Memo

Oregon Department of Transportation

Metro
600 NE Grand Ave.
Portland, OR 97232-2736

Date: November 29, 2022

To: Kim Ellis, Metro and Lidwien Rahman, ODOT

From: Susan Wright, PE, Molly McCormick, Kittelson & Associates, Inc.

Project: Regional Mobility Policy Update

Subject: Regional Mobility Policy Travel Speed Reliability Research Process

Introduction

The Regional Mobility Policy is a policy in Metro's Regional Transportation Plan (RTP) as well as ODOT's Oregon Highway Plan (OHP). It applies to system planning and plan amendment processes only within the Portland metropolitan area. The regional mobility policy is one of many policies that helps the region choose where to focus resources for the transportation system to support implementation of city and county comprehensive plans. The goal of the updated policy is to better align the policy and measures with shared regional values, goals, and desired outcomes identified in RTP and 2040 Growth Concept, as well as with local and state goals. Specifically, the updated policy is intended to support mobility outcomes related to equity, efficiency, access and options, safety, and reliability. Six policies and three measures are included in the policy that have direct relationships to these desired mobility outcomes.

The project team conducted further review and research around measures of reliability and forecasted hours of congestion as a predictor of reliability to address questions from partner agencies and local practitioners. The main questions include:

- Is travel speed useful in identifying location and duration of reliability issues?
- If forecast hourly travel speed is used to assess reliability, what average hourly travel speed should be used as a threshold?
- Should expressways and non-expressway throughways have the same targets?
- How well does Metro's travel demand model forecast average hourly travel speed?

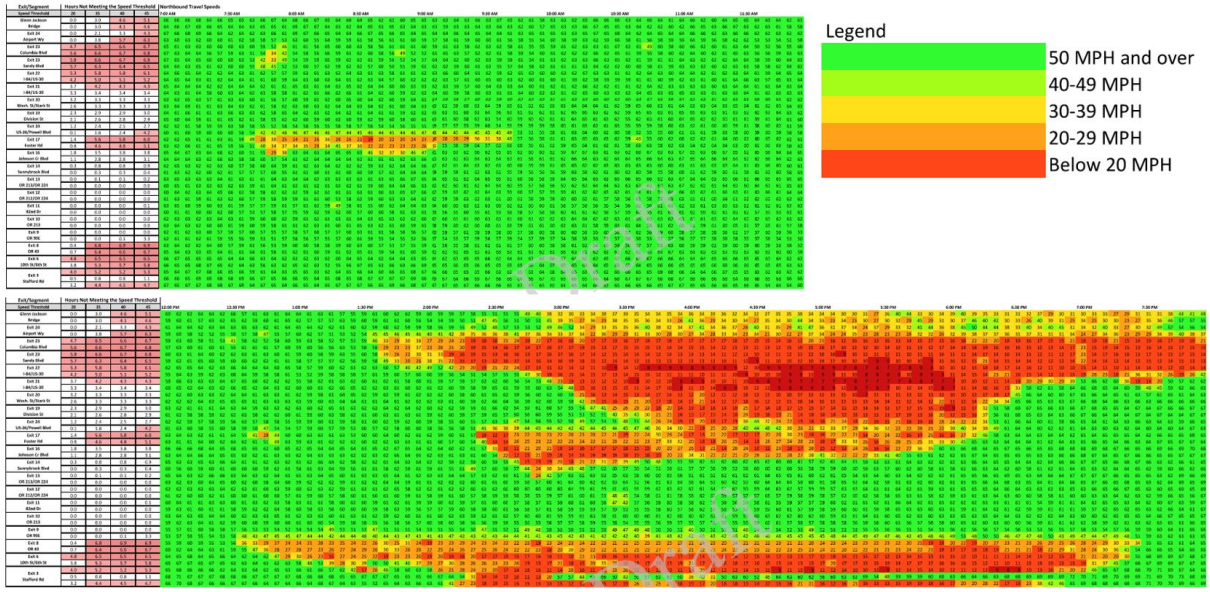
The project team completed the following steps to answer these questions and to inform the draft Regional Mobility Policy.

Step One: INRIX Data Case Study

The project team reviewed INRIX travel speed data from July 11 to July 15, 2021 for I-5 northbound travel, US 26 eastbound travel, and I-205 northbound and southbound travel to assess the number of hours different segments fell below different speed thresholds and evaluate potential methodologies of assessing reliability. Graphics were created to visualize the 5-minute travel speed data and to summarize the hours per day that would be considered congested based on several potential travel speed thresholds. Example graphics for I-205 northbound travel are shown below. To see the graphics for all four sample corridors, see Attachment A.

