REGIONAL TWELVE-YEAR BOTTLENECK ANALYSIS

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TPB Technical Committee
December 2, 2022

Agenda Item 8

National Capital Region
Transportation Planning Board

Introduction

- On July 8, 2022, the TPB Technical Committee accepted as final the 2022 Congestion Management Process (CMP) Technical Report
- During discussion, the committee had questions about the top ten bottleneck analysis in the report (for calendar year 2021)
  - The bottleneck methodology had changed: the University of Maryland Probe Data Analytics [PDA] Suite bottleneck tool instead of TPB staff in-house methods used for previous reports
  - The methodology change influenced changes in the top ten rankings compared to the most recent previous report (2020)
- It was not feasible to redo analysis with the previous methodology, but staff offered to undertake a multi-year analysis with the current PDA Suite methodology to examine changes over time

Today's Presentation

- Bottom Line Up Front: results of staff's analyses show a complex set of occurrences, but with one persistent top-ranked bottleneck
- Today's presentation will look at:
  - The PDA Suite bottleneck tool methodology, how options within the tool cause variations in results, and caveats
  - Observations on how choosing alternative tool options would impact results
  - Results from analyzing the twelve years available in the PDA database (2010 through 2021) using the same (staff-recommended) tool options as used for the 2022 CMP Technical Report
  - Observations on why bottleneck rankings change over time

