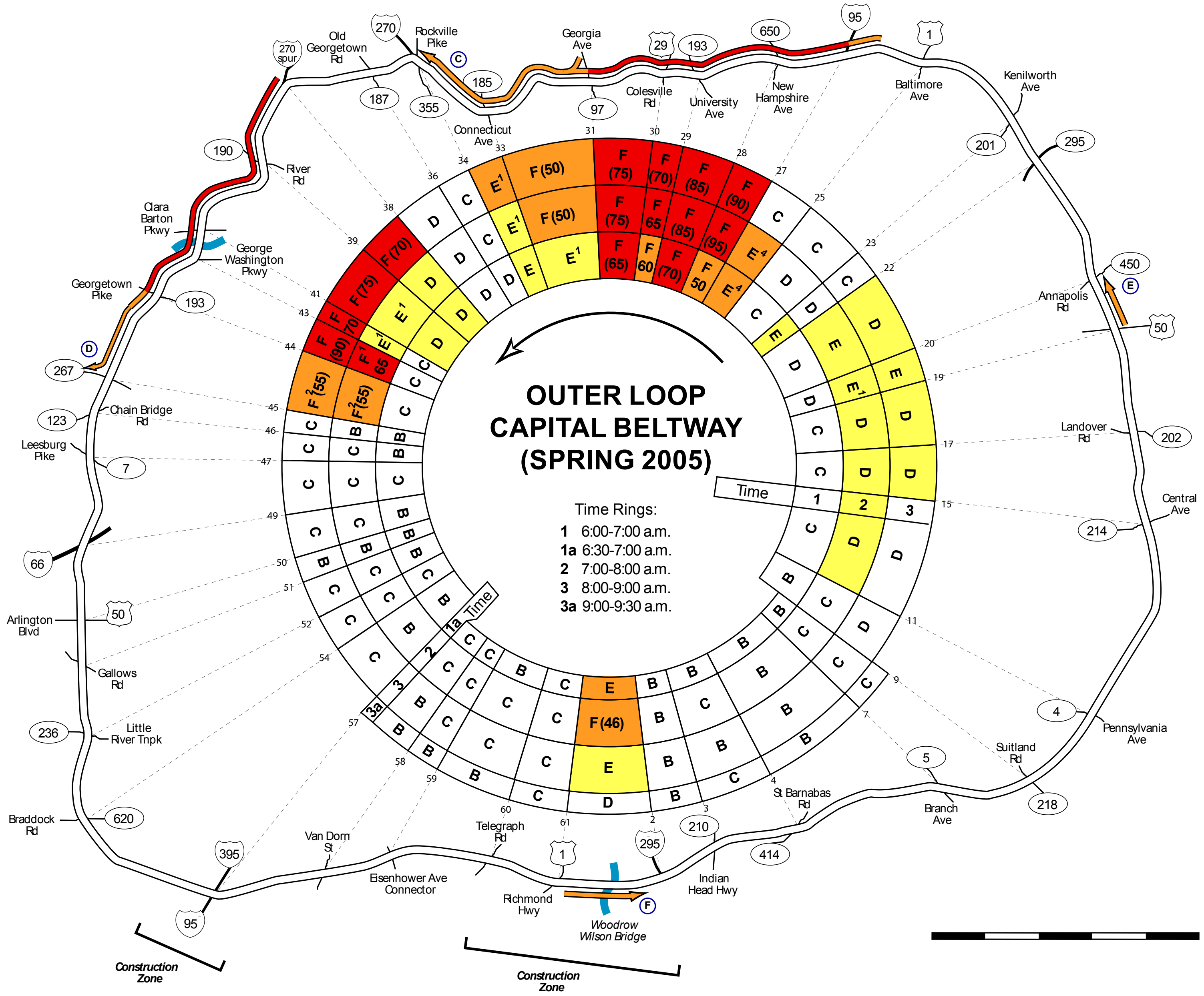
A
After 6:30 a.m., a three to six-mile zone of northbound congestion was found on the inner loop of the Beltway between I-95/I-395 and I-66; average estimated speeds ranged widely, from 15 to 35 mph. Congestion appeared to be caused or exacerbated by traffic entering at the Braddock Rd, VA 236, US 50 and I-66 interchanges.

B
Throughout the morning survey period, a three to four-mile zone of westbound congestion was found on the inner loop of the Beltway between St. Barnabas Rd and the Woodrow Wilson Bridge; average estimated speeds typically ranged from 5 to 15 mph. Factors contributing to the congestion were: 1) the lane drop (4 lanes to 3) at MD 295; 2) traffic entering at MD 210 and I-295 and 3) ongoing construction at the I-295 interchange. West of I-295, traffic flow gradually improved across the Woodrow Wilson Bridge.

Freeway LOS Legend



I-495/95 CAPITAL BELTWAY (OUTER LOOP) - MORNING



Freeway LOS Legend

A	B	C	D	E	F
Density	Light	Moderate	Heavy	Congested	Severe

10 20 30 40 50 60 70 80 90

I-495/95 CAPITAL BELTWAY (OUTER LOOP) - MORNING

C
During most observations, an extended zone of westbound congestion was found on the outer loop of the Beltway between I-95 and I-270; average estimated speeds ranged widely, from 10 to 40 mph. The primary bottleneck was located at Georgia Ave where traffic entered the Beltway (the geometrics of the ramp at Georgia Ave appeared to limit vehicle speeds prior to entering the Beltway). An additional factor that contributed to the congestion was the series of lane drops (6 lanes to 5 and 5 lanes to 4) in the vicinity of New Hampshire Ave.

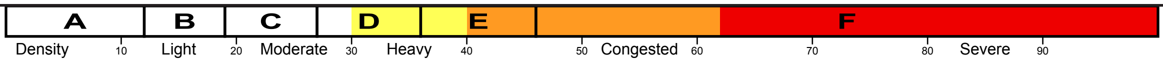
While congestion persisted west of Georgia Ave, traffic flow typically improved approaching I-270; average estimated speeds along this corridor typically ranged from 35 to 50 mph.

D
During most observations after 7:00 a.m., an extended zone of southbound congestion was found on the outer loop of the Beltway between the I-270 western spur and VA 267; average estimated speeds along this corridor typically ranged from 15 to 45 mph. Congestion on the ramp to VA 267 typically extended back into the right lane and eventually across all lanes of the outer loop.