KITTELSON & ASSOCIATES MIG APG

Example Graphic Visualizing INRIX Travel Speed Data – I-205 Northbound (7/14/2022)



Example Graphic Summarizing Number of Hours Per Day Below Different Travel Speed Thresholds using INRIX Travel Speed Data– I-205 Northbound (7/11-7/15/2022)

I-205 Northbound - Hours per day not meeting the speed threshold

Exit/Segment	July 11, 2021 (Monday)				July 12, 2021 (Tuesday)				July 13, 2021 (Wednesday)				July 14, 2021 (Thursday)				July 15, 2021 (Friday)			
Speed Threshold	20	35	40	45	20	35	40	45	20	35	40	45	20	35	40	45	20	35	40	45
Glenn Jackson Bridge	0.0	2.4	2.7	2.9	0.0	2.2	2.9	3.0	0.0	1.3	3.0	3.8	0.0	3.0	4.6	5.1	0.0	3.7	4.4	4.9
	0.0	1.4	1.9	1.9	0.0	1.8	2.3	2.7	0.0	1.7	2.5	3.1	0.0	3.0	4.1	4.6	0.0	3.1	3.9	4.5
Exit 24 Airport Wy	0.0	1.1	1.4	1.8	0.0	0.8	1.8	2.3	0.0	0.7	1.8	2.8	0.0	2.1	3.3	4.3	0.0	1.5	3.2	3.8
	0.2	2.0	3.3	4.3	0.0	2.2	3.6	4.2	0.1	2.8	4.5	5.5	0.0	3.8	5.7	6.3	0.1	3.3	5.1	6.3
Exit 23 Columbia Blvd	3.2	4.3	4.3	4.6	2.5	4.2	4.3	4.3	4.0	5.5	5.5	5.6	4.7	6.5	6.6	6.7	4.1	6.4	6.5	6.9
	4.1	4.3	4.3	4.3	3.0	4.1	4.2	4.6	4.8	5.5	5.6	5.7	5.6	6.6	6.7	6.8	5.2	6.8	6.9	7.0
Exit 23 Sandy Blvd	4.1	4.3	4.3	4.3	3.5	4.0	4.3	4.4	4.7	5.4	5.6	5.7	5.8	6.6	6.7	6.8	5.6	6.8	6.9	6.9
	3.9	4.2	4.2	4.2	3.7	3.8	4.0	4.1	4.8	5.3	5.4	5.4	5.7	6.3	6.4	6.5	5.8	6.5	6.6	6.6
Exit 22 I-84/US-30	3.4	3.8	3.8	3.8	3.5	3.8	3.8	3.8	4.7	4.8	4.8	4.9	5.3	5.8	5.8	6.1	5.5	6.2	6.3	6.3
	3.1	3.3	3.3	3.3	2.5	3.2	3.4	3.6	4.3	4.5	4.5	4.5	4.2	5.0	5.1	5.2	4.0	4.3	4.5	5.3
Exit 21 I-84/US-30	2.8	3.1	3.2	3.2	2.6	3.0	3.0	3.2	4.3	4.4	4.4	4.4	3.7	4.2	4.3	4.3	3.8	3.9	4.3	4.4
	2.4	2.6	2.7	2.8	1.8	2.6	2.6	2.8	3.9	4.1	4.3	4.3	3.3	3.4	3.4	3.4	3.4	3.6	3.7	3.7
Exit 20 Wash. St/Stark St	1.9	2.2	2.3	2.4	1.0	1.9	2.3	2.5	3.8	3.9	3.9	4.0	3.2	3.3	3.3	3.3	3.1	3.3	3.3	3.3
	0.9	1.7	1.8	2.1	0.0	0.4	0.8	1.1	3.1	3.7	3.7	3.8	2.6	3.3	3.3	3.3	2.6	3.0	3.1	3.1
Exit 19 Division St	0.4	1.2	1.2	1.3	0.0	0.0	0.0	0.0	3.0	3.4	3.6	3.6	2.3	2.9	2.9	3.0	2.2	2.7	2.8	2.8
	0.0	0.8	0.8	0.9	0.0	0.0	0.0	0.0	2.9	3.3	3.4	3.4	2.1	2.6	2.8	2.9	2.0	2.7	2.7	2.7
Exit 24 US-26/Powell Blvd	0.0	0.2	0.2	0.4	0.0	0.0	0.0	0.1	2.7	3.3	3.3	3.3	1.2	2.4	2.5	2.7	2.1	2.5	2.5	2.6
	0.0	0.3	0.6	2.8	0.0	0.1	0.5	3.2	2.1	3.3	3.8	5.6	0.1	1.8	2.4	4.2	1.1	2.9	3.3	6.1
Exit 17 Foster Rd	0.0	4.3	4.6	4.9	0.1	4.1	4.8	5.1	2.8	5.9	6.2	6.3	1.4	5.6	5.8	6.0	2.7	7.3	7.6	7.6
	0.0	3.3	3.8	4.5	0.0	2.4	3.5	3.9	2.5	4.9	4.9	5.3	0.8	4.6	4.8	5.1	1.9	7.1	7.3	7.3
Exit 16 Johnson Cr Blvd	1.1	2.8	2.9	2.9	0.8	2.3	2.7	2.8	3.5	4.1	4.2	4.5	1.8	3.5	3.8	3.8	4.6	5.4	5.7	5.8
	0.5	1.2	1.2	1.7	0.1	1.1	1.3	1.8	2.9	3.8	3.8	3.9	1.1	2.8	2.8	3.1	2.8	4.3	4.6	4.8
Exit 14 Sunnybrook Blvd	0.0	0.3	0.4	0.5	0.0	0.0	0.0	0.0	0.2	2.1	2.5	2.7	0.3	0.8	0.8	0.9	1.0	1.9	2.2	2.2
	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.3	0.0	0.3	0.3	0.4	0.0	0.4	0.6	1.2
Exit 13 OR 213/OR 224	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.0	0.0	0.1	0.2
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exit 12 OR 212/OR 224	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.2	0.3	0.8	0.0	0.0	0.0	0.0	0.3	0.5	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2
Exit 11 82nd Dr	0.4	1.1	1.1	1.2	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.7	0.0	0.0	0.0	0.1	0.0	0.3	0.4	0.8
	0.3	0.8	0.8	1.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4
Exit 10 OR 213	0.3	0.5	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.2	0.4	0.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exit 9 OR 99E	0.1	0.4	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.1	0.5	0.7	3.0	0.0	0.0	0.1	2.3	0.0	0.0	0.1	2.8	0.0	0.0	0.1	3.3	0.0	0.0	0.1	3.3
Exit 8 OR 43	0.3	5.3	5.8	6.2	0.5	5.3	5.5	5.7	0.3	6.3	6.5	6.6	0.4	6.8	6.9	6.9	0.3	6.4	6.6	6.8
	0.3	4.2	4.4	4.8	0.3	3.8	4.5	5.1	0.3	5.3	5.8	5.8	0.7	6.4	6.6	6.7	0.6	5.9	6.1	6.2
Exit 6 10th St/6th St	3.3	4.5	4.5	4.6	3.4	4.4	4.8	4.8	4.0	5.4	5.7	5.8	4.8	6.5	6.5	6.5	4.3	6.0	6.2	6.2
	1.6	3.8	4.3	4.3	2.0	3.9	4.0	4.2	3.2	5.0	5.2	5.3	3.8	5.3	5.7	5.8	2.5	5.0	5.6	5.8
Exit 3 Stafford Rd	2.7	3.7	4.1	4.1	2.6	3.6	4.0	4.2	3.7	4.9	5.2	5.2	4.0	5.2	5.2	5.3	2.7	4.8	5.2	5.3
	0.0	0.3	0.3	0.3	0.0	0.0	0.0	0.0	0.5	1.4	1.7	1.8	0.5	0.8	0.8	1.1	0.0	0.0	0.0	0.0
	0.2	2.7	3.2	3.6	0.3	1.5	2.2	2.5	2.7	4.3	4.4	4.7	3.2	4.4	4.5	4.7	0.3	2.3	2.3	2.8