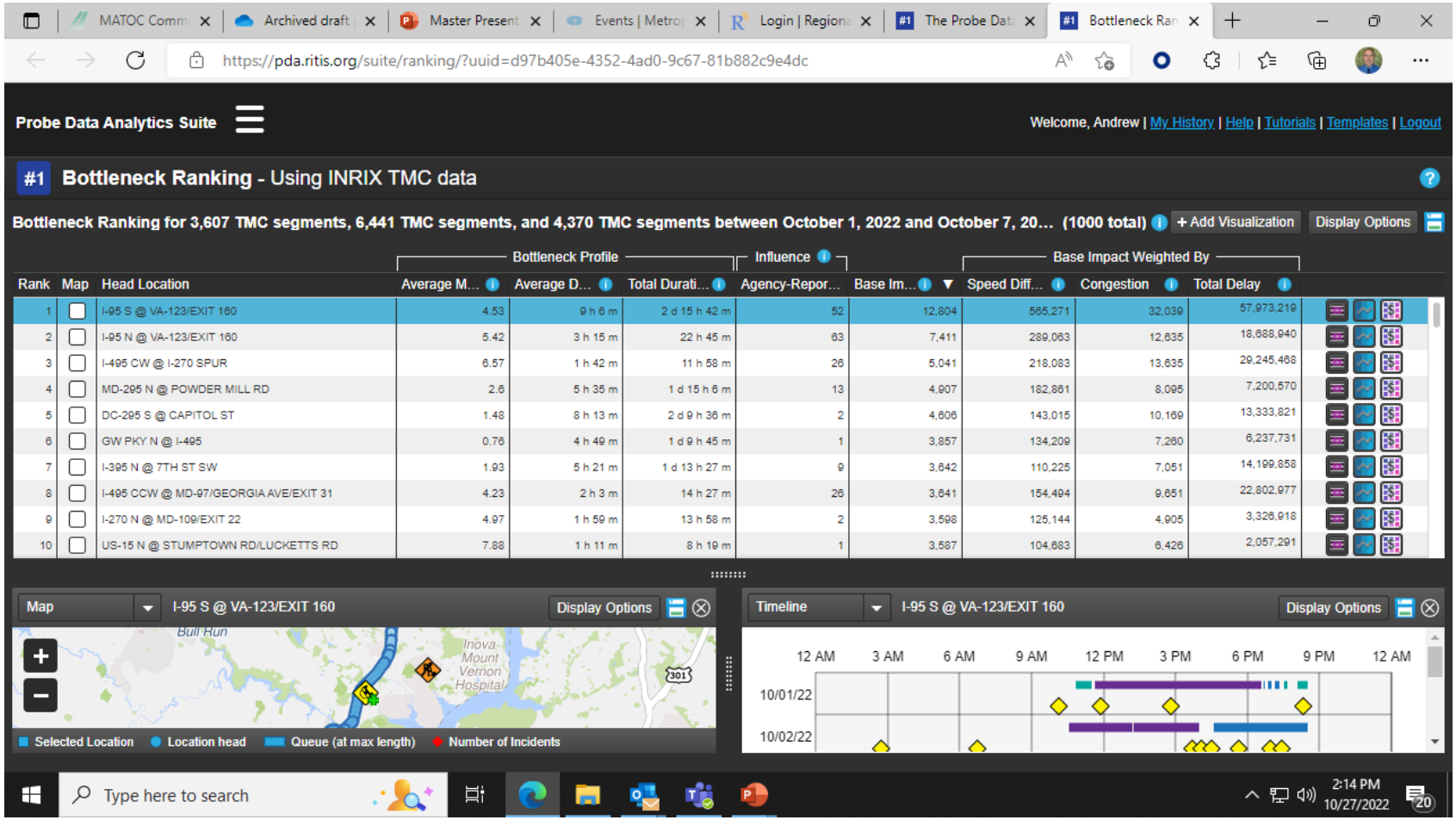
Elements Typically Defining Bottlenecks

- A traffic queue upstream of the bottleneck
- A beginning point for a queue
- Free flow traffic conditions downstream of the bottleneck that have returned to nominal or design conditions
- As it pertains to an operational deficiency, a predictable recurring cause
- Traffic volumes that exceed the capability of the confluence to process traffic

How the PDA Bottleneck Tool Works

- Uses vehicle probe data (speeds) provided for a set of network links
  - TPB staff has access to data sourced from Inrix for a robust set of roadways in our states (DC, MD, VA)
- We choose links of interest (not trivial – staff uses a saved set of thousands of roadway links) and set of days of interest (but the maximum period of analysis is one year)
  - Day and time options are limited (cannot screen out holidays; cannot analyze sub-24-hour periods)
- The tool produces a ranking table and maps of bottlenecks
- The rankings in the table can be sorted by several component factors
  - Note that staff has chosen not to use the default ranking factor

