Development of a Macro / Meso / Micro Framework for I-395 HOV Lane Conversion

TPB Travel Forecasting
Subcommittee

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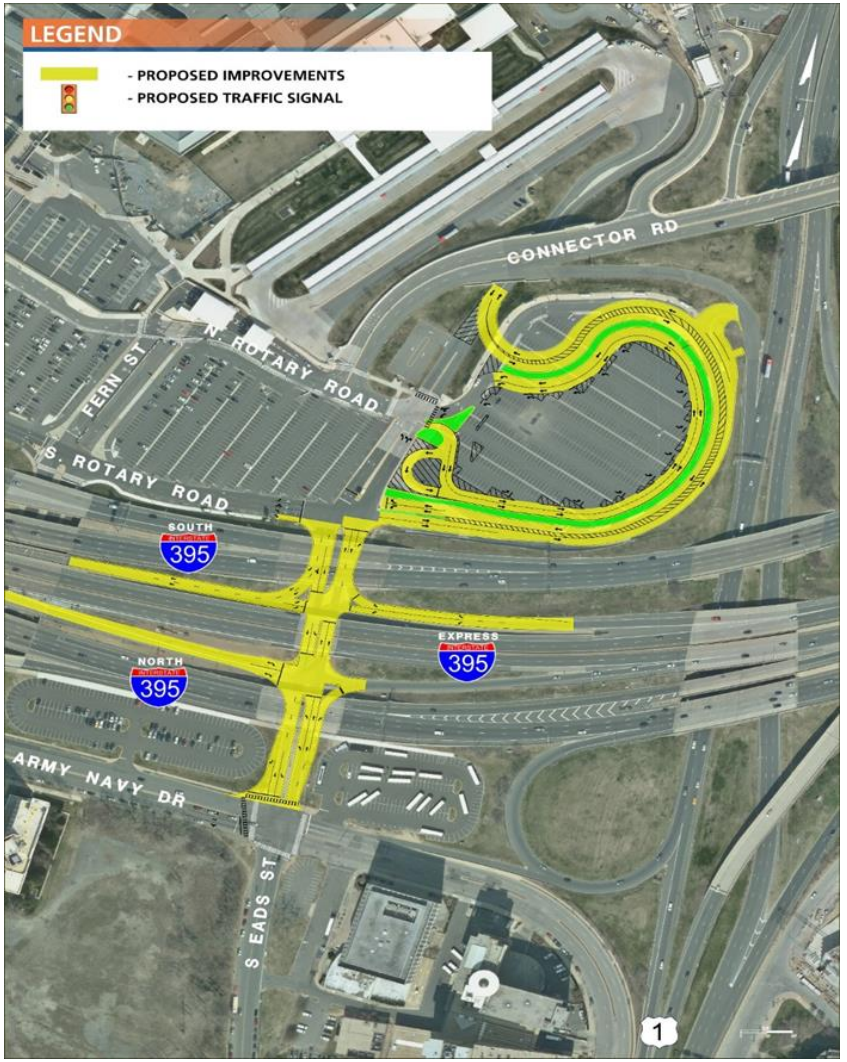
July 21, 2017

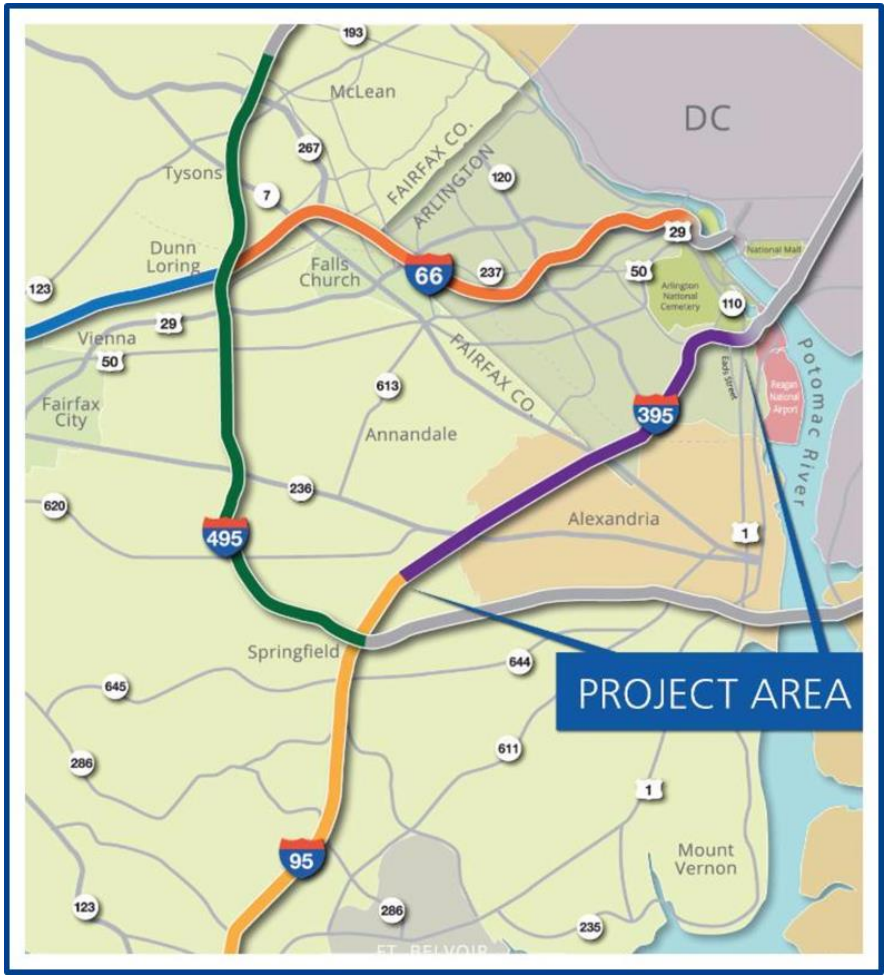
Agenda

- Project Overview
- Challenges
- Approach
  - MWCOG Model
  - Regional Model Post Processor
  - Regional Operational Analysis



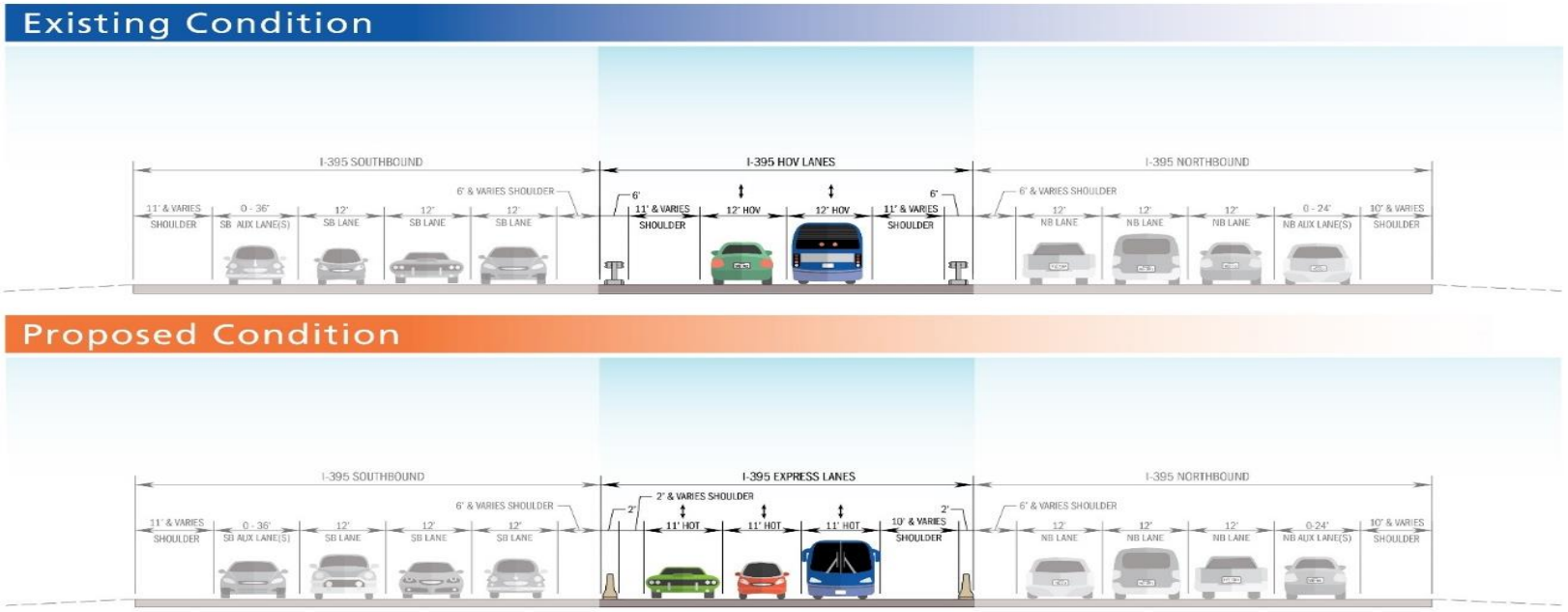
Project

- Development of Traffic Forecasts to support the Environmental Assessment and Interchange Justification Report
- I-395 study area extends from north of Edsall Road to Eads Street interchange (near the Pentagon)
- Three / four general purpose lanes per direction
- Two barrier-separated reversible HOV-3 lanes



Project

- Convert the two existing reversible HOV-3 lanes on I-395 to three managed lanes for eight miles from north of Edsall Road to the vicinity of Eads Street near the Pentagon



Project

- High Occupancy Toll lanes (HOT lanes)
- Dynamic toll prices manage demand to ensure free-flow travel speeds
- All existing access points to remain the same configuration except for the Eads Street