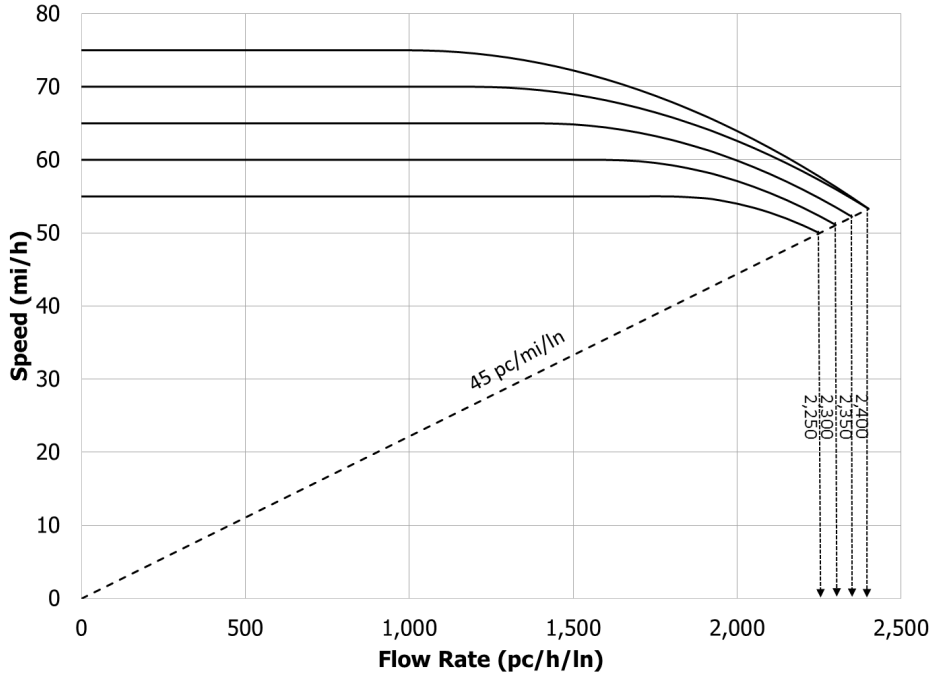
Through review of INRIX data, there were the following findings:

- Travel speed data is useful in identifying location and duration of reliability issues
- For the Portland region, 30 to 35 mph is a clear threshold where conditions tend to be better or worse rather quickly on Interstates and unsignalized throughways.

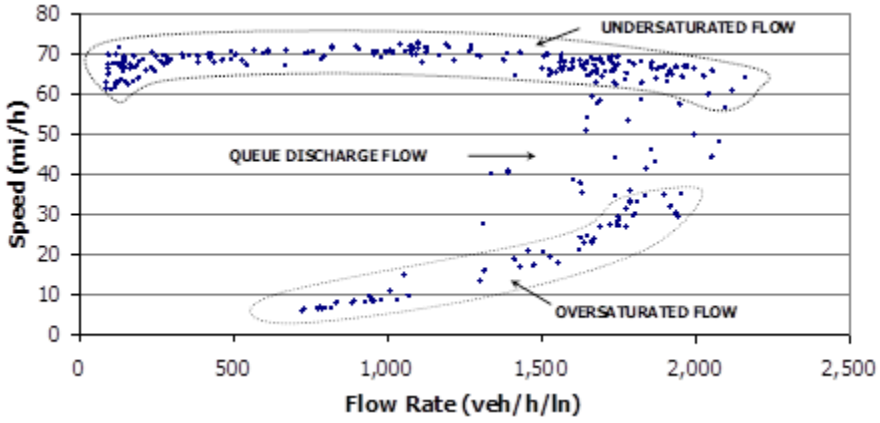
Step Two: HCM Speed/Flow Relationship

After determining that travel speed had potential to evaluate reliability through the INRIX data review, further review of the speed and flow rate relationship was conducted. The Highway Capacity Manual (HCM) 7 (published by the National Academy of Science's Transportation Research Board)- and prior versions of the HCM include the following graphs highlighting when unstable flow is most likely occur based on travel speed.

HCM 7 Graphic on Speed-Flow Relationship



Prior HCM Versions Graphic on Speed-Flow Relationship



Based on review of the HCM and previous versions of the HCM, unstable flow can be seen around 35 to 45 mph. While maximum flow rates occur between 45 and 65 mph, below 35 mph, flow rates decline rapidly. A Strategic Highway Research Program (SHRP) 2 report titled "Incorporating Travel Time Reliability into the *Highway Capacity Manual*" (SHRP 2 Report S2-L08-RW-1) also includes Table 8.3 that shows freeway reliability level of service (LOS) defined by travel speed, shown below. A freeway reliability LOS of F occurs for travel speeds less than 35 mph.

SHRP 2 Report S2-L08-RW-1 Table 8.3

Table 8.3. Freeway Reliability LOS Defined by Travel Speed or Travel Time Index Ranges

LOS	Travel Speed (mph)[a] and Equivalent TTI	Percentage of Trips in Each LOS Range, Weekdays, 4:30–6:00 p.m.			
		Seattle, I-405		Atlanta, I-75, Northside	
		NB	SB	NB	SB
A	≥60 (TTI ≤ 1.083)	27.7	1.6	0.4	15.4
B	50–59 (1.083 < TTI ≤ 1.300)	71.9	48.3	6.6	80.5
C	45–49 (1.300 < TTI ≤ 1.444)	0.3	12.0	3.2	1.4
D	40–44 (1.444 < TTI ≤ 1.625)	0.0	9.3	8.5	0.3
E	35–39 (1.625 < TTI ≤ 1.857)	0.1	11.0	14.4	0.8
F	<35 (TTI > 1.857)	0.0	17.8	66.8	1.6
Mean TTI		**1.016**	**1.352**	**1.984**	**1.050**

Note: NB = northbound; SB = southbound.
[a] Average speed over the length of the facility (i.e., the space mean speed).