Example Screenshot from the PDA Tool



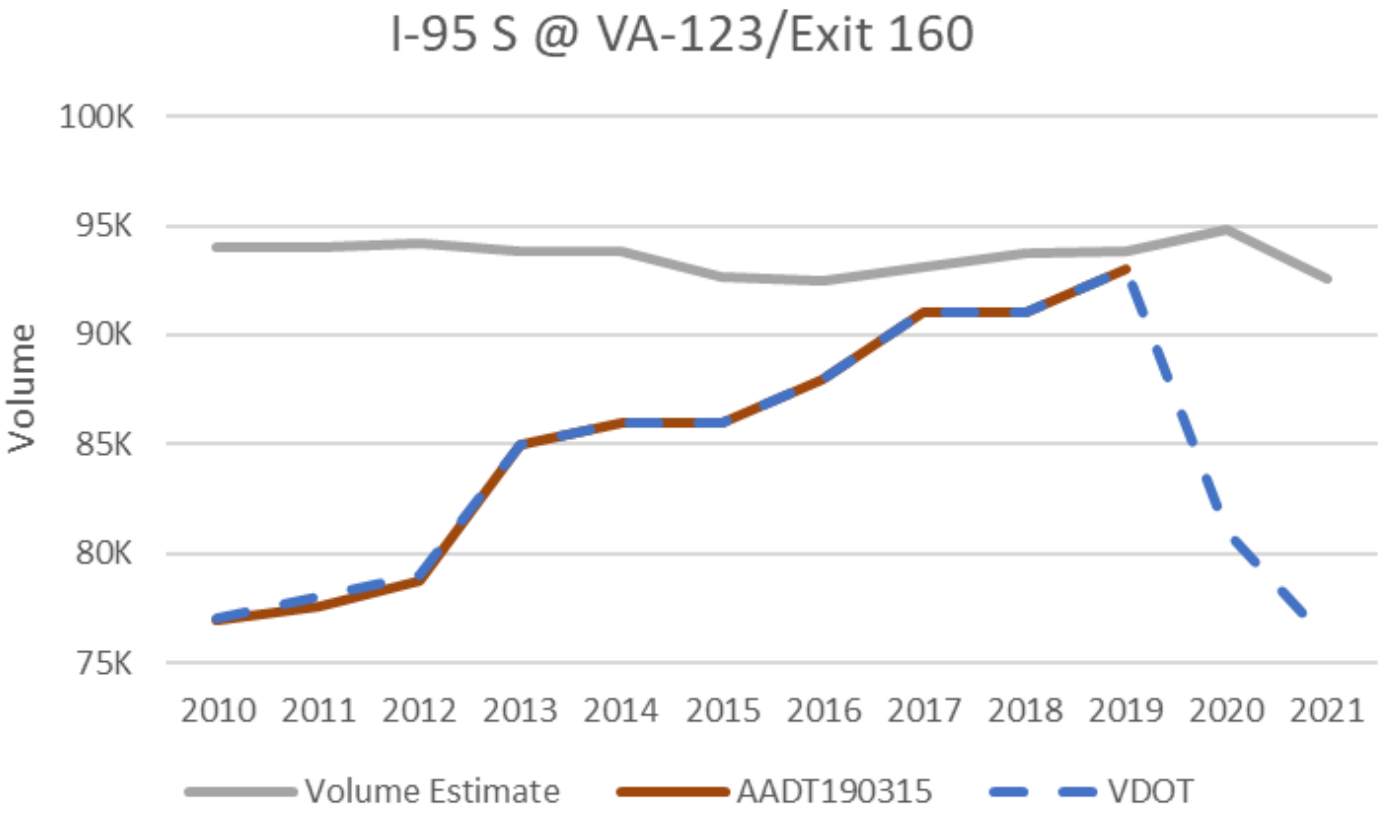
Exploring the Tool's Ranking Factors

- The PDA Suite Bottleneck Tool offers several bottleneck ranking factors using tool-specific methodology:
  - ***Base Impact*** (queue length and duration) – judged to be most consistent with TPB's prior (consultant) aerial photography-based analyses; emphasizes major roadways
  - ***Congestion*** (queue length and speed drop) – inclusion of speed drop may increase emphasis on smaller roadways
  - ***Total Delay*** (speed drop weighted by traffic volume) – the database's traffic volumes seem inconsistently derived, and are often a temporal mismatch (e.g., using 2019 volumes to weight 2010 conditions)
- Based on staff sensitivity tests, ranking by "**base impact**" produces results that are logical and the most consistent with other TPB work

Bottleneck Tool Caveats

- Traffic Message Channel (TMC) roadway networks are imperfect and change over time
- Tool allows analysis of no more than one year of data (i.e., we could not do a single 12-year analysis, just 12 one-year analyses)
- Time options include only a date range and days of the week (e.g., can screen out weekends, but cannot screen out holidays)
- Staff's recommended ranking factor is not the default in the system (make sure to re-sort by Base Impact to be consistent)
- Traffic volumes seem to be inconsistent across locations and time periods – not reliable for a multi-year/historical analysis
- "Black box" issues (e.g., how reference speeds are determined)
- Nevertheless, the tool is handy and useful