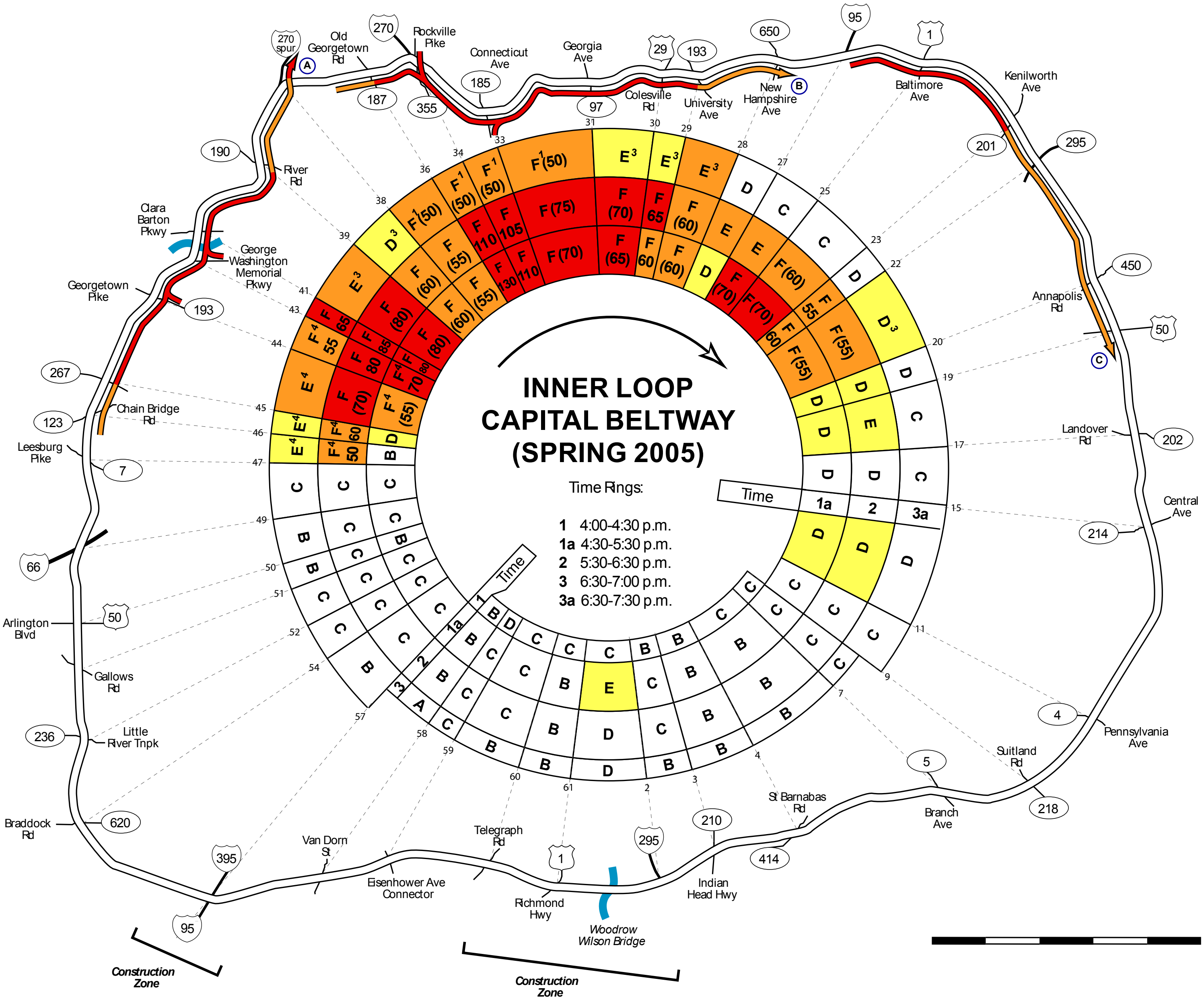
E
On some days but not others, northbound congestion was found on the outer loop of the Beltway between US 50 and MD 450; when congested, average estimated speeds ranged from 40 to 50 mph. Congestion appeared to be caused or exacerbated by traffic entering at US 50.

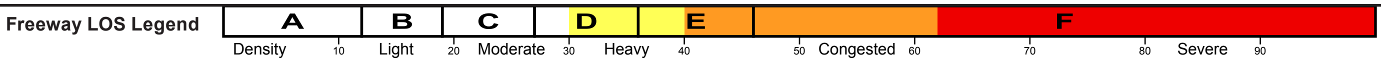
F
On some days but not others, a short zone of eastbound congestion was found on the outer loop of the Beltway between US 1 and I-295; congestion was most severe in the right lane approaching the I-295 interchange. Ongoing construction at the Woodrow Wilson Bridge may have contributed to the congestion.

Freeway LOS Legend



I-495/95 CAPITAL BELTWAY (INNER LOOP) -EVENING





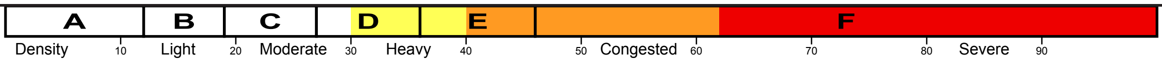
I-495/95 CAPITAL BELTWAY (INNER LOOP) -EVENING

A
During most observations, a seven to nine-mile zone of northbound congestion was found on the inner loop of the Beltway between the vicinity of VA 123 and the I-270 spur; average estimated speeds typically ranged from 20 to 40 mph. The primary bottleneck appeared to be the weaving where the road divides at the I-270 spur; traffic entering at VA 193 and the George Washington Memorial Parkway appeared to exacerbate the congestion.

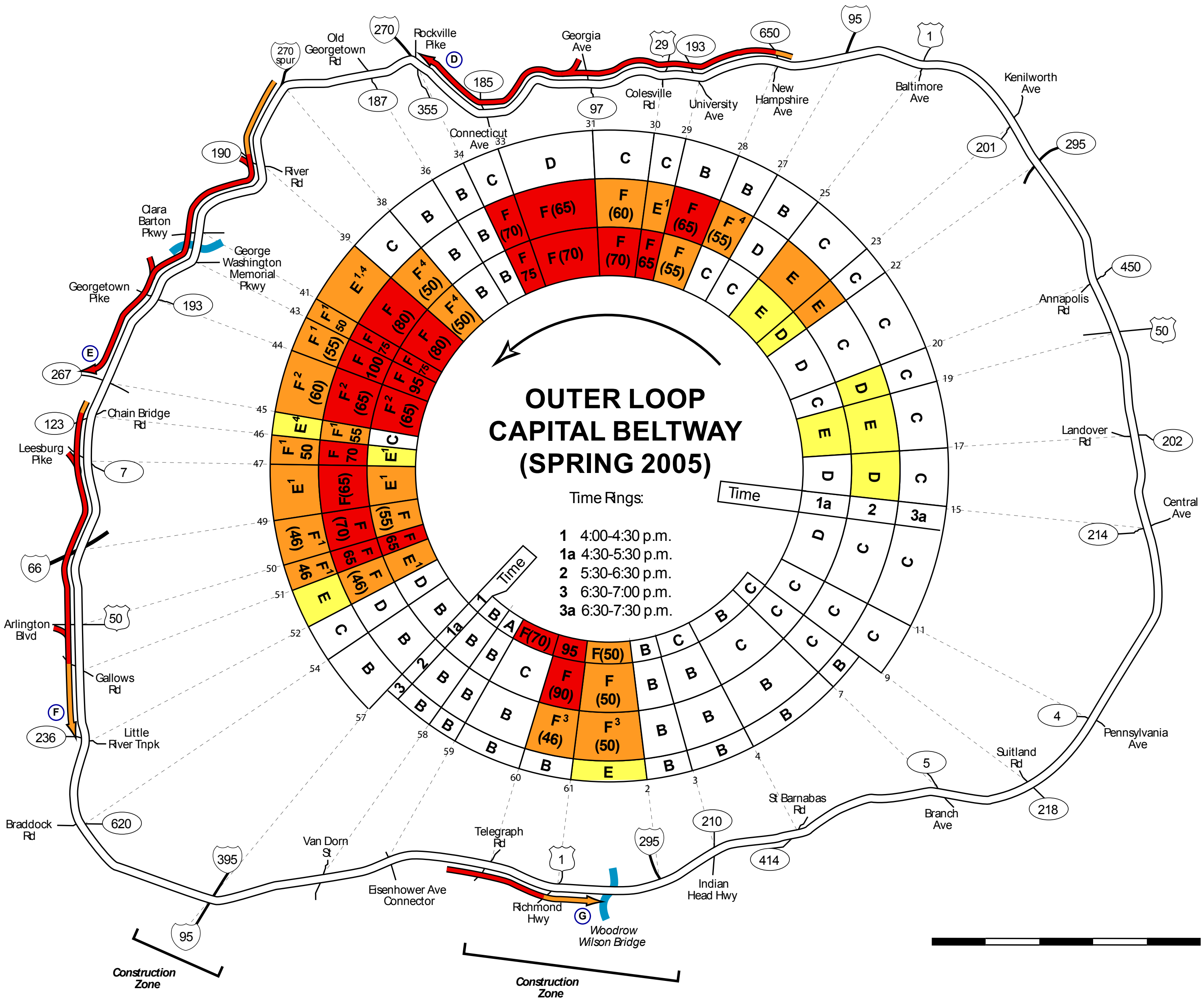
B
During most observations, eastbound congestion was found on the inner loop of the Beltway between the vicinity of the I-270 western spur and New Hampshire Ave; congestion was most severe between I-270 and Connecticut Ave. Traffic entering at MD 355 and Connecticut Ave appeared to exacerbate the congestion; average estimated speeds along this section of the inner loop typically ranged from 10 to 20 mph. Eastbound congestion persisted on the inner loop approaching US 29; average estimated speeds ranged from 25 to 35 mph. While congestion persisted east of US 29, traffic flow gradually improved.

C
During most observations before 6:30 p.m., a five to seven-mile zone of southeastbound congestion was found on the inner loop of the Beltway between I-95 and US 50; average estimated speeds typically ranged from 30 to 50 mph. Congestion appeared to be caused or exacerbated by weaving approaching the US 50 interchange.