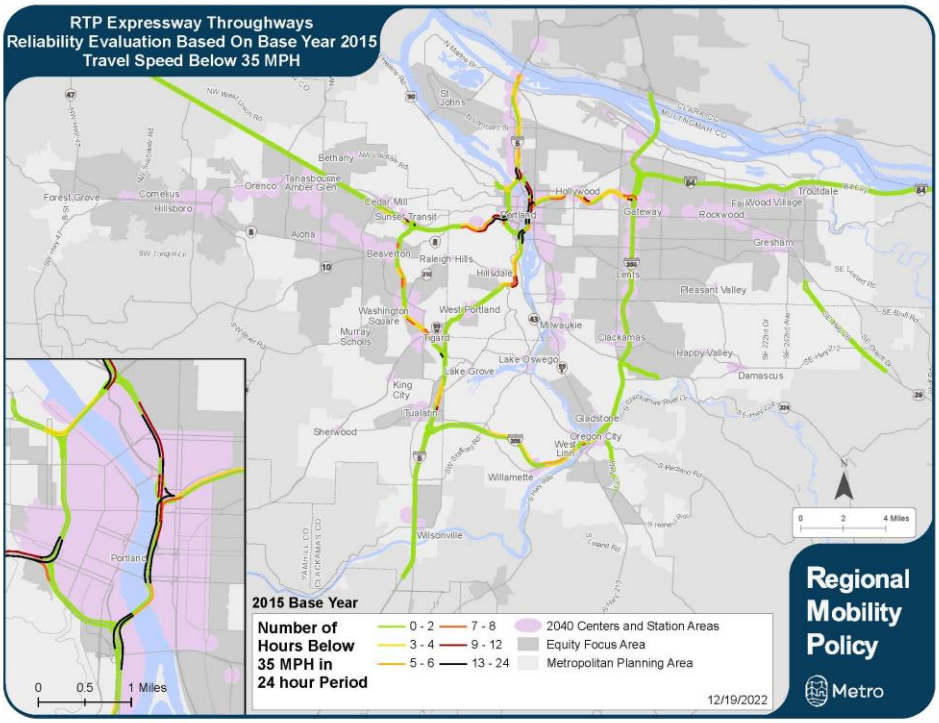
A desired outcome of the Regional Mobility Policy is to define "reliable" conditions for throughways designated in the Regional Transportation Plan. Based on review of the HCM, SHRP research, and current INRIX data, 35 mph was identified as a draft threshold identifying reliable travel conditions.

Step Three: Review of Metro's Model Forecasting Capabilities for Travel Speed

The project team reviewed Metro's model output for forecasting capabilities of travel speed, including output from both the 2015 base year model scenario and 2040 Financially Constrained model scenario prepared by Metro for the 2018 RTP. The following map shows the hours per day that average hourly travel speeds are below 35 mph based on 2015 base year Metro model outputs. The maps based on Metro model output use roadway segmentation from the Metro model. Attachment B includes the Metro Regional Travel Demand Model Segmentation figure to highlight the roadway links from the model.

The project team compared this map to the INRIX data reviewed in Step One. There is some alignment for the I-5 corridor, but there were more segments of I-205 and US-26 with higher number of hours below the speed thresholds for the INRIX data. One reason for the differences may be that the 2015 base year Metro model and the INRIX data are not based on the same study year. The project team recommends additional calibration based on INRIX travel speeds and travel times as Metro works on an updated base year model moving forward.