Volume Data Caveat



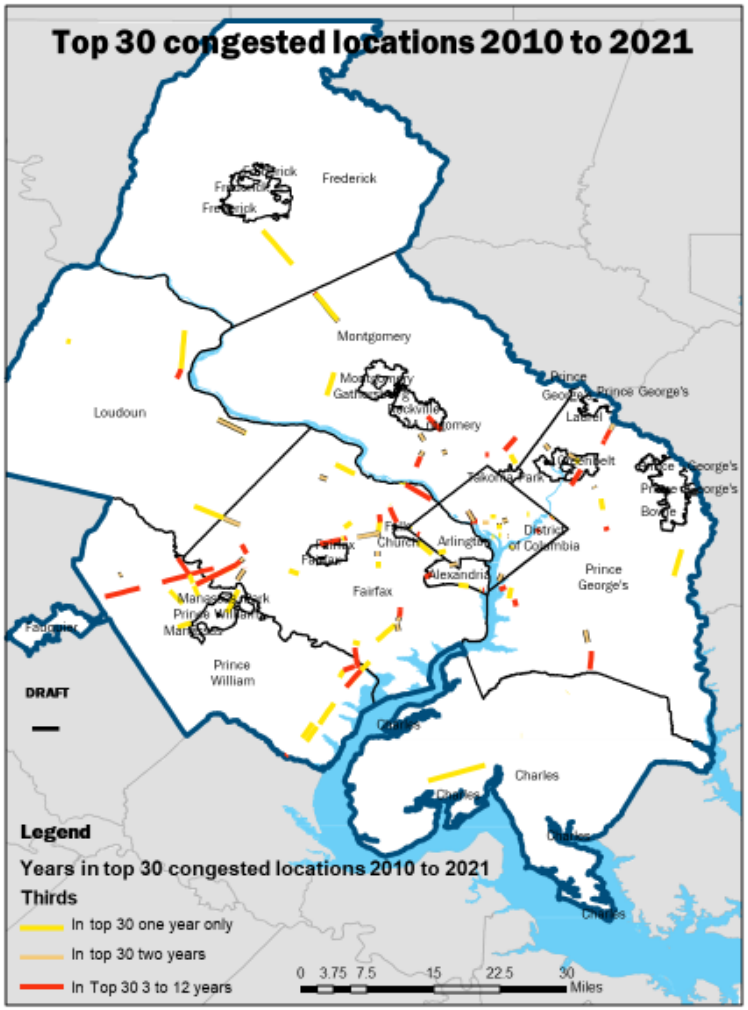
This example shows that PDA Suite traffic volume estimates may not be consistent with DOT or HPMS sources

The 12-Year Analysis

- Vehicle probe speed data (from Inrix) are available in the PDA Suite back to the year 2010
- Staff chose to perform one-year bottleneck ranking analyses for each of the twelve years of 2010 to 2021
  - Determined top ten rankings for each year
  - As noted, base impact was used as the ranking factor
- Looked for persistent versus short-lived bottleneck locations, comparative severity, and trends

Top 30 Congested Locations 2010-2021

- Persistent bottlenecks were in a relatively limited number of locations
- Other locations appear for only a year or two
- Top bottleneck in the region: I-95 S @ VA-123/Exit 160
  - #1 in all 12 years using the staff-recommended ranking factor ("Base Impact")



2021 Bottlenecks by Delay, Max Length

	Location	Ranked by Base Impact	Ranked by Total Delay	Ranked by Maximum Length of Queue
1	I-95 S @ VA-123/EXIT 160	1	1	43
2	I-95 N @ VA-123/EXIT 160	2	3	27
3	DC-295 S @ EAST CAPITOL ST	3	4	303*
4	BALT-WASH PKWY N @ POWDER MILL RD	4	8	110
5	I-95 N @ VA-617/BACKLICK RD/EXIT 167	5	5	42
6	US-301 S @ MCKENDREE RD/CEDARVILLE RD	6	16	149
7	I-495 INNER LOOP @ I-270-SPUR	7	2	9
8	I-66 W @ VA-234/VA-234-BR/EXIT 47	8	9	8
9	I-270 S @ MD-109/EXIT 22	9	32	47
10	I-270 N @ MD-109/EXIT 22	10	34	21

*Anomalously high values may indicate data glitches for a given year rather than actual conditions.