Challenges

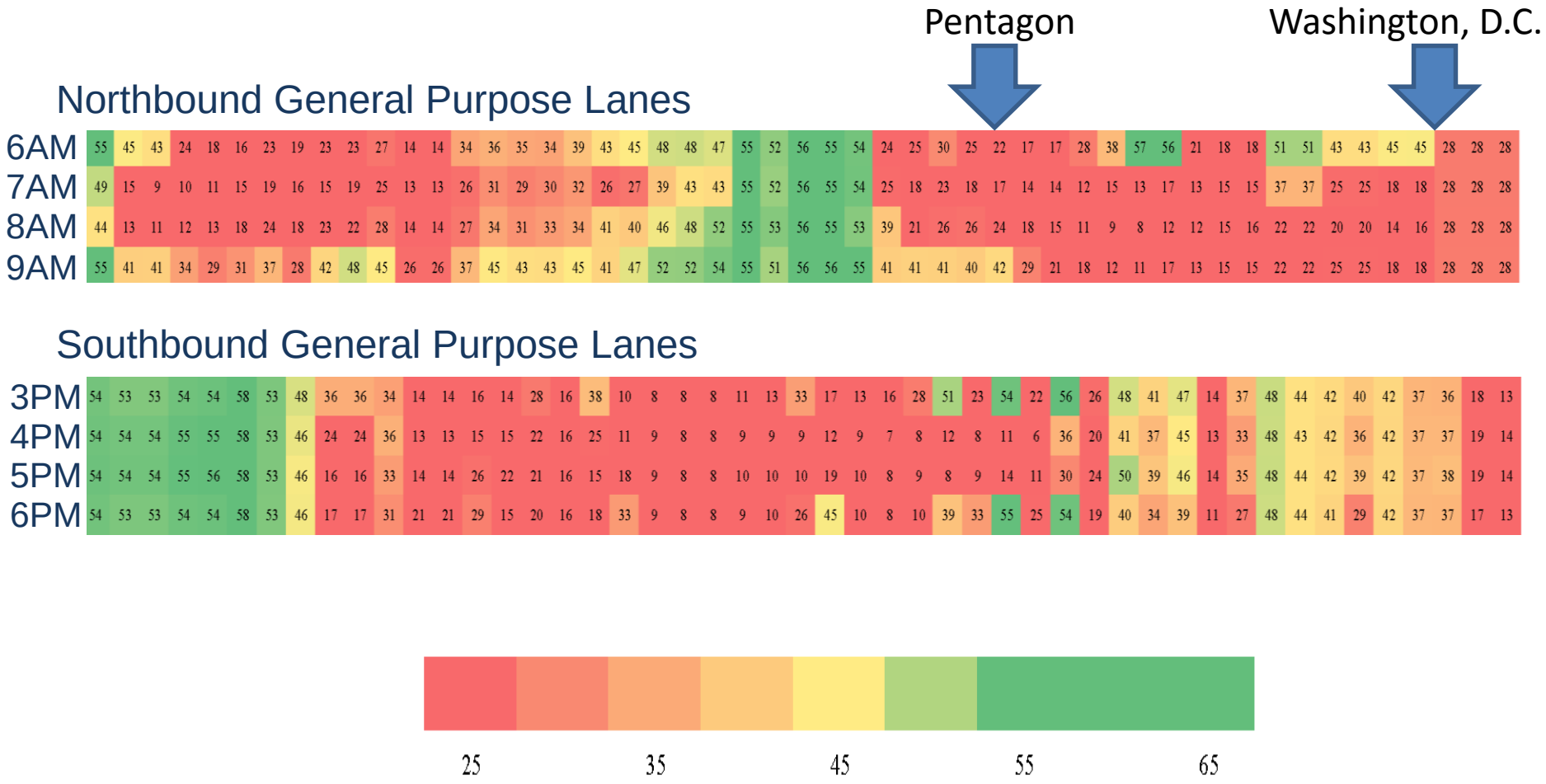
Challenge	Macro	Meso	Micro
Throughput of the Corridor	X	X	X
Operations of the facility (HOV3 / Toll / Direction)	X	X	X
Requirements of NEPA, IJR and Public Involvement	X	X	X
Highly Congested Conditions (Saturation of Traffic)	X	X	X
Maintenance of Operations	X	X	X

Challenges

Time Period	HOV Lane Operation
12 AM – 2:30 AM	Closed
2:30 AM – 6 AM	NB - All Vehicles Permitted
6 AM – 9 AM	**NB HOV-3 Only**
9 AM – 11 AM	NB - All Vehicles Permitted
11 AM – 1 PM	Closed
1 PM – 3:30 PM	SB - All Vehicles Permitted
3:30 PM – 6 PM	**SB HOV-3 Only**
6 PM – 12 AM	SB - All Vehicles Permitted

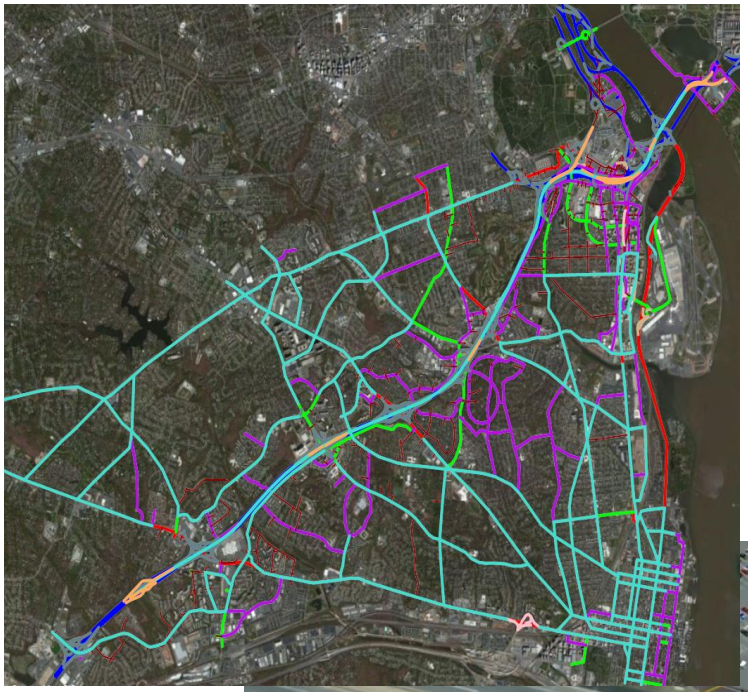
Challenges

Slow Speeds During Peak Periods

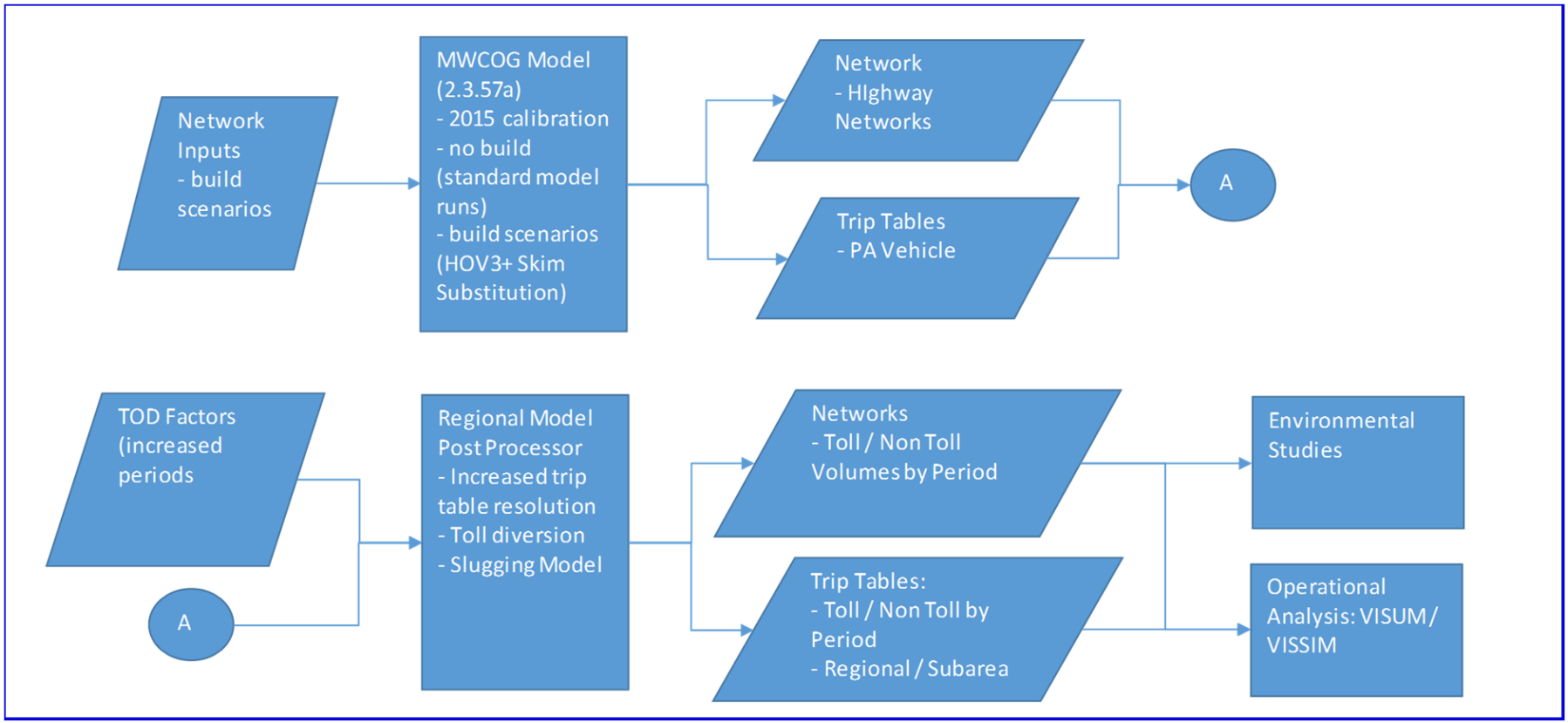


Approach

- Regional Travel Demand Model
- Model Post Processor
- Peak Hour Subarea Models
- Peak Period Operations Model



Approach


Network Inputs - build scenarios
MWCOG Model (2.3.57a) - 2015 calibration - no build (standard model runs) - build scenarios (HOV3+ Skim Substitution)
Network - Highway Networks
Trip Tables - PA Vehicle
A
TOD Factors (increased periods
A
Regional Model Post Processor - Increased trip table resolution - Toll diversion - Slugging Model
Networks - Toll / Non Toll Volumes by Period
Trip Tables: - Toll / Non Toll by Period - Regional / Subarea
Environmental Studies
Operational Analysis: VISUM / VISSIM

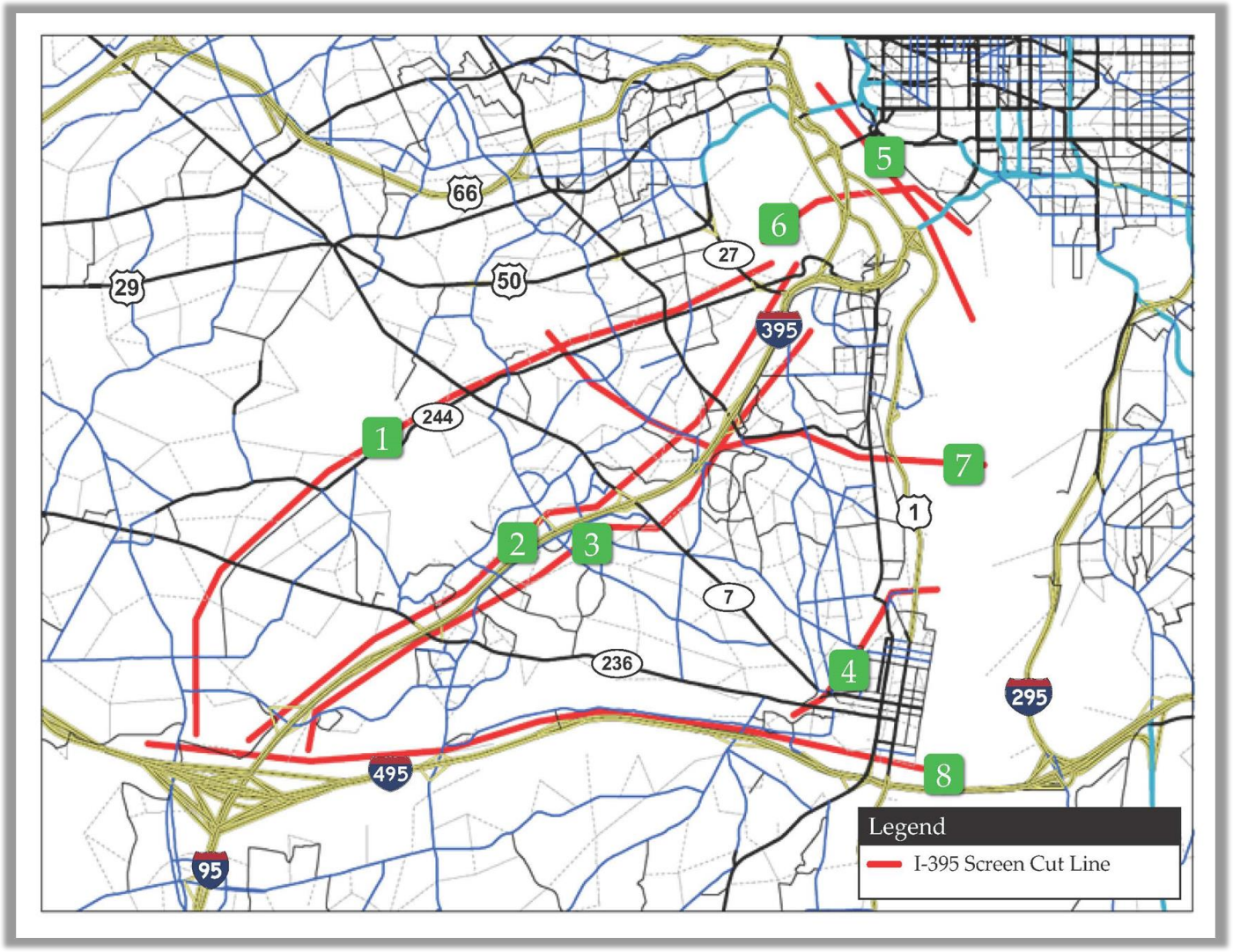
Approach

	Level	Tool	Application
Consistency	Macroscopic	MWCOG Regional Model	• Demand Estimation • Toll Diversion
		Regional Model Post Processor	• Demand by Analysis Hours for Meso and Micro Analysis • Testing of Tolling Strategies
	Mesoscopic	VISUM	• Use of ODME with Regional Model Trip Tables for Microscopic Analysis • Response to needs of NEPA
	Microscopic	VISSIM	• Operational Analysis for IJR