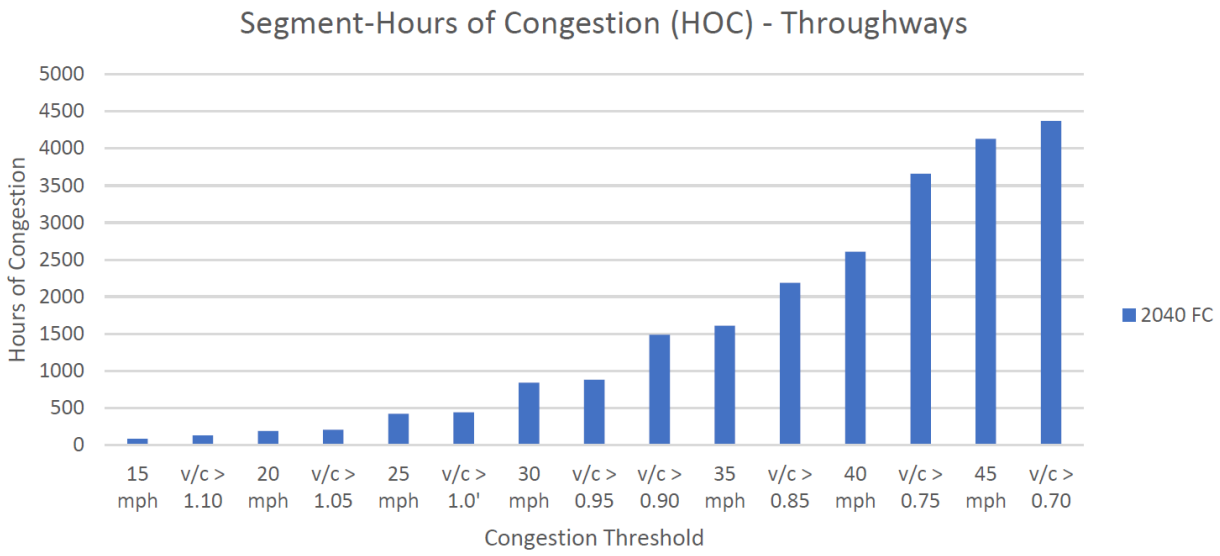
Reliability Evaluation for RTP Expressway Throughways Based on Based on Average Hourly Travel Speed Below 35 MPH – 2015 Base Year Metro Model Scenario



Because the current mobility policy measure (volume-to-capacity ratio) is assessed by forecasting of volumes from Metro's model, the project team then compared the volume-to-capacity (v/c) outputs and the travel speed outputs from the 2018 RTP for the 2040 Financially Constrained Metro model scenario. The project team reviewed different travel speed thresholds to understand impacts of how many hours per day different thresholds would be exceeded when doing a 24 hour analysis. Attachment B shows the set of maps used to consider potential travel speed thresholds for throughways. The following graph shows the segment-hours exceeding each potential v/c and travel speed threshold for RTP throughways. The graph highlights the links and similarities of v/c and hourly average speed, with hours exceeding the target based on both measures following a similar profile as the threshold becomes more restrictive (i.e. a lower maximum v/c threshold or a higher minimum travel speed threshold).

It is important to note that the Metro model output is based on whole hour increments. For example, the output includes hourly average speed for the 24 clock hours of an average weekday, such as 3 PM to 4 PM and 7 PM to 8 PM, and not for 3:30 PM to 4:30 PM. There may be instances where the average speed from 3 PM to 4 PM does not show as an hour exceeding the target but 3:30 PM to 4:30 PM would if it was analyzed. This is one limitation of the current Metro models, which is the same limitation as has been present in past studies analyzing hourly volumes to determine v/c ratios. See Attachment B for an excerpt of the calculations of hours exceeding the threshold (i.e. hours of congestion) based hourly travel speed.

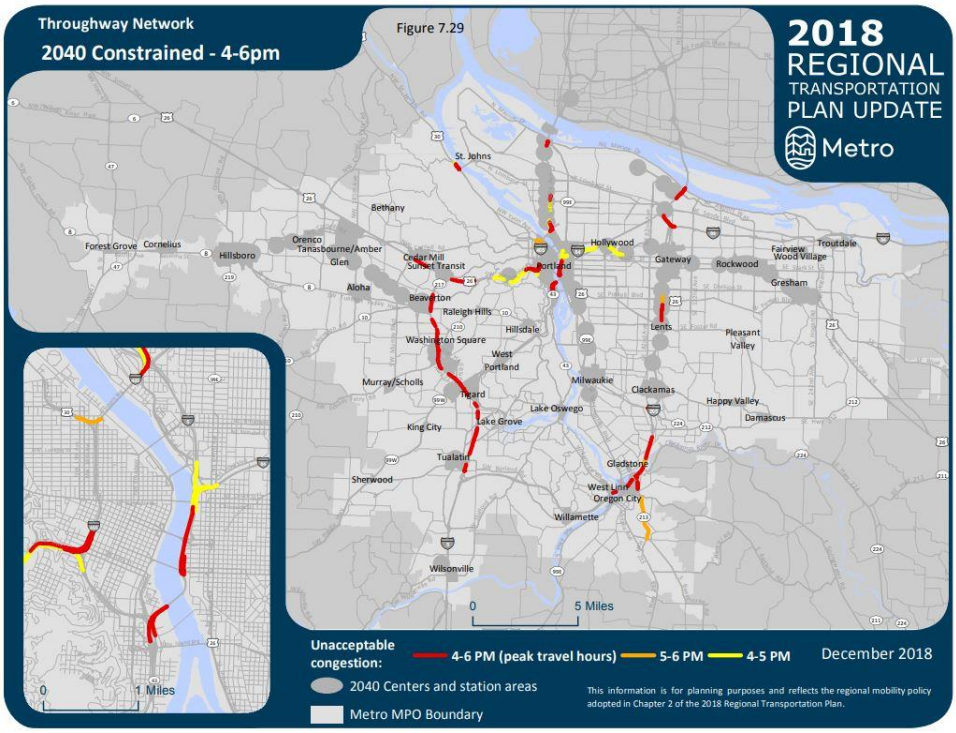
Comparison of Segment-Hours Operating Unreliably for RTP Throughways for Different "Reliability" Thresholds – 2040 Financially Constrained Metro Model Scenario