History of 2021 Bottlenecks

Rankings for each individual year 2010-2021

2021 Rank	Location	Highest Rank 2010-2021	Lowest Rank 2010-2021	Number of Times in Annual Top Ten 2010-2021
1	I-95 S @ VA-123/EXIT 160	1	1	12
2	I-95 N @ VA-123/EXIT 160	2	>100	8
3	DC-295 S @ EAST CAPITOL ST	2	>100	7
4	BALT-WASH PKWY N @ POWDER MILL RD	2	6	10
5	I-95 N @ VA-617/BACKLICK RD/EXIT 167	5	>100	1
6	US-301 S @ MCKENDREE RD/CEDARVILLE RD	3	31	10
7	I-495 INNER LOOP @ I-270-SPUR	2	>100	8
8	I-66 W @ VA-234/VA-234-BR/EXIT 47	3	66	3
9	I-270 S @ MD-109/EXIT 22	9	35	2
10	I-270 N @ MD-109/EXIT 22	10	>100	1

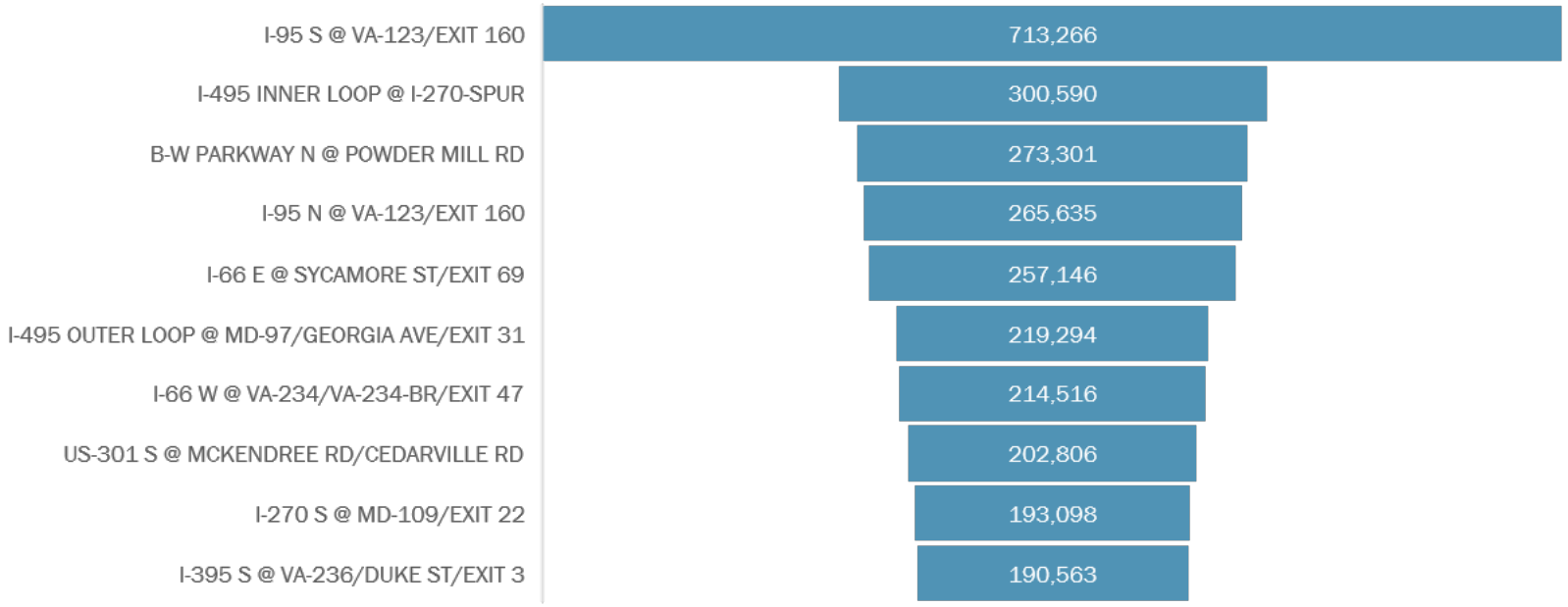
Persistent & Past Bottlenecks

Persistent Bottleneck Locations	Highest Rank 2010-2021	2021 Rank	Number of Times in Annual Top Ten 2010-2021
I-95 S @ VA-123/EXIT 160	1	1	12
BALT-WASH PKWY N @ POWDER MILL RD	4	2	10
US-301 S @ MCKENDREE RD/CEDARVILLE RD	6	3	10
I-95 N @ VA-123/EXIT 160	2	2	8
I-495 INNER LOOP @ I-270-SPUR	7	2	8
Past Bottleneck Locations	**Highest Rank 2010-2021**	**2021 Rank**	**Number of Times in Annual Top Ten 2010-2021**
I-66 E @ SYCAMORE ST/EXIT 69	2	>100	10
I-495 OUTER LOOP @ MD-97/GEORGIA AVE/EXIT 31	4	44	10
I-95 S @ MCB QUANTICO/EXIT 148	2	>100	5
I-66 W @ VADEN DR/EXIT 62	3	>100	4
I-66 E @ VADEN DR/EXIT 62	8	>100	4

Some Major Projects 2010-2021

- 2011: MD-200 (InterCounty Connector) (east end connection to US-1 completed 2014); included I-95 interchange
- 2012: 495Express lanes between VA-620 and north of VA-267
- 2012/2013: Woodrow Wilson Bridge approaches (main bridge was completed 2009)
- 2013: 11th Street Bridge
- 2014: Silver Line Metro to Wiehle–Reston East
- 2014: 95Express reversible lanes from VA-294 to VA-610
- 2017: I-66 inside the Beltway converted from HOV to HOV/toll lanes
- 2019: 395Express reversible lanes from Turkeycock Run to Potomac River

Bottleneck Magnitudes (2019 Example)



Provided as an example, the magnitude of 2019's top bottleneck (measured in Base Impact [integrating queue length and bottleneck duration]) was more than twice as much of the second-ranked bottleneck, and almost four times as much as the 10th-ranked bottleneck