Approach - MWCOG

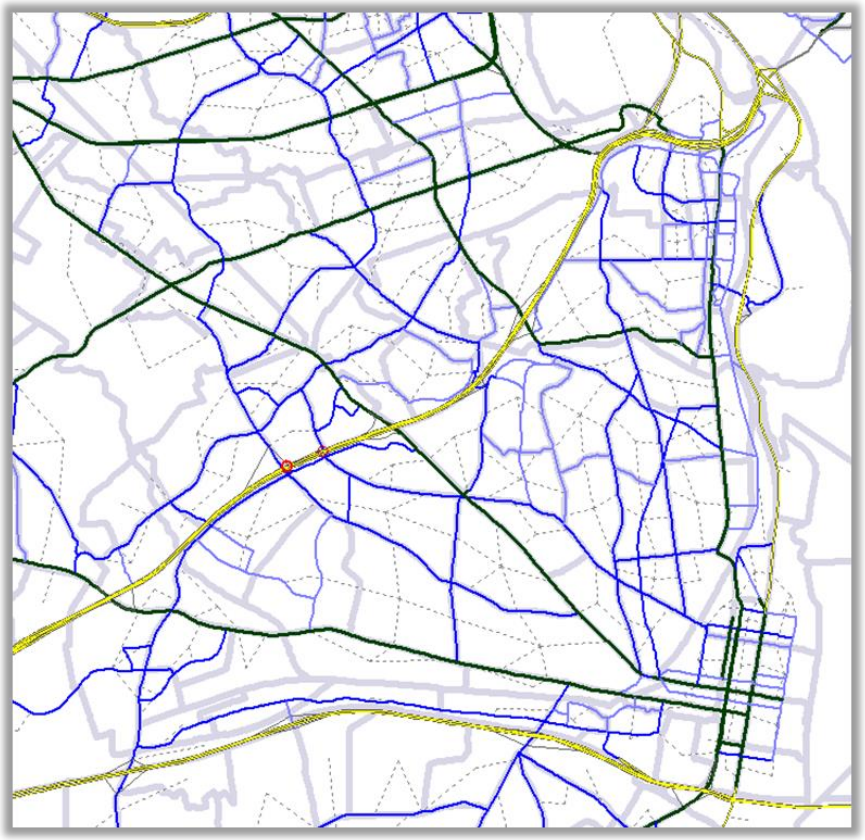
- TPB regional travel demand forecasting model (Ver. 2.3.57a)
- Used as the basis for the development of traffic forecasts
- Validated along I-395 and regional cutlines on daily traffic
- Forecast year
  - Existing conditions (2015)
  - 2020
    - No Build
    - Build Conditions (reflecting the proposed conversion of the two HOV lanes to three HOT lanes and improvements to the Eads Street interchange)
  - 2040
    - No Build
    - Build Conditions (reflecting the proposed conversion of the two HOV lanes to three HOT lanes and improvements to the Eads Street interchange)

MWCOG Study Area



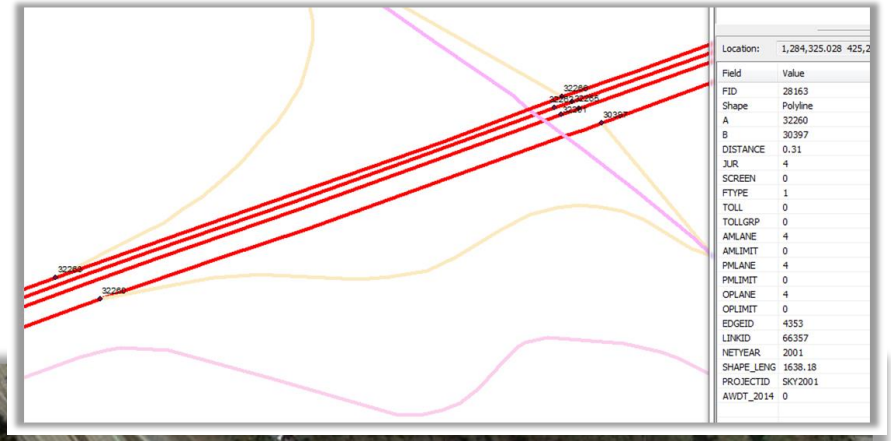
MWCOG Network Review

- Network detail level for project and TAZ compatibility
- Network attributes reviewed
  - Facility type
  - Number of lanes by time of day
  - Restriction to facilities by time of day



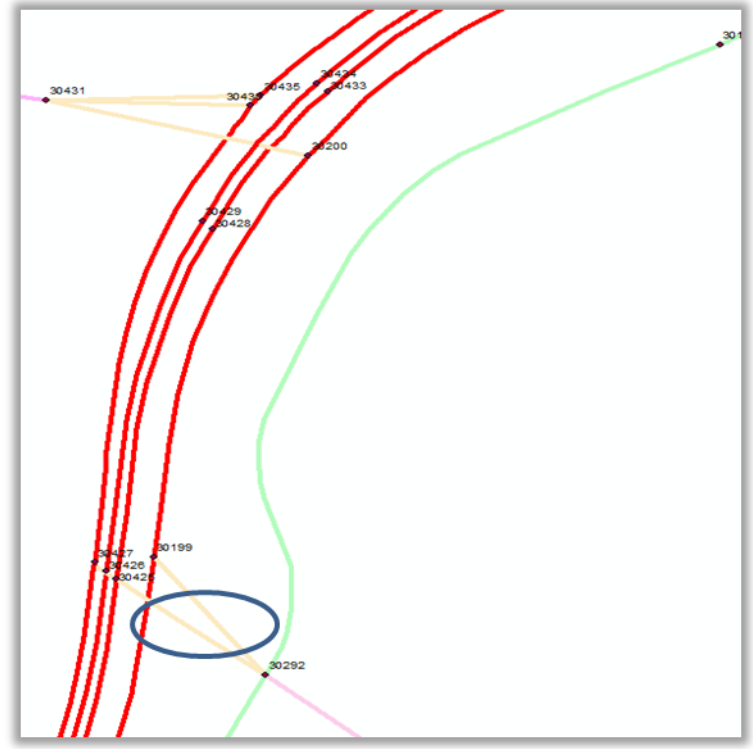
MWCOG Network Review

I-395 NB general purpose (GP) lanes between the Route 7/King Street ramps were modified from 4 lanes to 3 lanes



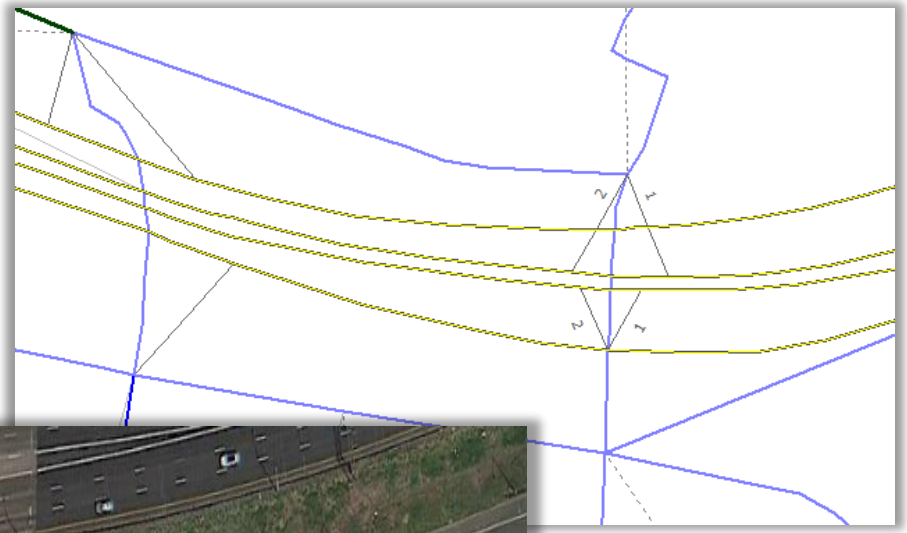
MWCOG Network Review

S. Arlington Ridge Road ramps to and from I-395 were modified from 2 lanes to 1 lane



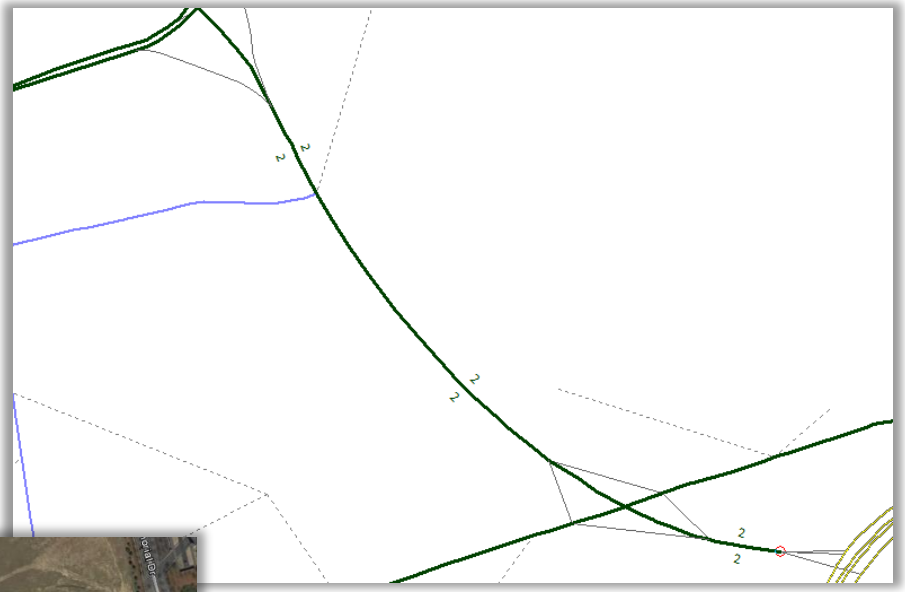
MWCOG Network Review

I-395 HOV ramps to and from the south at Eads Street were modified from 2 lanes to 1 lane