Freeway LOS Legend



I-495/95 CAPITAL BELTWAY (OUTER LOOP) -EVENING



Freeway LOS Legend

A	B	C	D	E	F
Density	Light	Moderate	Heavy	Congested	Severe

10 20 30 40 50 60 70 80 90

I-495/95 CAPITAL BELTWAY (OUTER LOOP) -EVENING

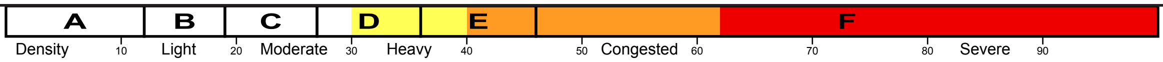
D
During most observations before 6:30 p.m., westbound congestion was found on the outer loop of the Beltway between New Hampshire Ave and I-270; when congested, average estimated speeds typically ranged from 20 to 40 mph. Factors contributing to the congestion were: 1) the series of lane drops (6 lanes to 5 and 5 lanes to 4) in the vicinity of New Hampshire Ave 2) traffic entering at Georgia Ave (the geometrics of the ramp at Georgia Ave appeared to limit vehicle speeds prior to entering the Beltway) and 3) weaving approaching the I-270 interchange.

E
Throughout the evening survey period, a five to seven-mile zone of southbound congestion was found on the outer loop of the Beltway between the I-270 spur and VA 267; average estimated speeds typically ranged from 15 to 20 mph. Factors contributing to the congestion were: 1) traffic entering at MD 190 and George Washington Memorial Parkway and 2) congestion on the ramp to VA 267, that typically extended back into the right lane and eventually across all lanes of the outer loop.

F
During most observations, southbound congestion was found on the outer loop of the Beltway between VA 123 and VA 236; average estimated speeds typically ranged from 25 to 45 mph. Congestion appeared to be exacerbated by traffic entering at VA 7 and US 50.

G
During most observations, eastbound congestion was found on the outer loop of the Beltway between Telegraph Rd and the Woodrow Wilson Bridge; average estimated speeds typically ranged from 10 to 30 mph. The primary bottleneck was the lane drop (4 lanes to 3) at the US 1 interchange; ongoing construction at the Woodrow Wilson Bridge may have exacerbated the congestion.

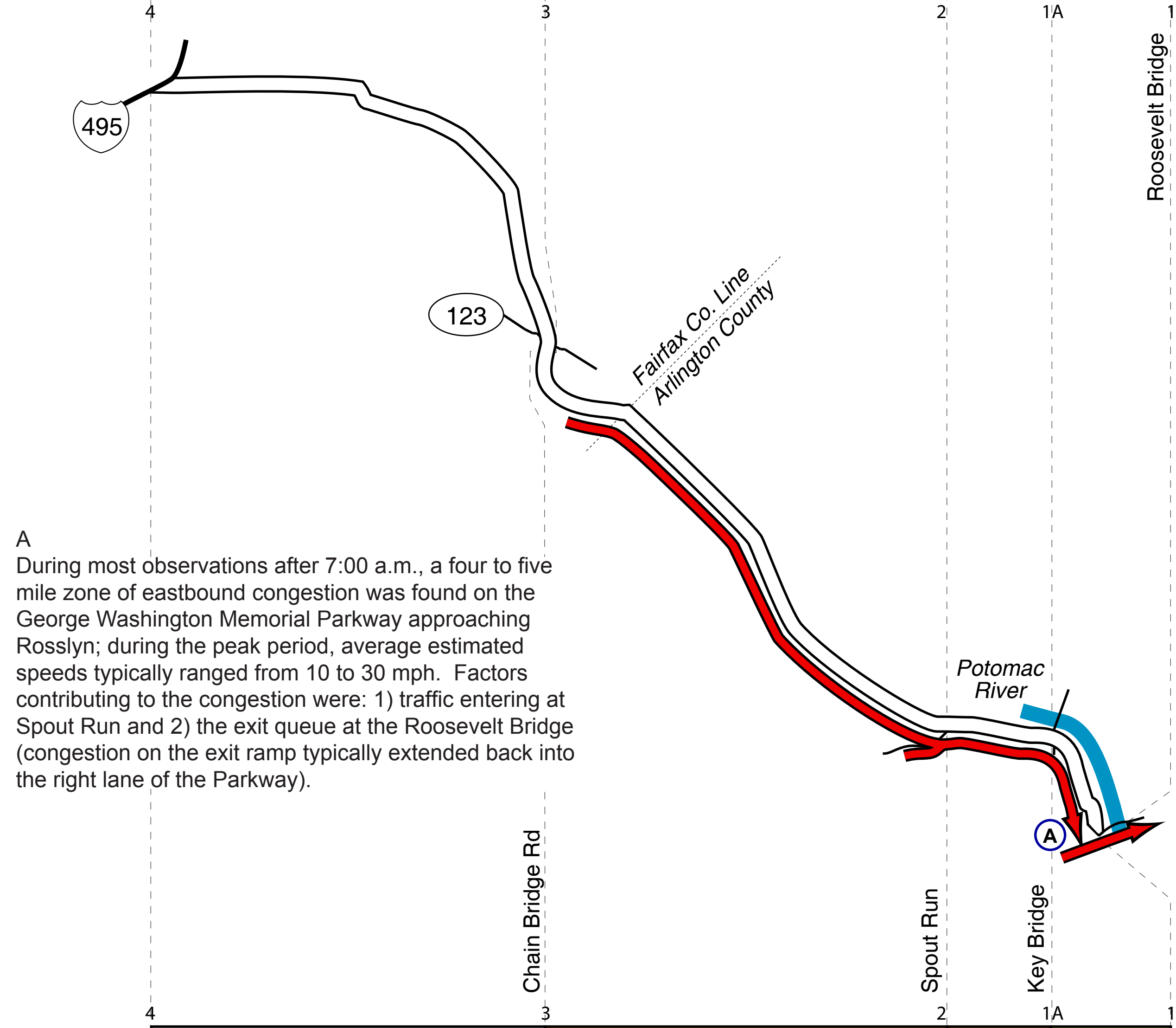
Freeway LOS Legend



GEORGE WASHINGTON MEMORIAL PARKWAY (VIRGINIA) - MORNING

WESTBOUND ←

	4 – 3	3 – 2	2 – 1A	1A – 1
6:30 - 7:30 a.m.	C	C	D	D
7:30 - 8:30 a.m.	C	E	D	C
8:30 - 9:30 a.m.	B	D	D	C



A
During most observations after 7:00 a.m., a four to five mile zone of eastbound congestion was found on the George Washington Memorial Parkway approaching Rosslyn; during the peak period, average estimated speeds typically ranged from 10 to 30 mph. Factors contributing to the congestion were: 1) traffic entering at Spout Run and 2) the exit queue at the Roosevelt Bridge (congestion on the exit ramp typically extended back into the right lane of the Parkway).

	4 – 3	3 – 2	2 – 1A	1A – 1
6:30 - 7:30 a.m.	C	E[3]	F[3] (50)	E
7:30 - 8:30 a.m.	C	F[4] (70)	F (100)	F (60)
8:30 - 9:30 a.m.	B	F[4] (90)	F (85)	F (60)

