# Background

## Motivation

Inspired by various agency and jurisdictional dashboard efforts around the country (e.g., the Virginia Department of Transportation Dashboard), and driven by the emergence of probe-based traffic speed data from the Eastern Transportation Coalition/University of Maryland Vehicle Probe Project (VPP), this quarterly National Capital Region Congestion Report (NCRCR) takes advantage of the availability of rich data and analytical tools to produce customized, easy-to-communicate, frequently updated traffic congestion and travel time reliability performance measures for the Transportation Planning Board (TPB) Planning Area. The goals of this effort are to summarize the region's congestion, to illustrate the programs of the TPB and its member jurisdictions that aim to have an impact on congestion, and to examine reliability and non-recurring congestion for recent incidents/occurrences, in association with relevant congestion management strategies.

## Methodology

### Travel Time Index (TTI)

TTI is defined as the ratio of actual travel time to free-flow travel time for a roadway segment or set of roadways, measuring the intensity of congestion. The higher the index, the more congested traffic condition it represents, e.g., TTI = 1.00 means free flow conditions, while TTI = 1.30 indicates the actual travel time is 30% longer than the free-flow travel time. For more information, please refer to Travel Time Reliability: Making It There On Time, All The Time[1], a report published by the Federal Highway Administration and produced by the Texas Transportation Institute with Cambridge Systematics, Inc. The NCRCR uses the following method to calculate TTI:

1. Download INRIX 5-minute raw data from the VPP Suite website (https://pda.ritis.org/suite/).
2. Aggregate the raw data to monthly average data by day of the week and hour of the day. Harmonic Mean was used to average the speeds and reference speeds (Harmonic Mean is only used here; other averages used are all Arithmetic Mean). For each segment (TMC), the monthly data have 168 observations (7 days in a week * 24 hours a day) in a month.
3. Calculate TTI = reference speed / speed in the monthly data. If TTI < 1 then make TTI = 1. If constraint TTI >= 1 was not imposed, some congestion could be cancelled by conditions with TTI < 1.
4. Calculate regional average TTI for the Interstate system, non-Interstate NHS, non-NHS, and all roads for AM peak (6:00-10:00 am) and PM Peak (3:00-7:00 pm) respectively, using segment length as the weight.
5. Calculate the average TTI of the AM Peak and PM Peak to obtain an overall congestion indicator.

### Planning Time Index (PTI)

PTI is defined as the ratio of the 95th percentile travel time to free flow travel time, measuring travel time reliability. The higher the index, the less reliable traffic conditions it represents, e.g., PTI = 1.30 means a traveler has to budget 30% longer than the uncongested travel time to arrive on time 95% of the time (i.e., 19 out of 20 trips), while TTI = 1.60 indicates that one has to budget 60% longer than the uncongested travel time to arrive on time most of the time. For more information, please refer to Travel Time Reliability: Making It There On Time, All The Time[2], a report published by the Federal Highway Administration and produced by the Texas Transportation Institute with Cambridge Systematics, Inc. This report uses the following method to calculate PTI:

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[1] FHWA, (2005, December 1st). Travel Time Reliability: Making It There On Time, All The Time, https://transportationops.org/publications/travel-time-reliability-making-it-there-time-all-time

[2] Ibid.

1. Calculate TTI = reference speed / speed in the monthly data obtained in step 2 of the above TTI methodology. Do not impose constraint TTI >= 1, since the purpose of this calculation is to rank the TTIs to find the 95th percentile, not to average the TTIs.
2. Calculate monthly average PTI: including sorting the data obtained in step 1 by segment, peak period, and month, finding the 95th percentile TTI and this TTI is PTI by definition, and averaging the PTIs using segment length as the weight to get regional summaries (for the Interstate system, non-Interstate NHS, non-NHS, and all roads for AM peak (6:00-10:00 am) and PM Peak (3:00-7:00 pm) respectively).
3. Calculate yearly average PTI: including sorting the data obtained in step 1 by segment and peak period, finding the 95th percentile TTI and this TTI is PTI by definition, and averaging the PTIs using segment length as the weight to get regional summaries.
4. Calculate the average PTI of the AM Peak and PM Peak to obtain an overall travel time reliability indicator.