Observations from the 12-Year Analysis

- Southbound I-95 at VA-123/Exit 160 (near the Occoquan River) is unrivaled as the region's top bottleneck in both frequency and severity
- Several other locations appeared in the top ten bottlenecks seven or more times in the 12-year period
- Some previous bottleneck locations appear to have lessened over time, particularly on I-66
- Locations that appeared in the top ten a limited number of times may have been due to temporary conditions, likely construction
    - Pandemic-impacted 2020, with its disrupted traffic patterns, did have a few 2020-only top ten locations

12-Year Analysis Caveats

- Results of this analysis are subject to refinement
- The databases and geographic networks in the PDA Suite tool are generally reliable, but missing data or technical glitches may occur
- Traffic Message Channel geographic networks (developed by companies in the navigation industry for their own needs) vary in lengths, which may impact results
    - Staff removed reversible roadways (e.g. 395Express, Rock Creek Parkway) from analysis networks due to unreliable data/results
- The PDA Suite Bottleneck tool provides options for analysis – staff's choices for this analysis underpins this presentation's results, and other choices will result in other outcomes
- Staff may not have information as to why results came out as they did

Why Bottlenecks May Change Over Time

- Temporary impacts of construction zones
- Long-term impacts after construction projects
- Regional and national population and business growth
- Regional and national economic ups and downs
- Year-to-year variations in the impacts of storms and major incidents
- Still-evolving long-term travel demand impacts of the pandemic
- Changes within the PDA Suite tool and its underlying databases

Acknowledgements

- Jan-Mou Li, TPB Transportation Engineer
- C. Patrick Zilliacus, TPB Transportation Engineer
- Eric Randall, TPB Transportation Engineer and Manager, Systems Performance Planning and Reporting
- University of Maryland Probe Data Analytics Suite developers and support personnel

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