EASTBOUND →

Freeway LOS Legend

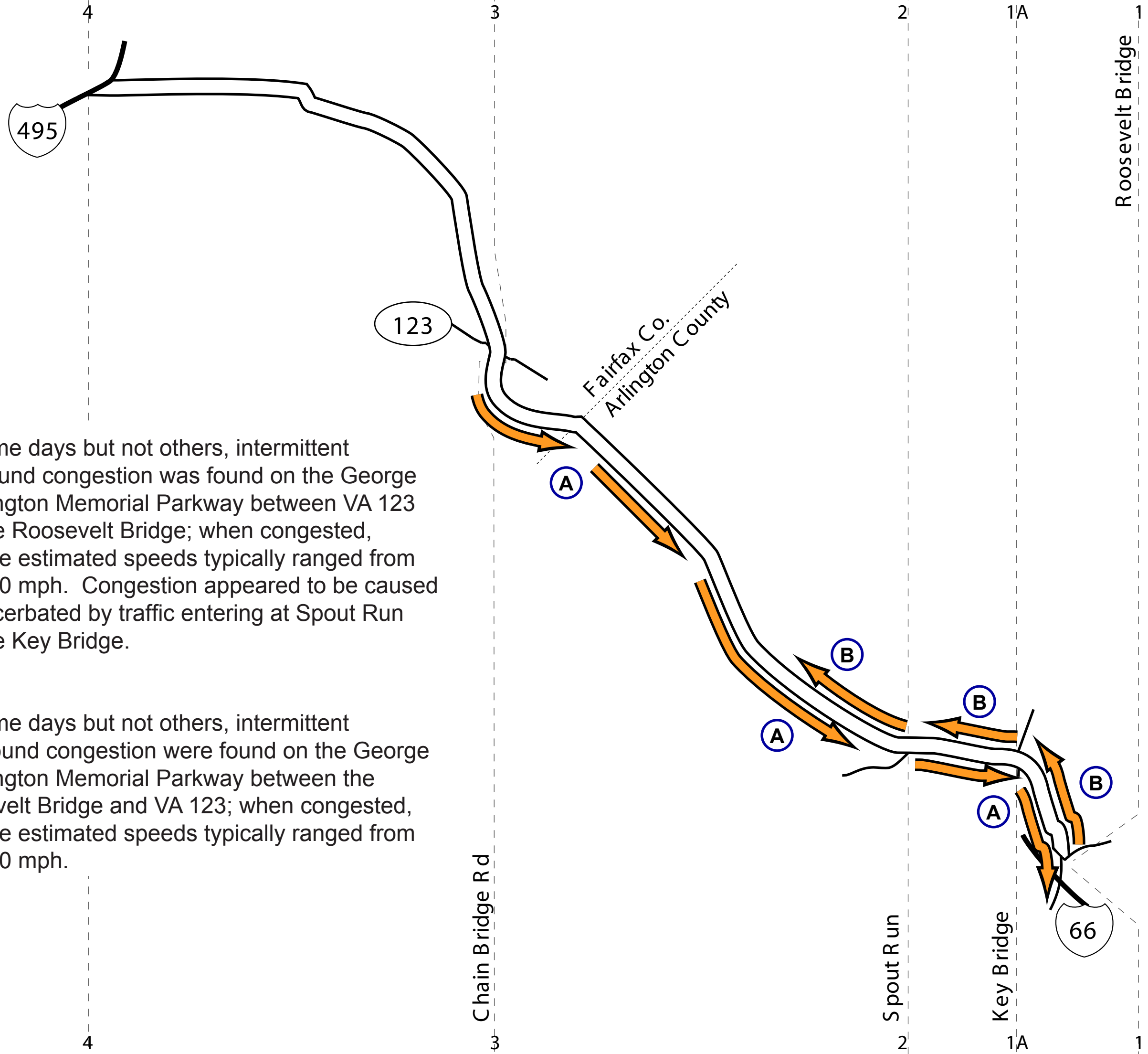
A	B	C	D	E	F
Density	Light	Moderate	Heavy	Congested	Severe

0 Density 10 Light 20 Moderate 30 Heavy 40 50 Congested 60 70 80 Severe 90

GEORGE WASHINGTON MEMORIAL PARKWAY (VIRGINIA) - EVENING

← WESTBOUND

4:00 - 5:00 p.m.	C	D	D	D
5:00 - 6:00 p.m.	C	D	E[1]	E[1]
6:00 - 7:00 p.m.	C	D	E[1]	D



A
On some days but not others, intermittent eastbound congestion was found on the George Washington Memorial Parkway between VA 123 and the Roosevelt Bridge; when congested, average estimated speeds typically ranged from 40 to 50 mph. Congestion appeared to be caused or exacerbated by traffic entering at Spout Run and the Key Bridge.

B
On some days but not others, intermittent westbound congestion were found on the George Washington Memorial Parkway between the Roosevelt Bridge and VA 123; when congested, average estimated speeds typically ranged from 40 to 50 mph.

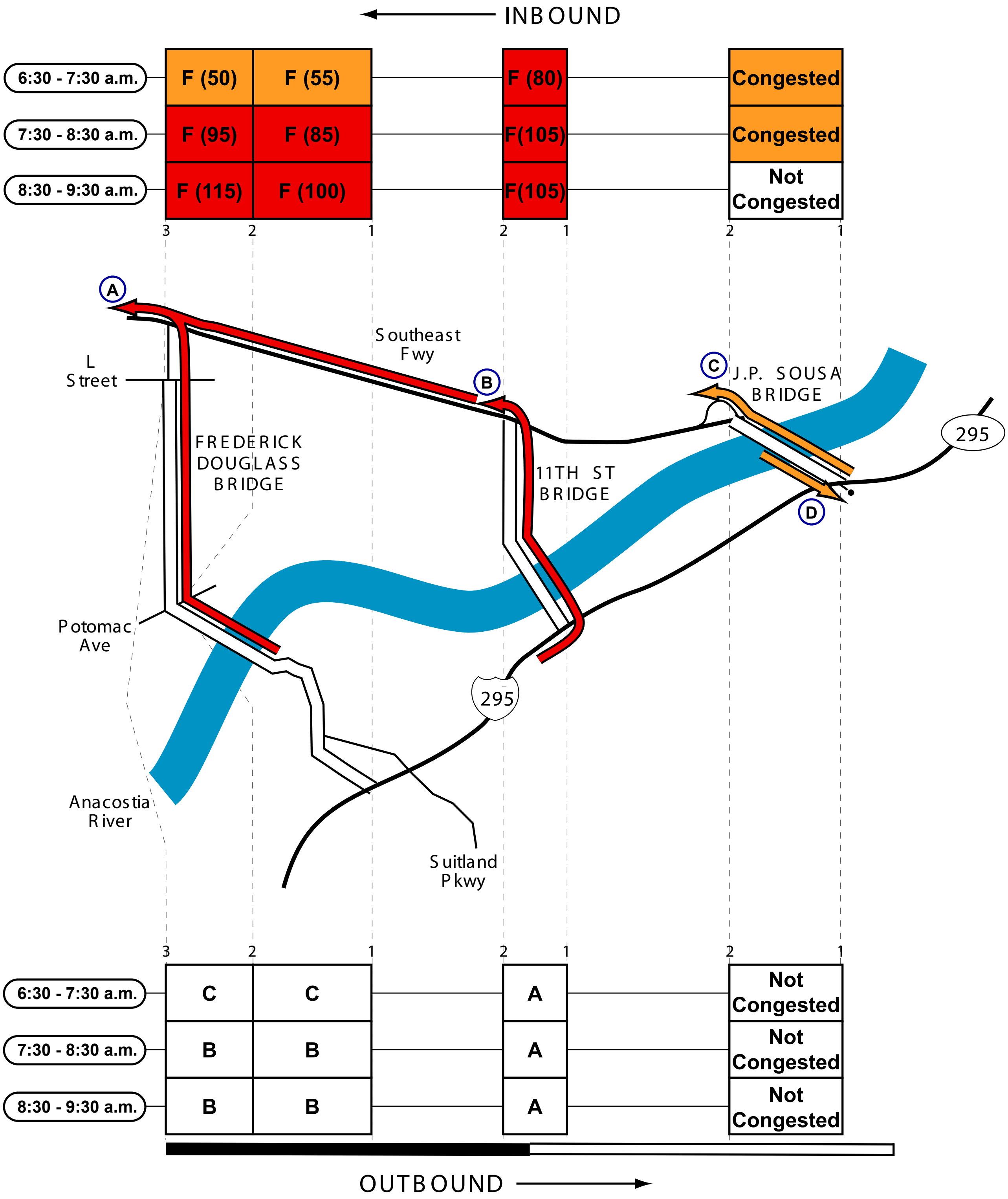
4:00 - 5:00 p.m.	B	D[1]	D[1]	E[1]
5:00 - 6:00 p.m.	C	E[1]	E[1]	E[1]
6:00 - 7:00 p.m.	C	D	D	D

EASTBOUND →

Freeway LOS Legend

A	B	C	D	E	F
Density 10	Light 20	Moderate 30	Heavy 40	50 Congested 60	70 80 Severe 90

ANACOSTIA RIVER BRIDGES - MORNING



INBOUND

6:30 - 7:30 a.m.	F (50)	F (55)	F (80)	Congested
7:30 - 8:30 a.m.	F (95)	F (85)	F(105)	Congested
8:30 - 9:30 a.m.	F (115)	F (100)	F(105)	Not Congested

OUTBOUND

6:30 - 7:30 a.m.	C	C	A	Not Congested
7:30 - 8:30 a.m.	B	B	A	Not Congested
8:30 - 9:30 a.m.	B	B	A	Not Congested

Freeway LOS Legend

A	B	C	D	E	F
Density 10	Light 20	Moderate 30	Heavy 40	50 Congested 60	70 80 Severe 90

Anacostia River Bridges - Morning

A

During most observations after 7:00 a.m., inbound congestion was found on the Frederick Douglas Bridge and South Capitol St; average estimated speeds typically ranged from 10 to 30 mph. The head of the queue was found at the merge into congested flow on the Southeast Freeway.