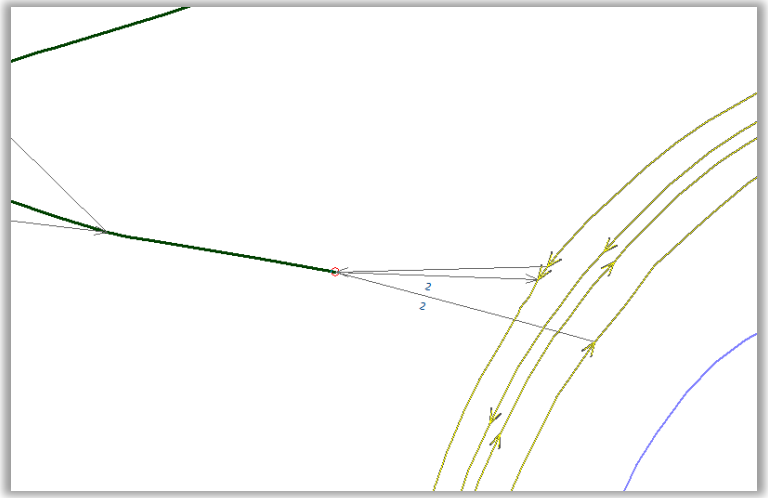
MWCOG Network Review

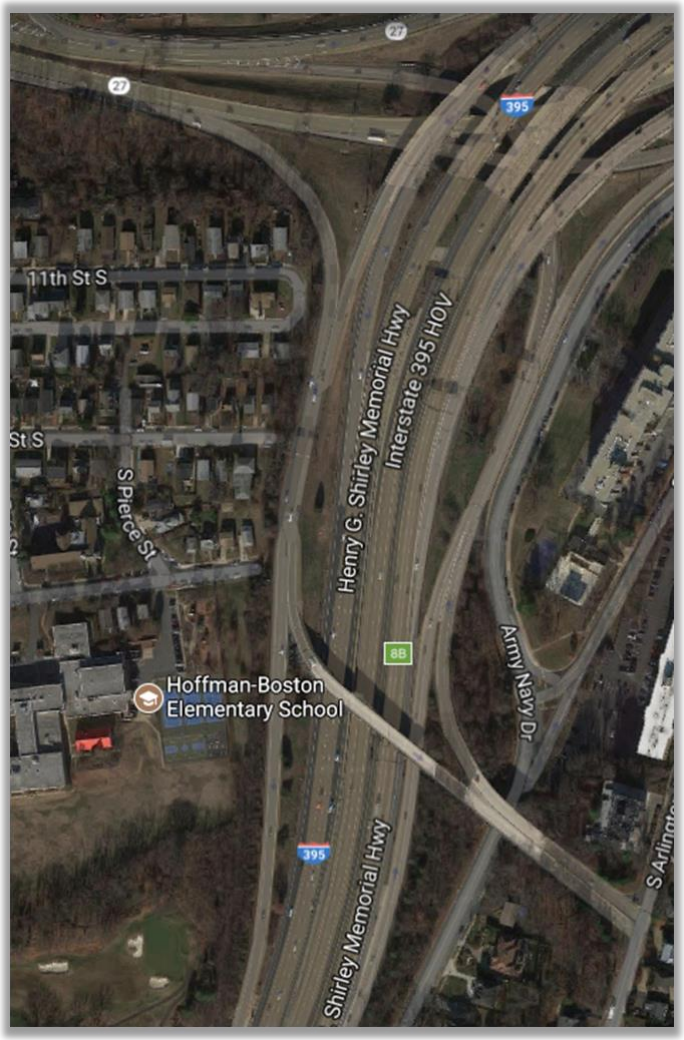
S. Washington Boulevard between the I-395 interchange and the US 50 interchange was modified from a major arterial with FTYPE of 2 to an expressway with a FTYPE 5 according to VDOT Website



MWCOG Network Review

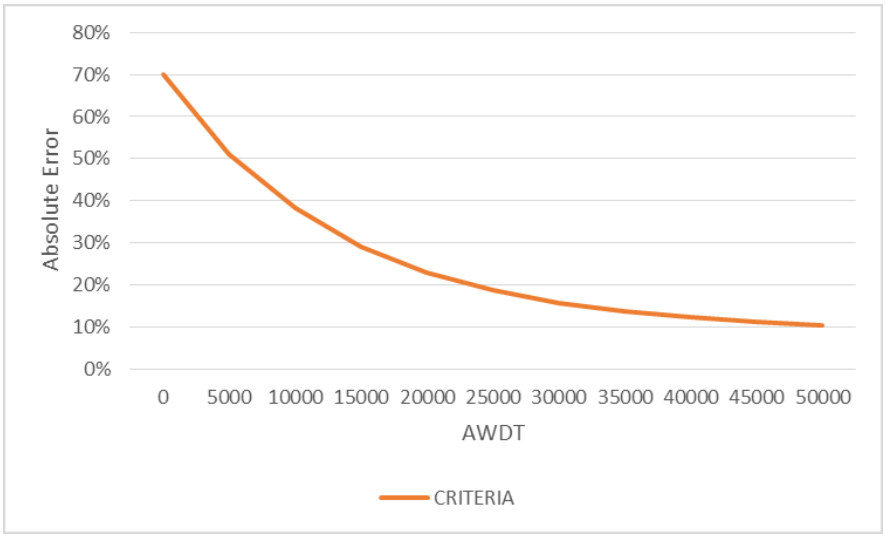
I-395 NB GP off ramp to S. Washington Boulevard was modified from 2 lanes to 1 lane



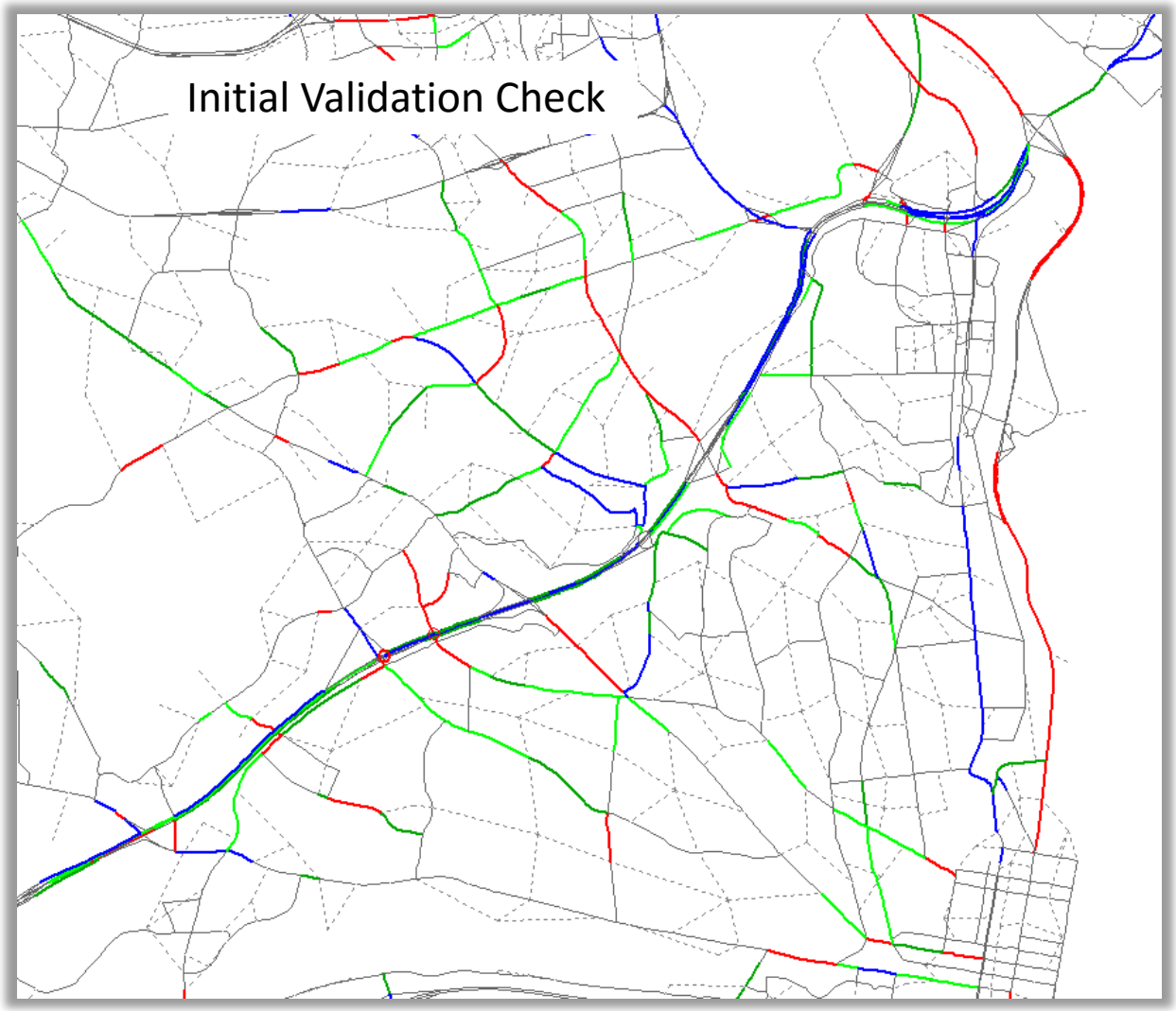


MWCOG Calibration Targets

- Calibration Targets
  - *Travel Demand Modeling Policies and Procedures, Ver. 2.00*. Virginia Department of Transportation, June 2014



MWCOG Initial Results



Cutline	Criteria	Original 2015
1	10%	-11%
2	10%	-16%
3	10%	7%
4	10%	5%
5	10%	-19%
6	10%	13%
7	10%	-2%
8	10%	-3%

Overloaded
- Within Criteria
- Outside Criteria

Underloaded
- Within Criteria
- Outside Criteria

MWCOG Calibration

- Centroid location
- Centroid connector loading points
- Add in additional FTYPE
  - GW. Parkway from FTYPE 1 (freeway) to FTYPE 8 - 2nd type expressway with lower free speed and capacity
  - US 50 from FTYPE 2 (major arterial) to FTYPE 7 - 2nd type major arterial with higher free speed and capacity
  - Changed Route 1 / Jefferson Davis Highway between City of Alexandria and Crystal City from FTYPE 2 (major arterial) to FTYPE 7 with a higher speed based on roadway function
  - Changed Jefferson Davis Highway and S. Washington Boulevard between I-395 and I-66 from FTYPE 1 (freeway) to FTYPE 5 (expressway) based on roadway design and speeds
- Removed the HOV ramp to/from I-395 south at Seminary Road by adjust AMLIMIT/ PMLIMIT/ OPLIMIT from 0 to 9 (the ramp was not opened until January 2016)
- Added the S. Joyce Street link between Columbia Pike and Amy Navy Drive
- Added the I-395 GP southbound off-ramp to Route 1
- Changed Jefferson Davis Highway and S. Washington Boulevard between I-395 and I-66 from FTYPE 1 (freeway) to FTYPE 5 (expressway) based on roadway design and speeds
- Updated transit route file to accommodate the modified highway network
- Adjusted speed / capacity tables used in the model to reflect the additional facility types added to the network.