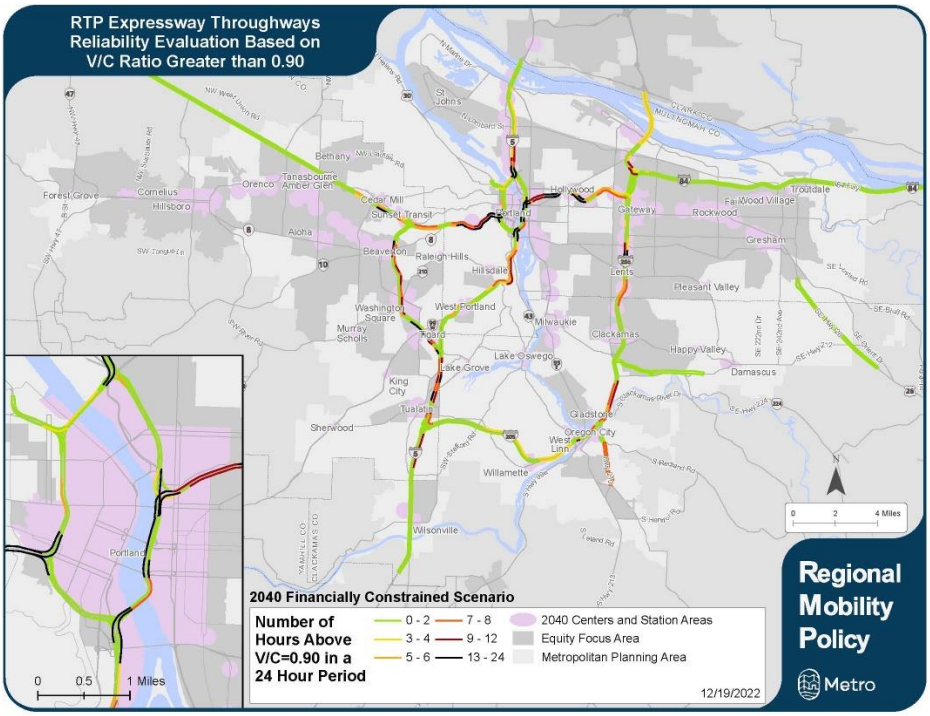
After verifying the similar patterns of hours operating unreliably based on v/c and hourly average travel speed, the 2040 Financially Constrained Metro model outputs were used to compare the geographic similarities of the two threshold types and to the 2018 RTP map of throughways not meeting the regional mobility policy. The following maps show the comparison of the hours per day that the v/c exceeds 0.90 and the hours per day that average hourly travel speeds are below 35 mph.

The maps highlight that the modeled speeds, volumes, and volume-to-capacity ratios are very linked. Comparing the number of hours operating unreliably on the two maps, there are clear equivalencies in segment hours operating unreliably based on speed versus based on v/c. The locations of poor reliability are also very similar between the two measures at equivalent segment hours operating unreliably on interstates and unsignalized throughways. Based on these comparisons, forecasted travel speeds are assumed to be at least as accurate at forecasted volumes from Metro's model. The locations of poor reliability based on hours below a target speed threshold highlight similar locations as the current regional mobility policy (based on v/c) while also highlighting additional areas of concern, including additional sections of US 26 and I-5. This matches feedback from some practitioners that the current mobility policy doesn't highlight all the segments that would be expected based on on-the-ground experience.