B

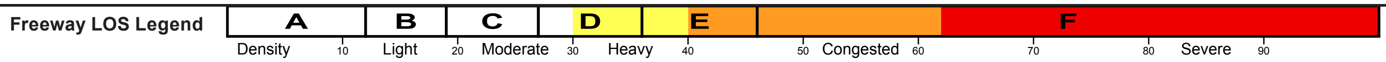
Throughout the morning survey period, inbound congestion was found approaching and across the 11th St Bridge; average estimated speeds typically ranged from 10 to 30 mph. In some cases, the head of the queue was found in the right lane of the Southeast Freeway where traffic exited at South Capitol St.

C

During most observations before 9:00 a.m., inbound congestion was found on the John Phillip Sousa Bridge; congestion appeared to be exacerbated by weaving approaching the Pennsylvania Ave/ Southeast Freeway split.

D

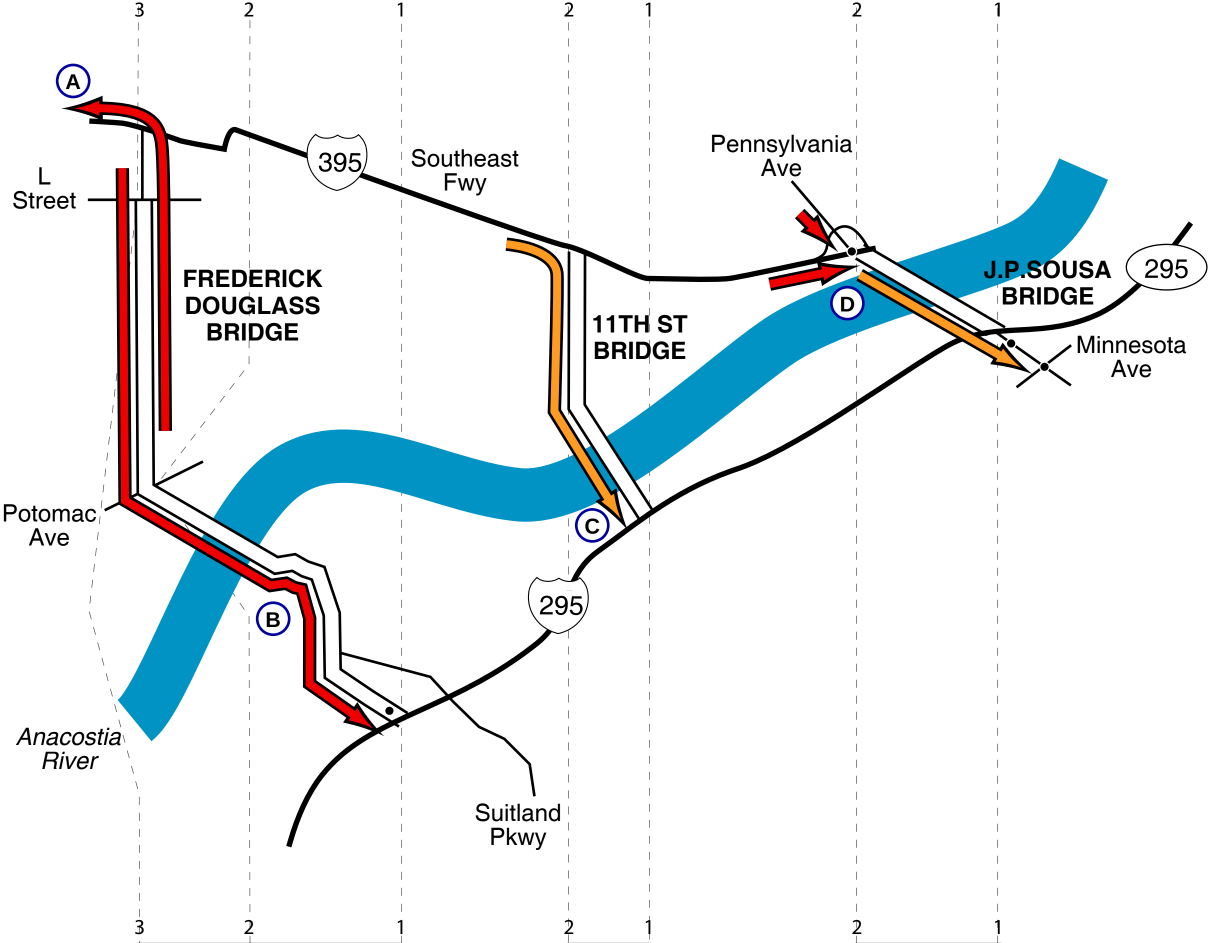
On some days but not others, outbound congestion was found on the Sousa Bridge approaching the signal at I-295; when congested, queue populations at the signal typically ranged from 20 to 40 vehicles per lane (2 left-turn lanes).



ANACOSTIA RIVER BRIDGES - EVENING

INBOUND

4:00 - 5:00 p.m.	B	B	C	Not Congested
5:00 - 6:00 p.m.	F (85)	B	C	Not Congested
6:00 - 7:00 p.m.	E	A	B	Not Congested



4:00 - 5:00 p.m.	F (95)	F (65)	F (50)	Congested
5:00 - 6:00 p.m.	F (105)	F (65)	F (50)	Congested
6:00 - 7:00 p.m.	F (95)	F (75)	E	Not Congested

OUTBOUND

Freeway LOS Legend

A	B	C	D	E	F
Density	Light	Moderate	Heavy	Congested	Severe

10 20 30 40 50 60 70 80 90

ANACOSTIA RIVER BRIDGES - EVENING

A

On some days but not others (after 5:00 p.m.), inbound congestion was found on the Frederick Douglas Bridge and South Capitol St; average estimated speeds typically ranged from 5 to 30 mph. When congested, the head of the queue was found at the merge into congested flow on the Southeast Freeway.

B

Throughout the evening survey period, outbound congestion was found approaching and across the Frederick Douglas Bridge; average estimated speeds typically ranged from 10 to 20 mph. The primary bottleneck was found at the signalized intersection at the I-295/Suitland Parkway.

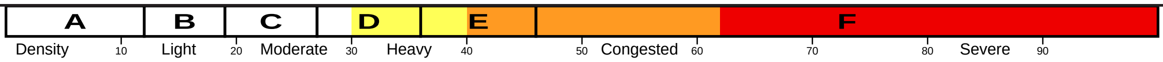
C

On some days but not others, outbound congestion was found approaching and across the 11th St Bridge; when congested, average estimated speeds typically ranged from 40 to 50 mph. Congestion appeared to be exacerbated by weaving approaching the 13th St/I-295 split.

D

On two of four evenings surveyed, outbound congestion was found approaching and across the Sousa Bridge; congestion appeared to caused or exacerbated by the signals at D.C. 295 and Minnesota Ave.

Freeway LOS Legend



APPENDIX A

PROCEDURE FOR DETERMINING FREEWAY LEVEL-OF-SERVICE

Introduction

Overlapping aerial photography can document many useful characteristics of traffic flow on highway networks. The photographs can be invaluable for screening problem sites, winning support for ideas, and explaining decisions to others. If formal rules and procedures are applied to the analysis of aerial photographs, the photography can provide a cost-effective basis for periodically rating the performance of large highway systems on a link-by-link basis.