MWCOG Calibration

Original Free Flow Speed

Facility Type	Area Type 1	2	3	4	5	6
Centroid Connector	15	15	20	25	30	35
Freeway	55	55	60	60	65	65
Major Arterial	35	35	45	45	50	50
Minor Arterial	35	35	40	40	40	45
Collector	30	30	30	35	35	35
Expressway	45	45	50	50	50	55
Ramp	20	20	30	30	35	50

Original Free Flow Capacity

Facility Type	Area Type 1	2	3	4	5	6
Centroid Connector	3150	3150	3150	3150	3150	3150
Freeway	1900	1900	2000	2000	2000	2000
Major Arterial	600	800	960	960	1100	1100
Minor Arterial	500	600	700	840	900	900
Collector	500	500	600	800	800	800
Expressway	1100	1200	1200	1400	1600	1600
Ramp	1000	1000	1000	1000	2000	2000

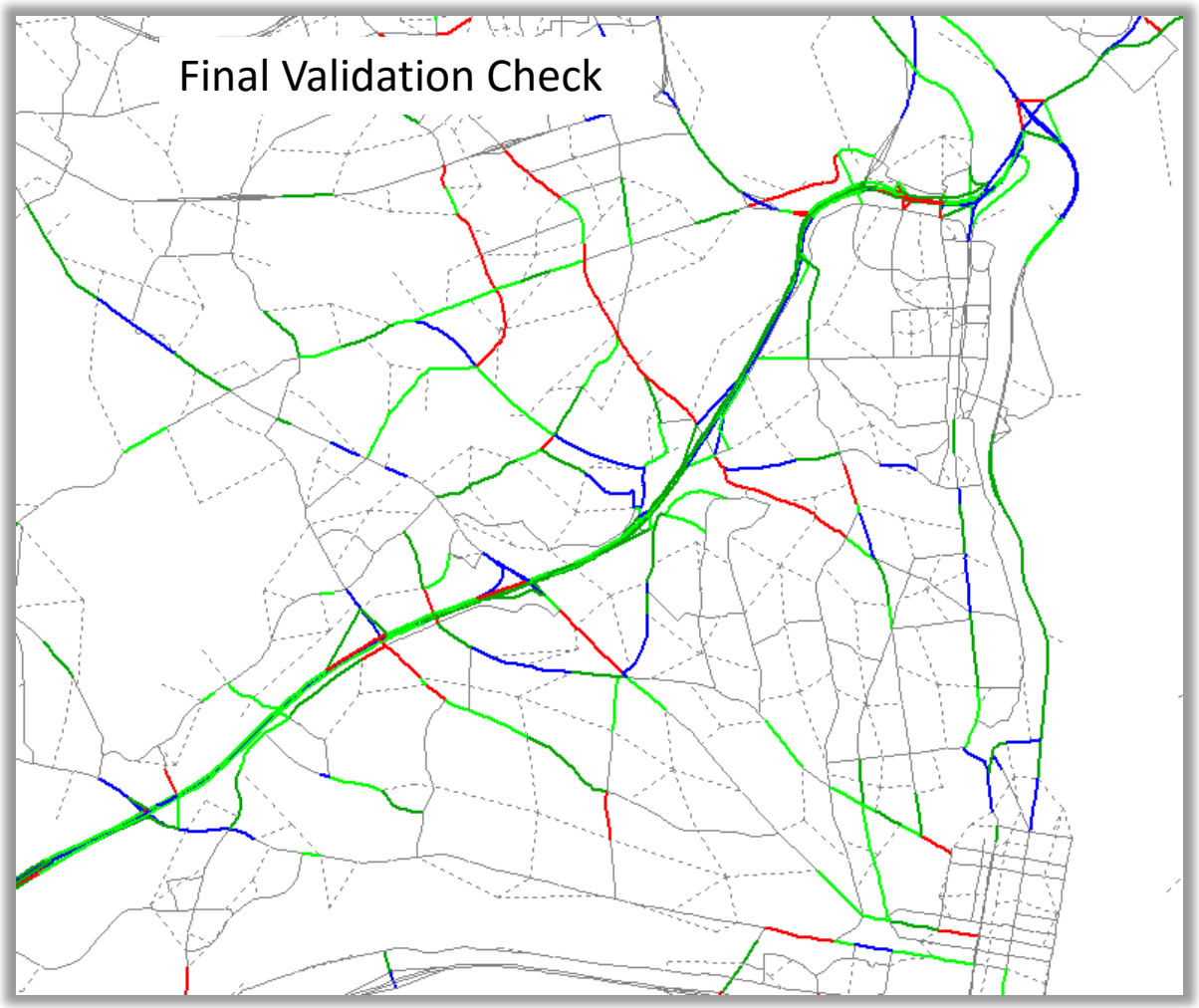
Modified Free Flow Speed

Facility Type	Area Type 1	2	3	4	5	6
Centroid Connector	15	15	20	25	30	35
Freeway	55	60	60	60	65	65
Major Arterial	35	35	40	45	45	50
Minor Arterial	30	35	40	40	40	45
Collector	25	30	30	35	35	35
Expressway	45	50	50	50	55	55
Ramp	20	20	30	30	35	50
Major Arterial 2	40	45	45	45	45	50
Expressway 2	45	48	50	50	50	55

Modified Free Flow Capacity

Facility Type	Area Type 1	2	3	4	5	6
Centroid Connector	3150	3150	3150	3150	3150	3150
Freeway	1900	2000	2000	2000	2000	2000
Major Arterial	600	700	800	900	1000	1100
Minor Arterial	500	600	700	750	900	900
Collector	500	500	700	800	800	800
Expressway	1100	1200	1400	1400	1600	1600
Ramp	1000	1000	1000	1000	2000	2000
Major Arterial 2	800	900	900	1000	1000	1100
Expressway 2	1100	1200	1200	1400	1400	1600

MWCOG Validation



Cutline	Criteria	Original 2015	Calibration 2015
1	10%	-11%	1%
2	10%	-16%	-11%
3	10%	7%	3%
4	10%	5%	4%
5	10%	-19%	-13%
6	10%	13%	-14%
7	10%	-2%	1%
8	10%	-3%	-2%

Overloaded
- Within Criteria
- Outside Criteria

Underload
- Within Criteria
- Outside Criteria

MWCOG Application

- No-Build
  - Incorporate the base year adjustment
  - Keep same facility limit
    - Northbound AM HOV3, PM prohibited, OP open to general traffic
    - Southbound AM prohibited, PM HOV3, OP open to general traffic
- Build
  - Incorporate the base year adjustment
  - Modify facility limit
    - Base run
      - Northbound AM HOV3, PM prohibited, OP HOV3
      - Southbound AM prohibited, PM HOV3, OP HOV3
    - Final run
      - Northbound AM truck prohibited, PM prohibited, OP truck prohibited
      - Southbound AM prohibited, PM truck prohibited, OP truck prohibited
  - Add toll related data in network and modified toll table

Approach – Regional Model Post Processor

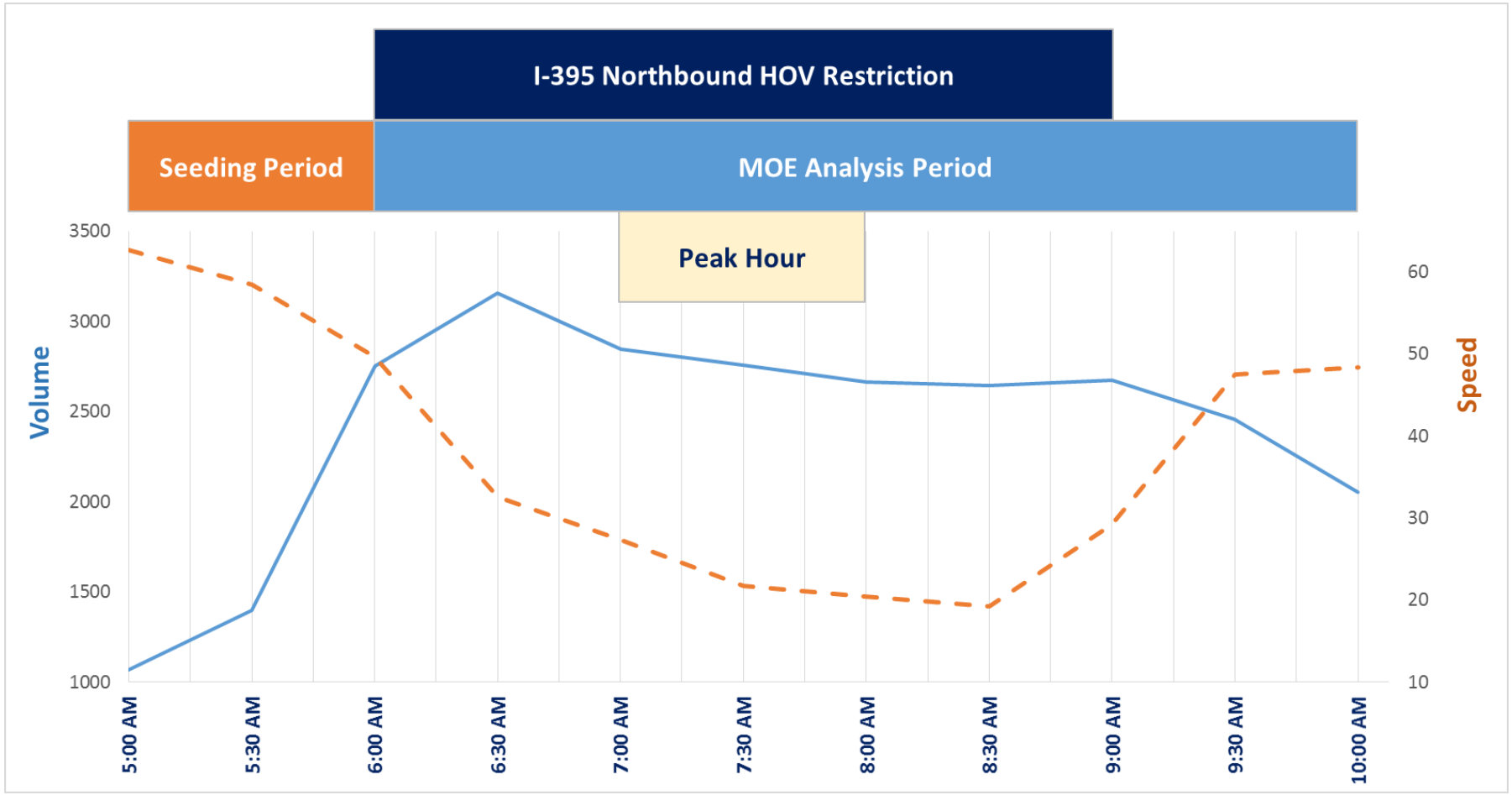
- Need for Post Processor
  - Alignment of operational periods of the facility to the demand
  - Development of hourly demand for input into meso and micro tools
  - Coding of Toll Choice vs Generalized Cost
  - Capturing of Informal Ride Sharing (SOV / HOV3 Conversion)
- Criteria
  - Maintain consistency with MWCOG demand and methods
  - Consistency in daily volumes

Time of Day Alignment

Hour Beginning	MWCOG Model	I-395 HOV Operations	MWCOG Post Processor	VISUM / VISSIM	Future I-395 HOT Lane Operations
0	NT ALL	CLOSED	NT 1		CLOSED
1					
2					
230 [1]		NB ALL			NB HOT
3					
4					
5			NT 2	AM 5-6	
6	AM NB HOV3	NB HOV3	AM 1	AM 6-7	
7				AM 7-8	
8				AM 8-9	
9	MD ALL	NB ALL	AM 2	AM 9-10	
10					
11		CLOSED	MD		CLOSED
12					
13		SB ALL	PM 1		SB HOT
14				PM 2-3	
15	PM SB HOV3		PM 2	PM 3-330	
1530 [2]		SB HOV3		PM 330-4	
16				PM 4-5	
17				PM 5-6	
18		SB ALL	PM 3	PM 6-7	
19	NT ALL		NT 1		
20					
21					
22					
23					