## Bottlenecks

This report uses the "Bottleneck Ranking" tool in the VPP Suite to get the top 10 most significant bottlenecks in the TPB Planning Area for a quarter. The VPP Suite uses the following methodology to track bottlenecks:

Bottleneck conditions are determined by comparing the current reported speed to the reference speed for each segment of road. **Reference speed** values are provided by INRIX, Inc. for each segment and represent the 85th percentile observed speed for all time periods with a maximum value of 65 mph. If the reported speed falls below 60% of the reference, the road segment is flagged as a potential bottleneck. If the reported speed stays below 60% for five minutes, the segment is confirmed as a bottleneck location. Adjacent road segments meeting this condition are joined together to form the bottleneck queue. When reported speeds on every segment associated with a bottleneck queue have returned to values greater than 60% of their reference values and remained that way for 10 minutes, the bottleneck is considered cleared. The total **duration** of a bottleneck is the difference between the time when the congestion condition was first noticed (prior to the 5 minute lead in) and the time when the congestion condition recovered (prior to the 10 minute lead out). Bottlenecks whose total queue length, determined by adding the length of each road segment associated with the bottleneck, is less than 0.3 miles are ignored.

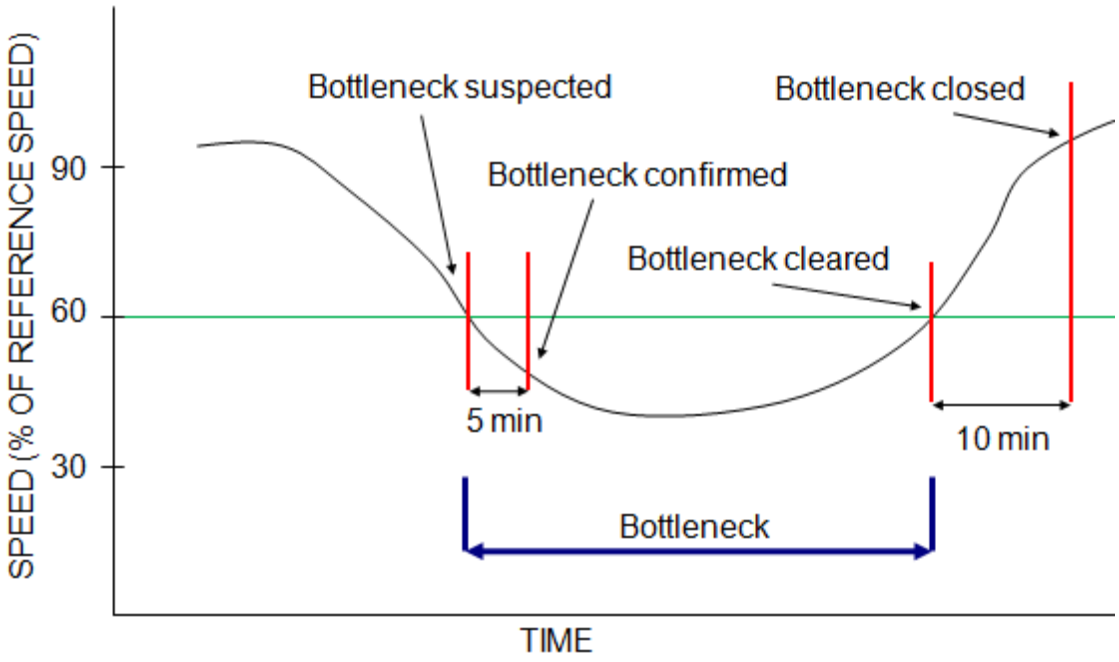


*Figure 1 The Life of a Bottleneck by Speed and Time*

Bottlenecks could be ranked by a variety of selected measures within the Bottleneck Ranking tool. For the NCRCR, they are now ranked by "Base Impact" (note that the measure of "Total Delay" was used for bottleneck rankings in a number of NCRCRs prior to the 1st quarter of 2019.) According to the tool (as of April 22, 2022), the "Base Impact" was defined as "the aggregation of queue length over time for congestion originating at each location in mile-minutes."

The University of Maryland is continuously reviewing the bottleneck ranking methodology and it may soon be improved given the observed variability from quarter to quarter. Nonetheless, the identified bottlenecks by the current methodology represent significant choke points along traffic flows.

Bottleneck location maps and spiral charts are all screen shots from the VPP Suite. As of April 22, 2022, bottleneck ranking, associated maps and spiral charts could be retrieved by following the procedure below:

0. Visit the bottleneck ranking tool at https://pda.ritis.org/suite/ranking/
1. Select Roads (Step 1 in the tool) for the National Capital Region
2. Select a time period to analyze (Step 2 in the tool) for the quarter
3. Select data sources (Step 3 in the tool); INRIX was chosen.
4. Select inclusion criteria (Step 4 in the tool); no selection was applied.
5. Select time zone (Step 5 in the tool); "Segment Local" was chosen.
6. Click the "SUBMIT" button, then wait for the results to be displayed (on the screen).

## Congestion Maps

The maps were generated by the "Trend Map" tool in the VPP Suite. Since the VPP Suite limits the total number of segments of a query, the maps only show the freeways and some major arterials.