Background

On motorized vehicle highways, traffic flow is normally measured in terms of three basic parameters: *volume*, *speed*, and *density*. These parameters are related mathematically such that, if only two are known, the third can be calculated (volume equals speed times density). Other useful flow parameters related to speed are *travel time* and *delay* between specific points on a system.

The *Highway Capacity Manual (HCM),* updated in 2000 by the Transportation Research Board of the National Research Council, is an authoritative governmental resource that has established a simplified concept by which the performance of all types of transportation facilities can be described and compared. This concept is called *level of service,* or *LOS*. For each type of facility, a single traffic flow parameter – the one deemed most appropriate by the committee that publishes the manual – is chosen to be the basis for defining six rating categories. These categories are represented by the letters “A” through “F”, ranging from the most favorable rating of LOS A (indicating high service quality associated with lightly-used facilities) to the poorest rating of LOS F (indicating a facility burdened by congestion or other undesirable performance characteristics). This LOS system, introduced in 1965 version of the HCM and revised periodically since, has been widely adopted for evaluating existing highway systems and planning future improvements. Because six LOS classes are easier to understand than tables of numbers, LOS has been widely used in the political process. In some jurisdictions, LOS standards are even found in legislation attempting to guide facility planning or control real estate development.

Uninterrupted-flow highways (grade-separated highways without signals)

Summary

The defining parameter for HCM LOS on freeways and other uninterrupted-flow highways is the *density* of traffic flow (in units of passenger cars per lane per mile). Density was chosen as the basis for HCM LOS because, when traffic flows without interruption, traffic density relates mathematically to both speed and volume. This means that a single LOS measure based on density provides not only general speed information, but also provides an approximation of how heavily the facility is utilized. It also indicates where demand has exceeded capacity, resulting in congestion and delays. (Speed is less desirable as a defining basis for LOS because uninterrupted-flow highways can process high volumes of traffic at high speeds; ratings based on speed alone might not differentiate clearly between facilities that were heavily or lightly utilized.) The most common way to determine LOS on an existing freeway is to measure the speed and volume of the traffic, and then calculate the density. Another method is to determine density directly from aerial photographs, which allows for cost effective data collection across very large highway networks. (This also affords the other benefits of aerial photography, which often shows the underlying causes of congestion as well as conditions on interchange ramps, merges and crossroads.) Accordingly, when Skycomp evaluates the performance of uninterrupted-flow highway facilities, Skycomp derives traffic densities from aerial photographs and then determines density-based HCM LOS ratings.

As discussed above, the LOS rating system uses the letters “A” through “F” to describe traffic conditions: LOS “A” represents superior traffic conditions (very light traffic), while LOS “F” represents poor traffic conditions (congested flow involving various degrees of delay). These letters are assigned based on how densely cars are traveling on the road. Research has shown that for all densities below 40 pcplpm, vehicles generally move at or close to normal highway speed; LOS “A” through “E” represent these densities according to the following table (pcplpm):

LOS “A”: densities from **zero to 11** (very light traffic);
LOS “B”: densities from **12 to 18** (light to moderate traffic);
LOS “C”: densities from **19 to 26** (moderate traffic);
LOS “D”: densities from **27 to 35** (moderate to heavy traffic);
LOS “E”: densities from **36 to approx. 45** (heavy traffic, but still at speeds close to free-flow)

At densities greater than **40**, speeds typically decrease and traveler delays are incurred. Because flow at all densities greater than **46** (approximately) are regarded as LOS “F”, this report attaches actual densities to all LOS “F” ratings. Accordingly:

LOS “F”:
- Densities from **46 to 60** indicate delay involving minor degrees of slowing; average speeds usually range between 50 and 30 mph;
- Densities from **60 to 80** indicate traffic flow at average speeds usually ranging between 40 and 15 mph;
- Densities from **80 to 100** indicate congested traffic flow, with some stopping possible; average speeds usually range between 10 and 25 mph;
- Densities above **100** indicate severe congestion, with considerable stop-and-go flow likely. For reference, densities above 120 almost always indicate the presence of unusual events (accidents, roadwork, etc.). The practical maximum value for density measurements is **180**; the theoretical maximum value is **264** (at 20 feet per vehicle).

Data Reduction Procedures

From overlapping time-stamped photographs, densities by highway segment were determined by manual counts taken along the entire segment length. Vehicles were classified as cars, trucks, buses, or tractor-trailers when counted; later, passenger-car equivalents (pce’s) were derived according to the following table:

Vehicle type:	PCE’s:
cars	1
buses	1.5
trucks	1.5
tractor-trailers	2.0

Data that were atypical due to roadwork or to known or suspected incidents were coded for exclusion from the averaging process. All data were then entered into a microcomputer database program, which performed the following tasks: 1) samples were grouped by time slice; 2) average densities were calculated; and 3) densities were converted into service levels “A” through “F”. The computer then prepared matrices showing each averaged service level rating plotted by time and highway segment. These data matrices were then copied into the traffic quality tables, which are provided in this report.

In the tables, all LOS F conditions (congested traffic flow) have darkly shaded; this permits quick identification of locations experiencing demand at levels exceeding capacity. Because LOS “F” encompasses a wide range of densities, the actual density values are entered next to the “F”; using the travel characteristics in the density ranges provided above, the nature of the flow in LOS F segments can be determined.

APPENDIX B

METHODOLOGY DESCRIPTION

Procedures for obtaining speed/density samples for calibration of the Van Aerde Speed / Density Model

BACKGROUND

In the spring of 1995, Skycomp collected data to compare the speed of vehicles through congested freeway zones with corresponding densities obtained from aerial photographs. The purpose was to explore the relationship between the two, and, given a reasonable correlation, to prepare a model by which vehicle speeds could be estimated from aerial density photographs.

The program was conceived and executed by the Metropolitan Washington (D.C.) Council of Governments (MWCOG). Aerial data were collected by Skycomp; analysis of the data and calibration of the Van Aerde speed/density model were conducted by MWCOG (draft paper included in this appendix).

A secondary objective was to evaluate the accuracy of aerial speed and density measurements by comparing them to data collected by traditional methods (floating cars and loop detectors embedded in the pavement).

Accordingly, segments of freeway were chosen to be surveyed that: 1) were expected to generate congested traffic flow; and 2) either contained a loop detector station or would accommodate quick turnarounds for multiple floating car runs. Thus, while data were being collected in the air (290 speed samples were obtained from the air, along with corresponding densities), loop detector or floating car data were collected concurrently on the ground.

The outcome of this study was a finding that travel speeds across congested freeway segments could be determined with reasonable accuracy using only aerial density photographs. It was also found that speeds and densities obtained through aerial techniques closely matched data obtained using the traditional ground methods.

PROCEDURES TO OBTAIN SPEED / DENSITY SAMPLES:

The observer/photographer followed the following procedure to obtain all speed/density samples: he first flew along the selected survey segment while taking time-stamped overlapping density photographs of the entire segment; next, at the upstream end, he selected a target "floating" car for tracking; he photographed the target as it entered and departed the segment, while simultaneously timing its run to the nearest second. He then took an "after" density photo set; and then recorded the following information on a clipboard: the time of the sample, the target vehicle description, lane(s) traveled, elapsed time, and any special notes. This procedure was repeated for each speed/density data point.

In the actual course of sampling, this procedure was modified in several ways. First, where cars were moving at high (free-flow) speeds, the density did not change significantly between samples; thus sometimes three or more floating cars were timed between density runs.

Another modification done in-flight is as follows: the observer noted in several cases that the density set taken before the target vehicle went through better reflected the conditions the car encountered than the density set taken after the vehicle went through (or vice versa). This was usually due to a delay in changing film, extra maneuvering the airplane, or any other event which delayed the "after" density sample for several minutes after the completion of the run. While normally the density associated with each speed sample was an average of the "before" and "after" density sets, in these cases only the "before" or "after" density set would be used (as directed by the observer).