[1] The HOV/HOT lanes are closed to traffic nightly from 12:00 AM to 2:30 AM
[2] The HOV 3+ restrictions are in place from 3:30 PM to 6:00 PM

Analysis Hours



Slugging

- Demand for slugging on the I-395 based on surveys conducted as part of the Pentagon Transportation Management Plan
- MWCOG Model does not capture the conversion of trips from SOV to HOV3 or the transfer of trips from transit to passenger mode
  - Significant volume (400 vehicles per hour) entering and leaving the facility
- Generate trip tables from MWCOG Model
  - Identification of SOV candidate trips / conversion to HOV3

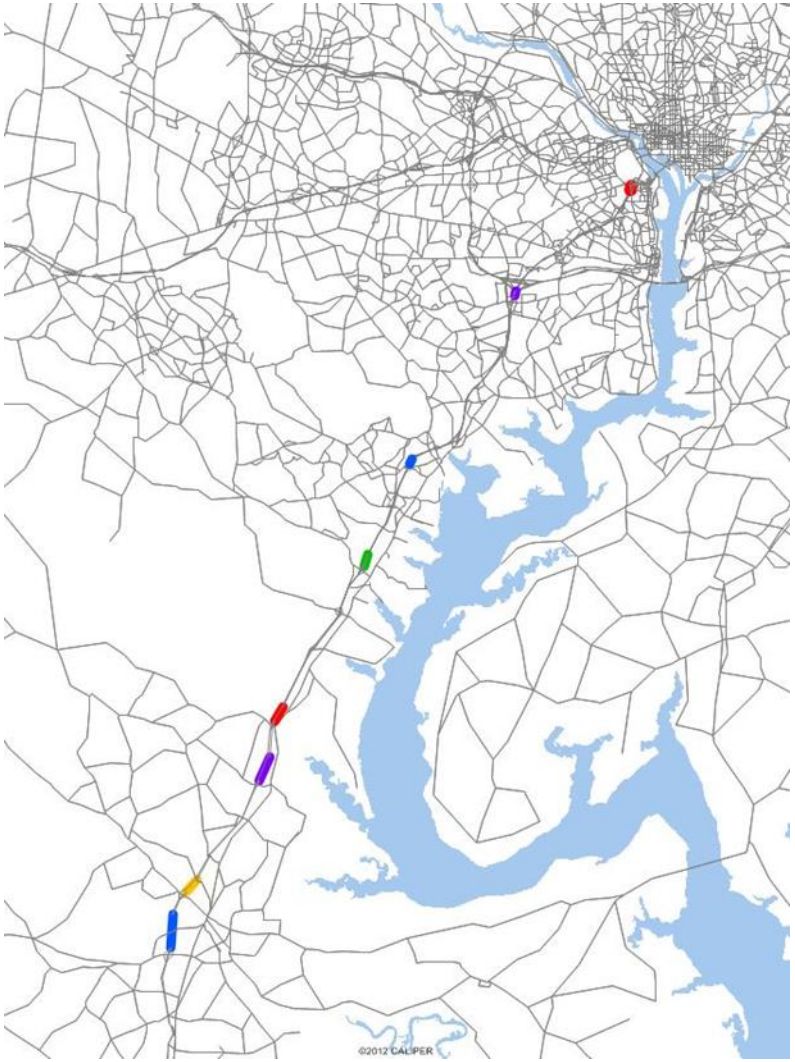
Table 2-1 Informal Rideshare/Slugging Demand Survey

Informal Rideshare Line	Vehicles (3:00 - 6:00 PM)	Riders (3:00 - 6:00 PM)
Rt. 3 Fredericksburg Gordan Rd	45	90
Rt. 17 Stafford	95	195
Rt. 610 Mine Rd.	130	250
Rt. 610 Stafford	165	320
Horner Rd./Potomac Mills	315	600
Montclair/Route 234	245	480
Tackett's Mill/Lorton/VRE	115	245
Burke/Springfield	130	275
Totals	1240	2455

Data source: October 2010 Data Collection

Slugging

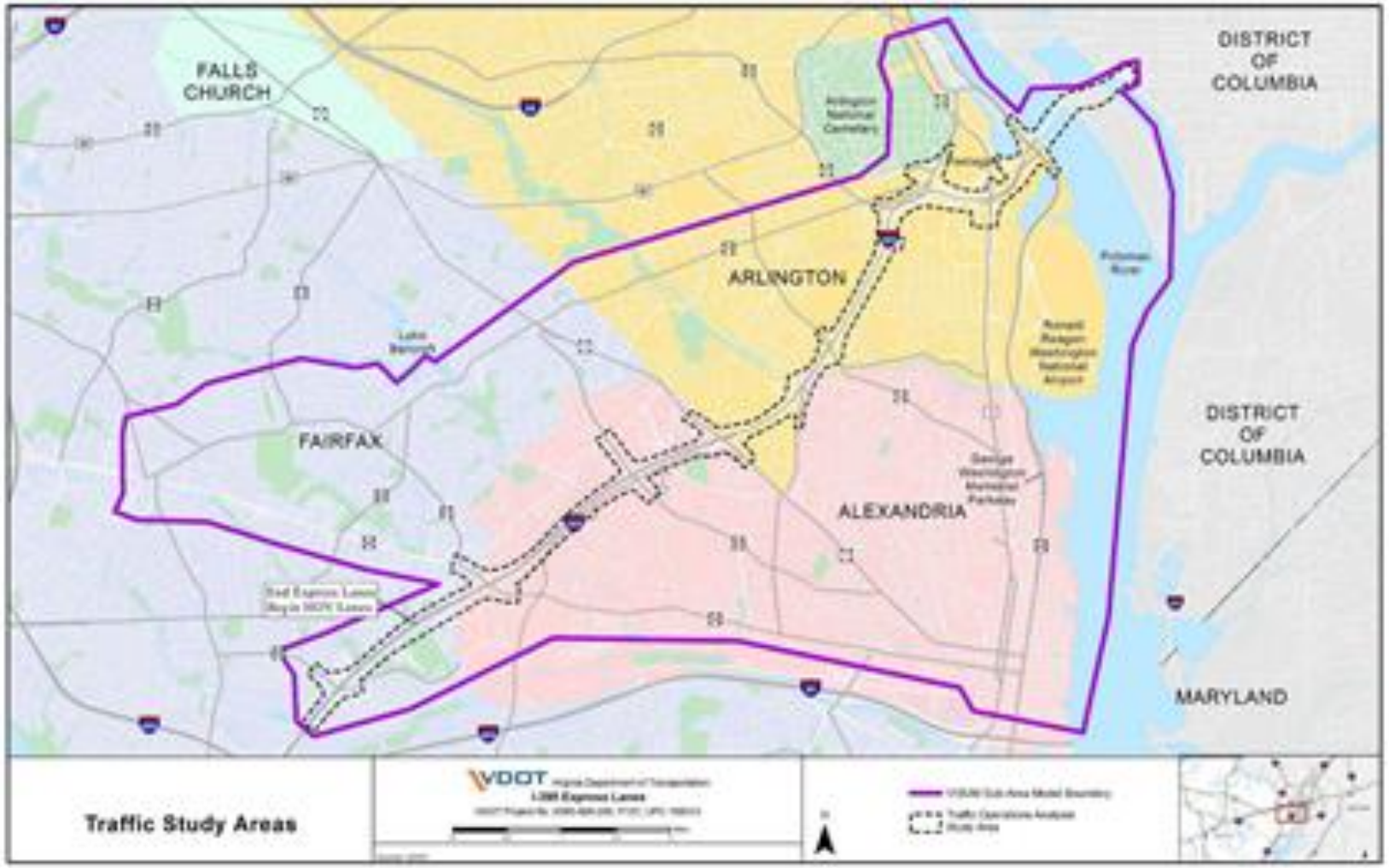
- Identification of Scraper Trips
  - Identified slugging locations along corridor based on reported stops
  - Used select link analysis in PM to identify candidate SOV trips passing by Pentagon and going to destinations
  - Compared model trips to survey
    - < Survey: adjusted upto survey
    - > Survey: took proportion
  - Converted SOV trip:
    - SOV / HOV3 / SOV



Approach – Peak Period Operational Models

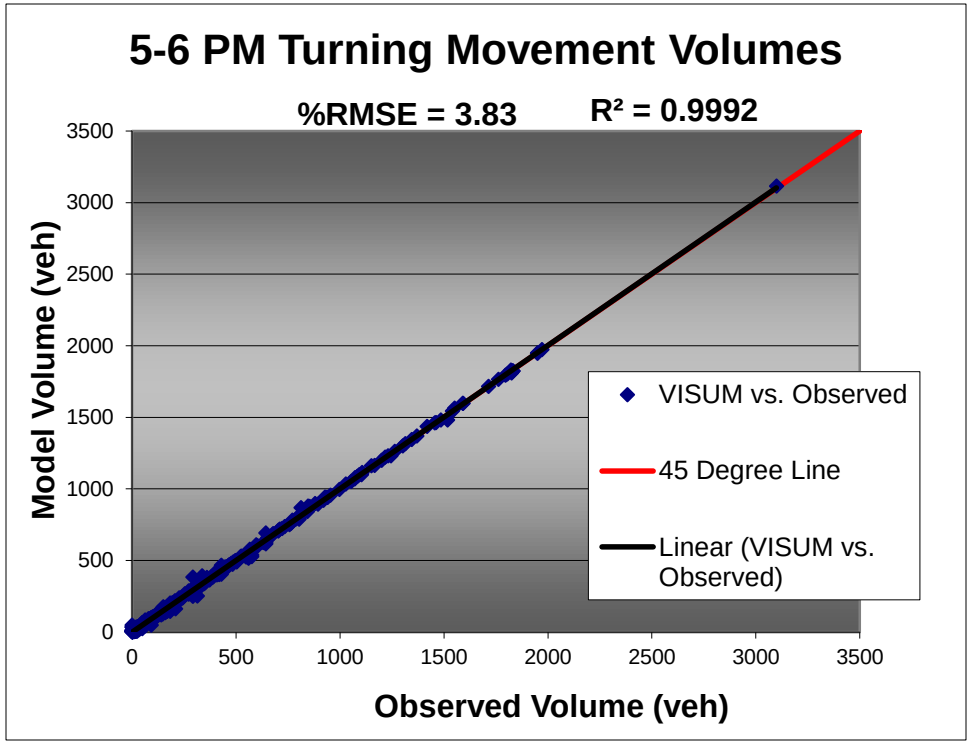
- Measures of Effectiveness:
- Environmental Assessment
  - Mesoscopic simulation
- Interchange Modification Report (IMR)
  - Microscopic simulation

Operational Models



Peak Hour Subarea Models

- Added network detail:
  - Zone disaggregation
  - Intersection geometry and control
- Used MWCOG Post Processor trip tables as input to ODME process
- Validated to link and turning movement target volumes for the 10 analysis hours
- Toll diversion refined for each hour for Build scenarios



Peak Period Operation Models

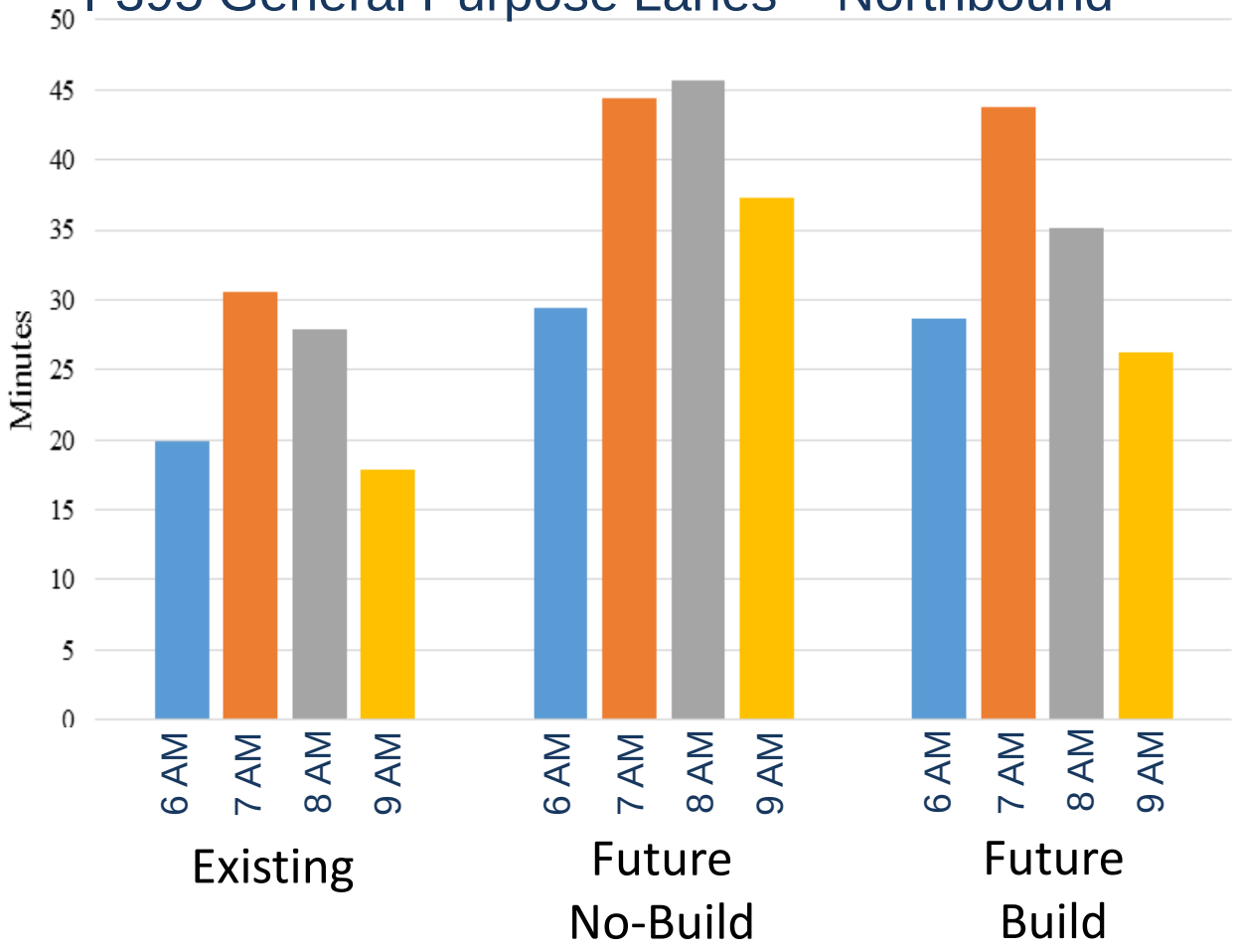
- Dynamic Traffic Assignment using subarea trip tables
- Validated to travel time and link counts
- Toll diversion refined for Build scenarios

Vehicle Travel Time Summary - AM Peak

I-395 General Purpose	VISSIM (sec)	Field (sec)	Difference (%Δ)
From North of I-495 interchange			
to Entrance Ramp from HOV Northbound (Turkeycock Run)	310	290	7
to Entrance Ramp from Little River Turnpike	245	224	9
to Entrance Ramp from Seminary Road	441	392	13
to Entrance Ramp from Glebe Road	258	300	14
to Entrance Ramp from Jefferson Davis Highway	332	361	8
to Exit Ramp to Route 1 North	306	321	5
to Exit Ramp to 12th Street Expressway / End of Run	93	96	3
Total Travel Time (sec)	1,985	1,984	0