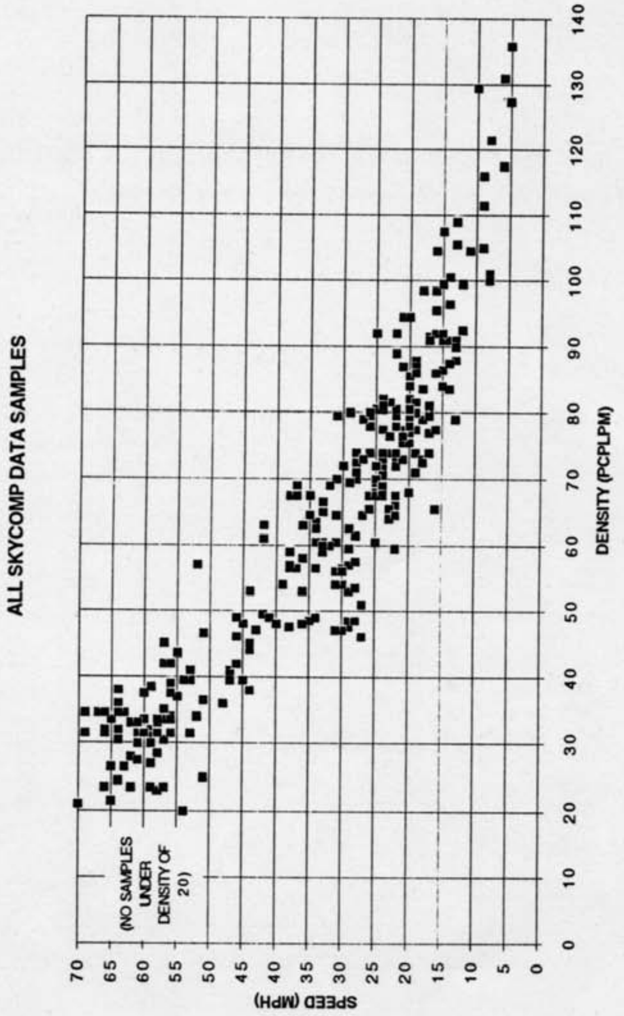
With regard to selection of target vehicles, the plan was to select cars that reflected the average speed of traffic, just as floating car drivers are instructed to approximate the speed of traffic flow. Fortunately, vehicles have little freedom to choose their speeds in the congested density ranges (above 40 pcplpm). So, for example, almost any vehicle in a congested traffic stream in the middle lane of three will give a suitable floating car measurement. Even tractor-trailers (unless heavily loaded and traveling uphill) moved at the same speed as passenger cars. Thus the criteria the observer used in selecting each target vehicle was 1) is it in the correct lane; and 2) does the vehicle stand out so that it is easy to keep track of?

Also, in the event that the highway had four travel lanes in one direction, alternating samples were taken from both middle lanes.

In the event that a driver switched lanes while being tracked, the observer noted the lane change and also noted which lane the car spent the majority of time in (this is the lane for which a density count would be made later). In several cases (infrequently), the observer abandoned tracking certain vehicles when: 1) the driver made multiple lane changes, trying to beat the average speed of traffic; 2) the driver switched lanes and changed speeds obviously and significantly; 3) the vehicle turned out to be a heavily loaded truck which delayed the traffic stream; or 4) the observer "lost" the vehicle being tracked. Also, for the samples made with traffic traveling at free-flow speeds, vehicles were abandoned which proved to be traveling significantly faster or slower than the average speed of traffic.

In the event that the target vehicle moved to the right lane in apparent preparation to exit, the observer often was able to switch tracking to another vehicle that had been just behind or ahead of the original vehicle in the same lane (and used the newly adopted vehicle to complete the sample). This was necessary because in some cases six or seven minutes had been invested in the tracking of a specific vehicle, and it was important to avoid wasting that time where possible.

It should also be pointed out that speeds were not tracked for very slow moving queues (densities over 120/MWCOG samples only). Instead, density runs were made at 5 or 10 minute intervals, such that later on the ground the same vehicles could be found in succeeding sets of density photos; this allowed computation of speeds and associated densities.


ALL SKYCOMP DATA SAMPLES
SPEED (MPH)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
DENSITY (PCPLPM)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
(NO SAMPLES UNDER DENSITY OF 20)

DATA PROCESSING

After each flight, a topographic map was prepared for each zone which showed the starting and stopping points for each tracked car. Measurements were then made of the segment length (distance traveled). Then each tracked vehicle was entered into the computer database, including:

1. vehicle description
2. time-of-day
3. initial lane and subsequent lane changes
4. precise travel time (from stopwatch or time-lapse photographs)
5. density-photo preference, if any (default was to average the before- and after- density samples)
6. any special notes pertaining to that vehicle.

After the photos had been processed, each set of overlapping "density" photographs was taped together into a "mosaic" that showed each entire segment. Then vehicles in the required lane(s) were counted, listed by "car", "truck", "tractor-trailer" and "bus". These totals were translated into passenger-car equivalents (PCE's) using the following values:

Vehicle type:	PCE's:
cars	1
trucks	1.5
tractor-trailers	2.0
buses	1.5

(It should be noted that the distinction between "cars" and "trucks" could not be cleanly made, since there are many varieties of light and heavy pick-ups (both covered and uncovered). In general, a pick-up or van had to be at least twice the size of an average-sized car to be considered a "truck".)

PCE's were then divided by segment length to calculate densities. These density samples were then matched to corresponding speed samples; each speed/density data pair was then plotted on the chart.

CALIBRATION OF THE VAN AERDE MODEL

The latest draft of the MWCOG paper describing the calibration of the Van Aerde Speed / Density Model for the Washington D.C. metropolitan area is provided next. This paper was authored by Paul DeVivo, the member of MWCOG staff who performed the analysis.

Van Aerde Model
DRAFT -- 15 Feb 96

The main advantages to a single-regime model are that boundaries between regimes do not have to be defined; and curves from adjacent regimes do not have to be spliced at the boundaries. A single-regime model allows for a more subjective and repeatable calibration process. This will beis especially true if more data from the high-speed end of the curve is ever incorporated into this process.

The disadvantages to this particular model are that it expresses this project's independent variable as a function of the dependent variable; and that it is a non-linear function. These disadvantages make performing the initial calibration more difficult. However, once SAS programs for the task are written, they can be used again usually with a minimum of effort.

The procedure for calibration was as follows: 1) The model's equation was coded into a spreadsheet so that the shape could be defined by recognizable parameters: two points that the curve passes through, the free-flow speed, and the speed at capacity. By overlaying this curve with the scatter plot of the observations, initial estimates of the parameters were made. 2) The initial parameter estimates, the equation, and the observations were used in a SAS PROC NLIN job to machine-calibrate the parameter estimates. 3) A second SAS program translated the calibrated equation into a look-up table that expresses speed as a function of density. 4) The results of the SAS work were imported into a spreadsheet for plotting and for calculation of prediction intervals.

Two outstanding technical issues related to this procedure are determination of the free-flow speed, and calculation of prediction intervals.

The free-flow speed for best fit can be determined by the PROC NLIN program, as are all other parameters. Due to the lack of data at the low-density region of the model, PROC NLIN returns a very high free-flow speed. Additional data from MD SHA was used to calculate a free-flow speed for general application on the Beltway. The calibration of the model presented here resulted from forcing the free-flow speed to match the SHA data analysis.

The prediction intervals shown in the current plot were calculated after the model was translated. This may have not been appropriate. PROC NLIN calculates prediction intervals directly as it calibrates the model. Those prediction intervals express density as a function of speed, however. Work is in progress to translate them, and to otherwise arrive at the most appropriate method of determining prediction intervals.

Since a single-regime model is more suitable in a computerized process, and for lack of significant difference in performance, the Van Aerde model is preferred over earlier approaches examined by MWCOG staff and presented before subcommittees.

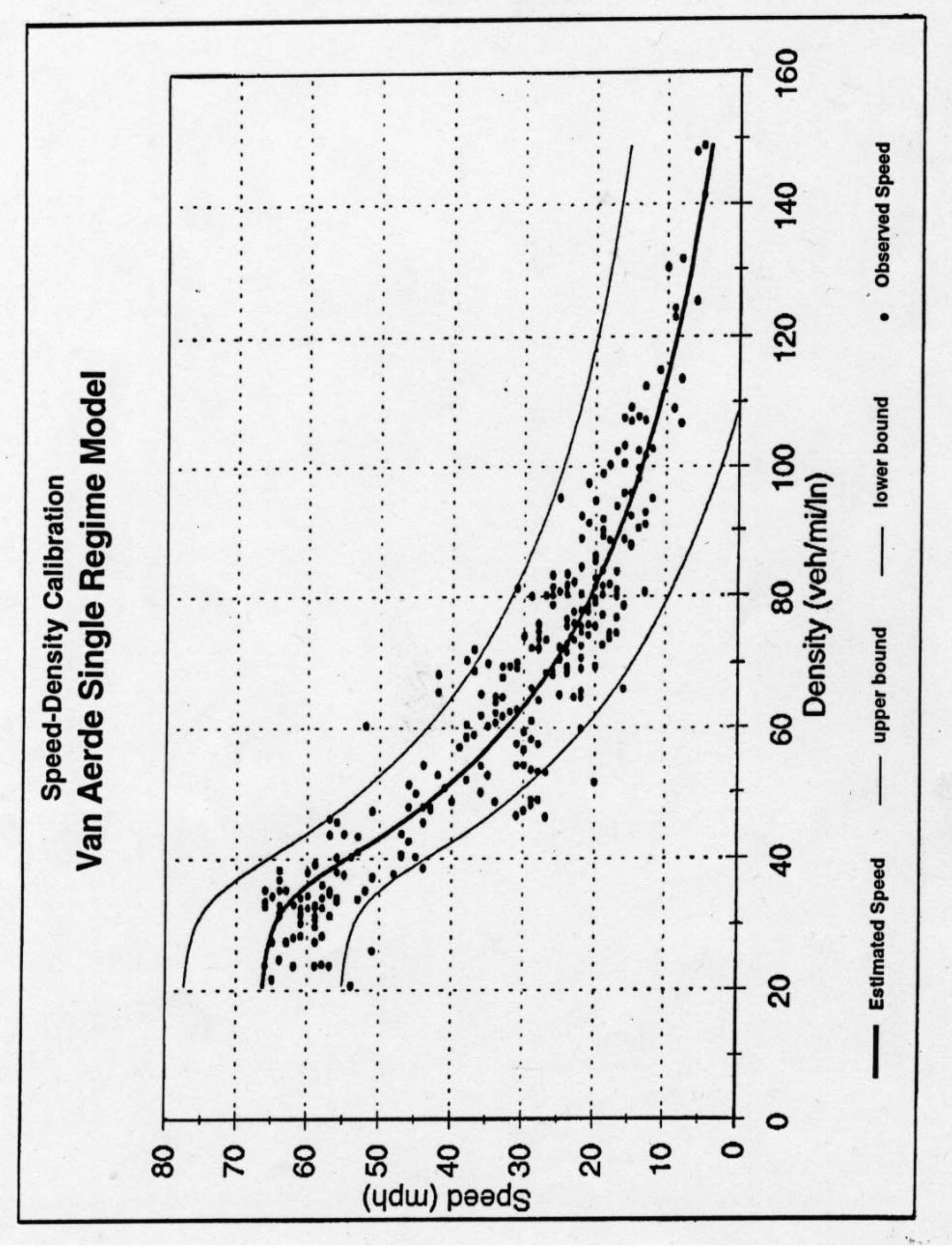
Speed-Density Calibration
Van Aerde Single Regime Model

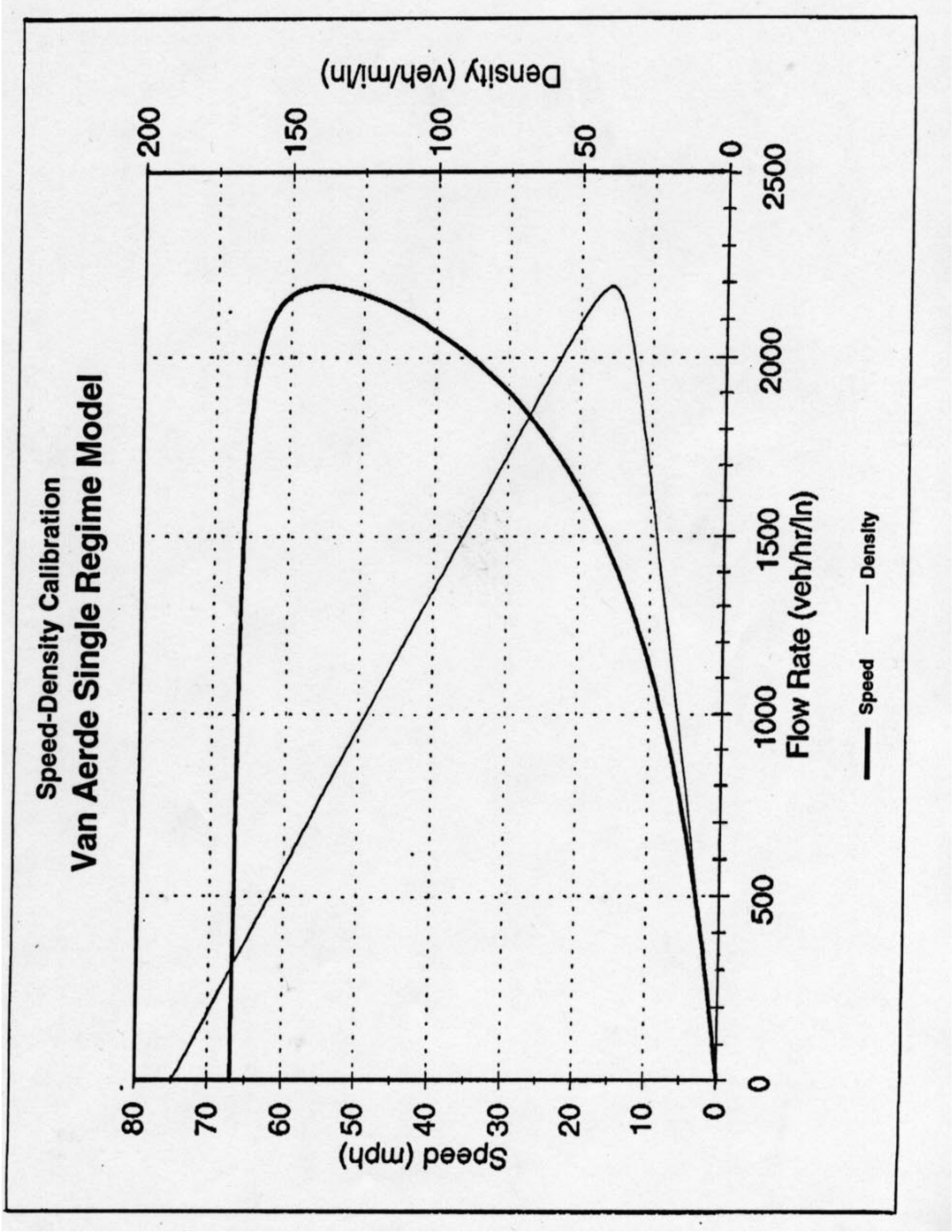
free-flow spd = 67 mph / c1 = 0.00512 / c2 = 0.0114 / c3 = 0.000342

	DENSITY (veh/ln/mi)	SPEED (mph)	VOLUME (veh/ln/hr)
free-flow	0	67.0	0
	20	66.4	1,328
	25	65.8	1,661
	30	64.6	1,946
	35	61.3	2,144
capacity	39	55.8	2,190
	40	54.7	2,189
	45	47.8	2,153
	50	41.9	2,094
	55	36.8	2,025
	60	32.6	1,954
	65	28.9	1,880
	70	25.8	1,806
	75	23.1	1,731

DENSITY (veh/ln/mi)	SPEED (mph)	VOLUME (veh/ln/hr)	
80	20.7	1655	
85	18.6	1580	
90	16.7	1503	
95	15.0	1425	
100	13.5	1350	
105	12.1	1271	
110	10.9	1197	
115	9.7	1117	
120	8.7	1043	
125	7.7	963	
130	6.8	885	
135	6.0	810	
140	5.2	729	
187	0	0	jam

Draft 15 February 1996


Speed-Density Calibration
Van Aerde Single Regime Model
Speed (mph)
80
70
60
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
Density (veh/mi/ln)
Estimated Speed
upper bound
lower bound
Observed Speed


Speed-Density Calibration
Van Aerde Single Regime Model
Speed (mph)
0
10
20
30
40
50
60
70
80
Density (veh/mi/ln)
0
50
100
150
200
Flow Rate (veh/hr/ln)
0
500
1000
1500
2000
2500
Speed
Density