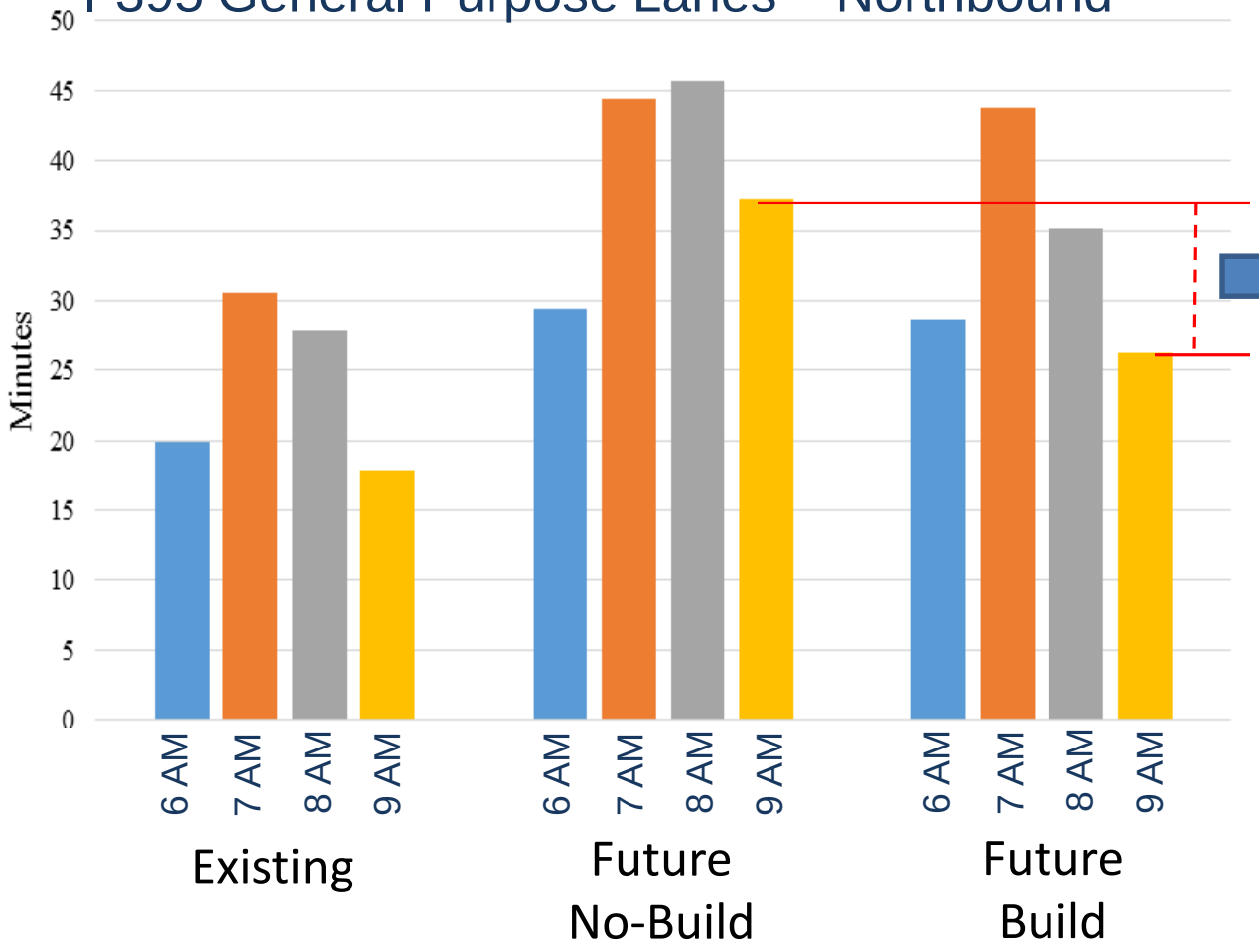
Project Benefits

2040 Corridor Travel Time
I-395 General Purpose Lanes – Northbound



Project Benefits

2040 Corridor Travel Time
I-395 General Purpose Lanes – Northbound

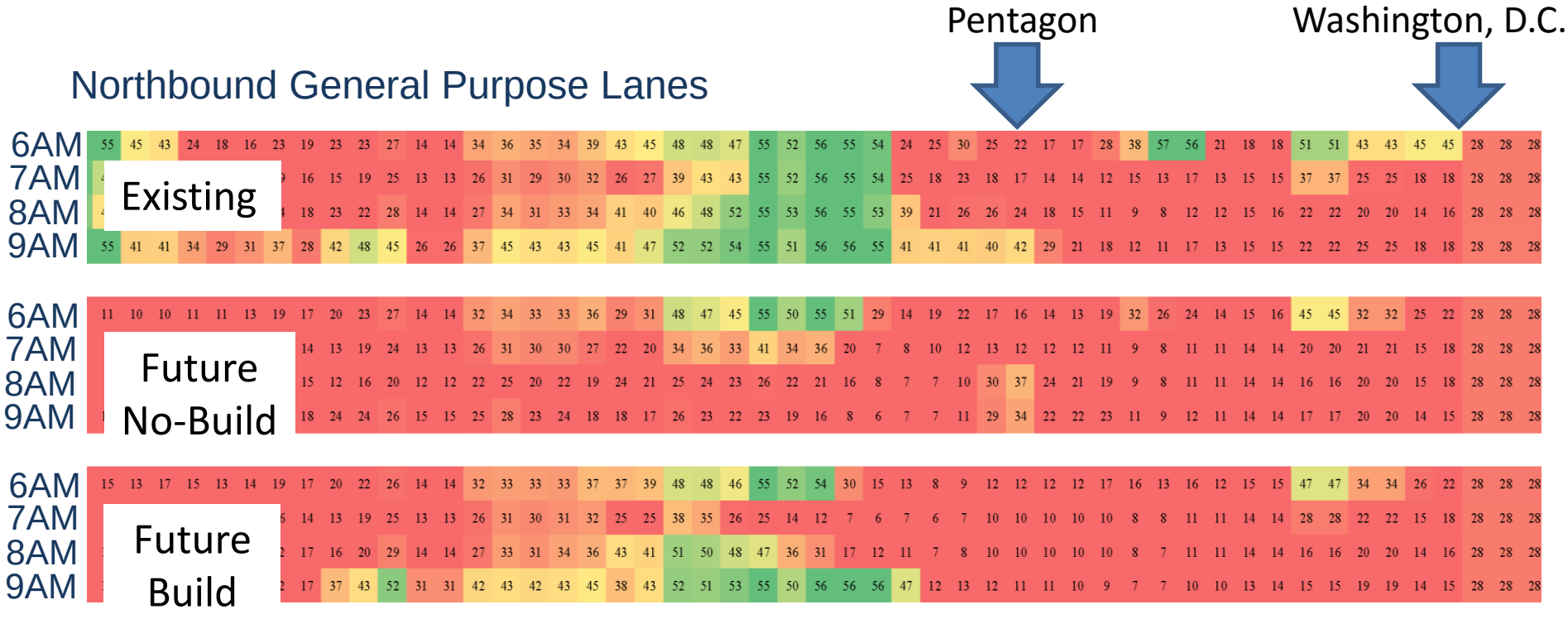


11 Minute Reduction between 9 - 10 AM

Project Benefits

2040 AM Corridor Speeds – I-395 General Purpose Lanes

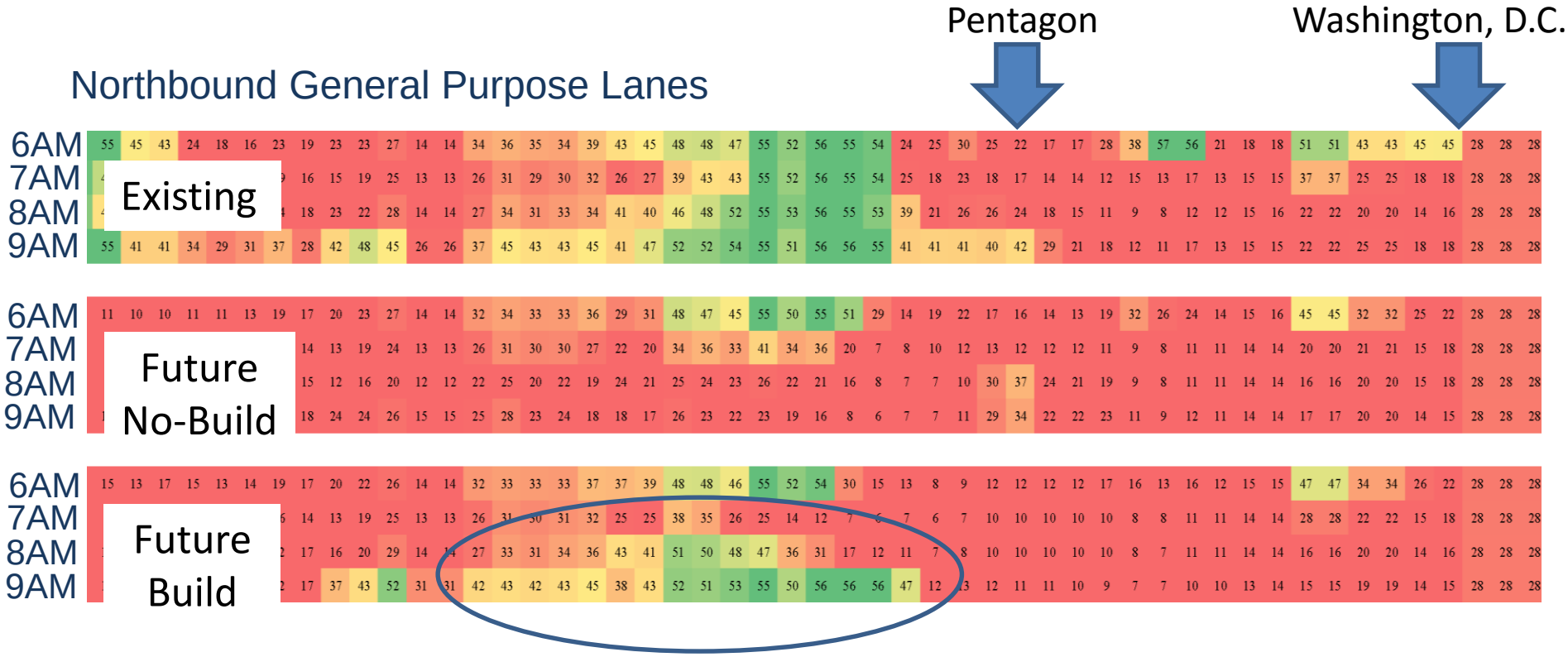
Northbound General Purpose Lanes



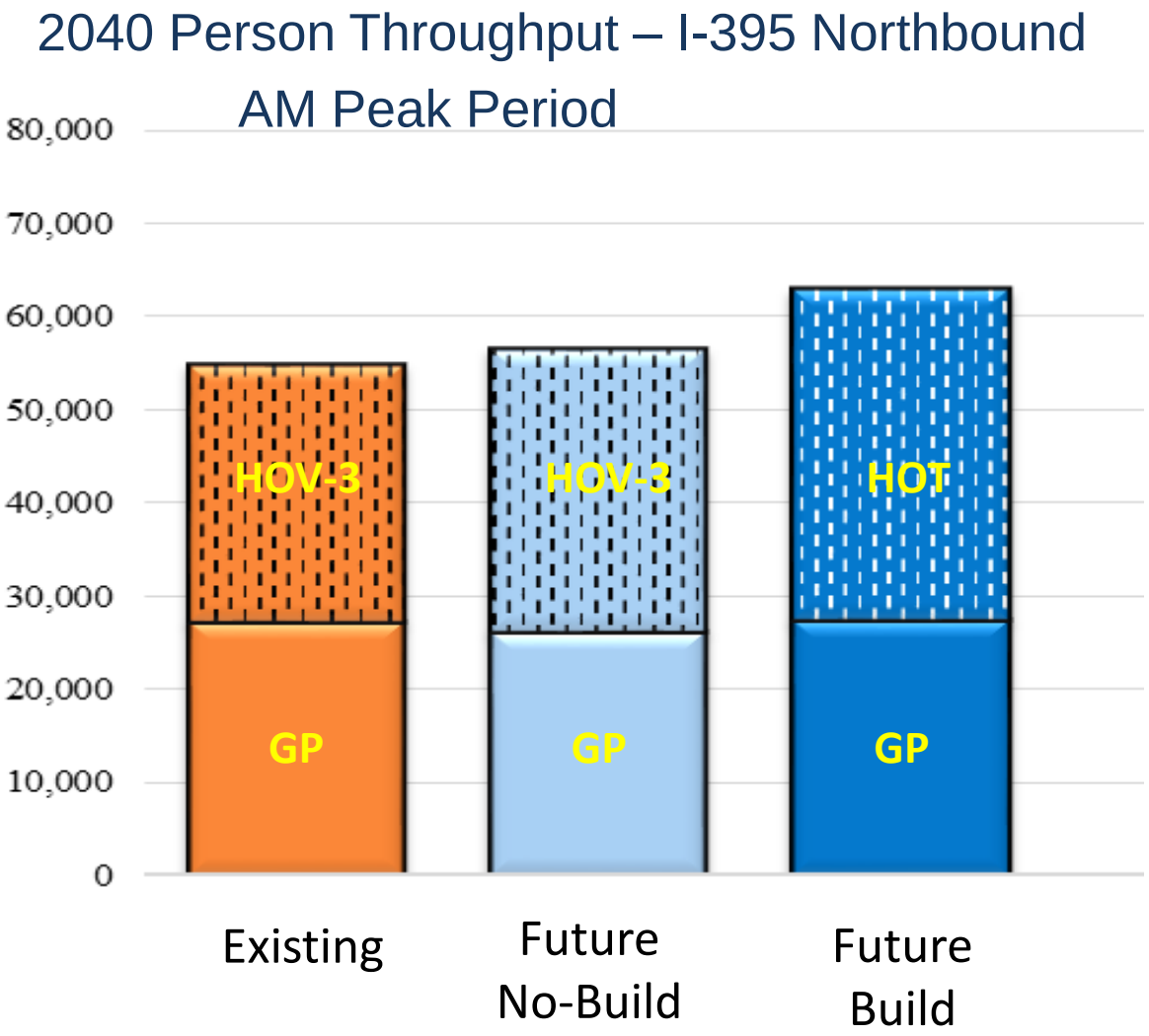
Project Benefits

2040 AM Corridor Speeds – I-395 General Purpose Lanes

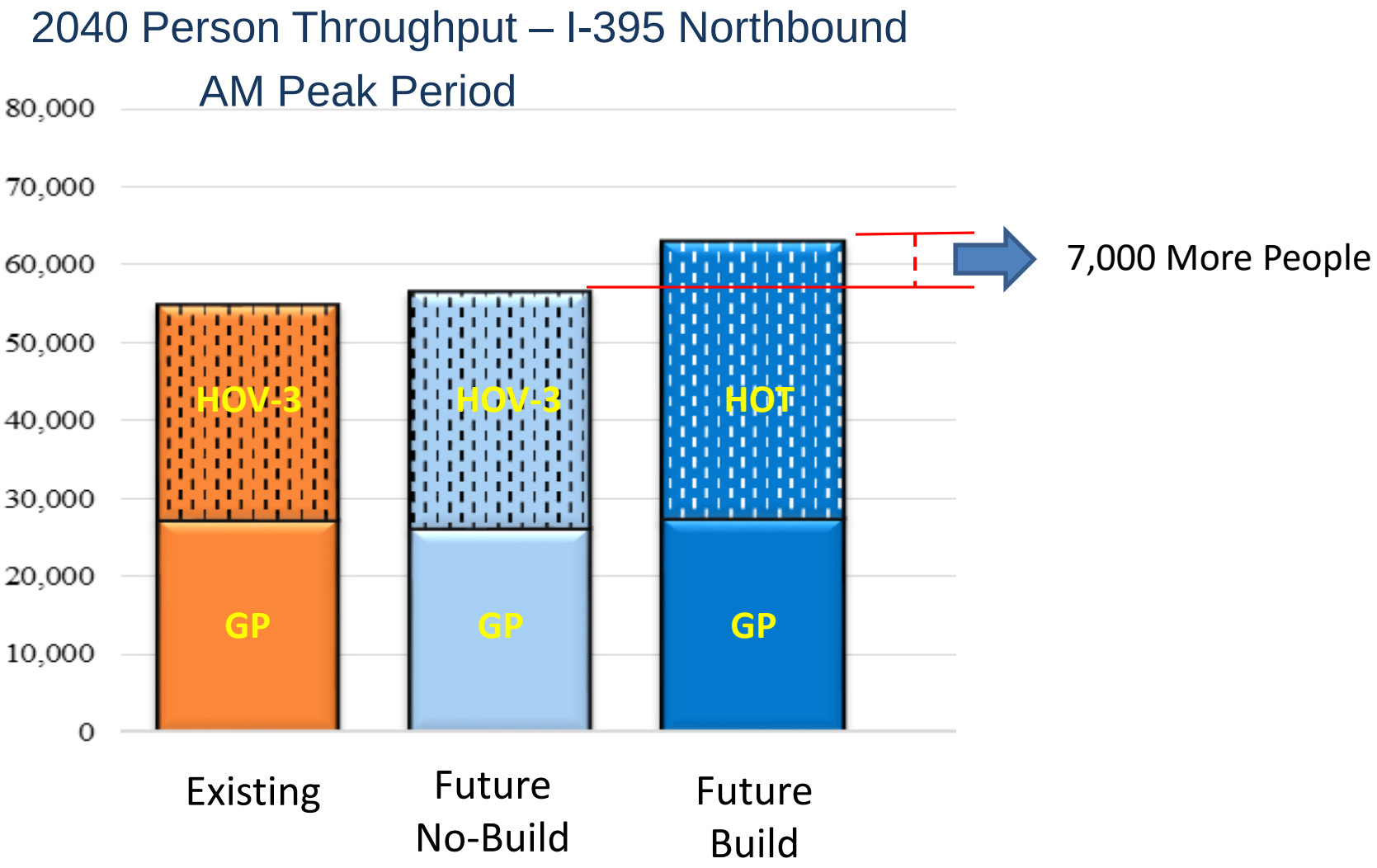
Northbound General Purpose Lanes



Project Benefits



Project Benefits



Summary

- Time of day periods were different between the regional traffic model and I-395 HOV facility operations
  - Post Processor to add sensitivity to the regional model
- Estimating demand for each analysis hour to produce an operational model that matches observed traffic counts
  - Subarea models and ODME process for each analysis hour
- Documenting meaningful results and project benefits
  - Project approach and peak period operations analysis
- Tight timeframe
  - Fixed schedule – construction already underway
  - Incorporated mesoscopic simulation to the approach

Questions

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