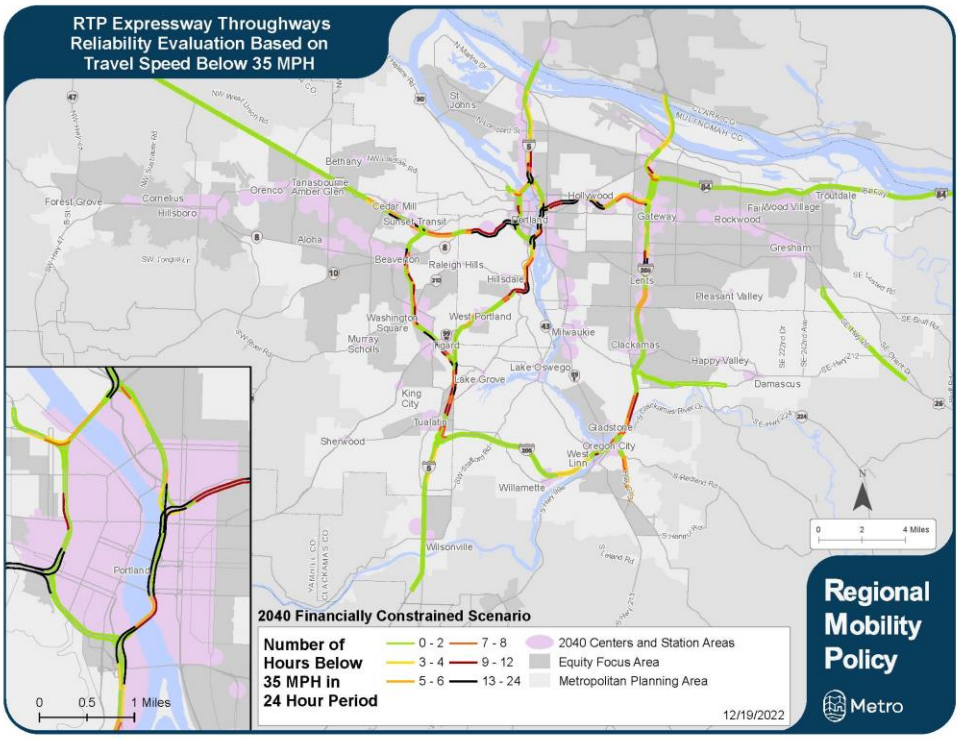
2018 RTP Throughways Not Meeting the Current Regional Mobility Policy for One or Two Hours During the PM Peak Period – 2040 Financially Constrained Metro Model Scenario



Reliability Evaluation for RTP Expressway Throughways Based on V/C Ratio Greater than 0.90 – 2040 Financially Constrained Metro Model Scenario



Reliability Evaluation for RTP Expressway Throughways Based on Average Hourly Travel Speed Below 35 MPH – 2040 Financially Constrained Metro Model Scenario



Step Four: Potential Travel Speed Threshold Considerations for Expressway Throughways

Research shows that when travel speeds drop below 30-35 mph the system quickly breaks down. Currently, ODOT uses 45 mph in identifying bottlenecks (pinch points in the system or locations of capacity constraints that cause traffic to slow down and has a spillback effect extending long distances) to provide a buffer above the breakdown point of 35 mph to account for non-reoccurring congestion that occurs from minor crashes or vehicle breakdowns. Metro staff suggested 30 mph as new v/c equivalent. Various ODOT staff recommended 35-45 mph. ODOT and Metro staff agreed to use 35 mph as the draft target for testing in the RTP update.

The proposed reliability target for ODOT expressways designated in the RTP as throughways is for **no more than four hours in a day when the average speed falls below 35 mph**. As a replacement of v/c to determine need, if the target is met or exceeded, a need exists. The goal is to focus on the commute peaks as they are the highest traffic volume and least reliable parts of the day. The 2023 RTP will use 2019 INRIX data and the Metro travel model to identify needs and evaluate system performance based on the draft target, providing a path for identifying potential solutions to address them following the RTP system sizing policy and congestion management process and OHP Policy 1G.[1] ODOT R1 currently uses speed as a determinate of need for freeway operational and capacity investments instead of v/c.

[1] The RTP Chapter 3 (pages 3-71 and 3-72) and Appendix L to the RTP provides more detailed information. Sections 3.08.220 and 3.08.510 of the Regional Transportation Functional Plan further direct how cities and counties implement the CMP in the local system planning process. OHP Policy 1G (Major Improvements) has the purpose of maintaining highway performance and improving highway safety by improving system efficiency and management before adding capacity

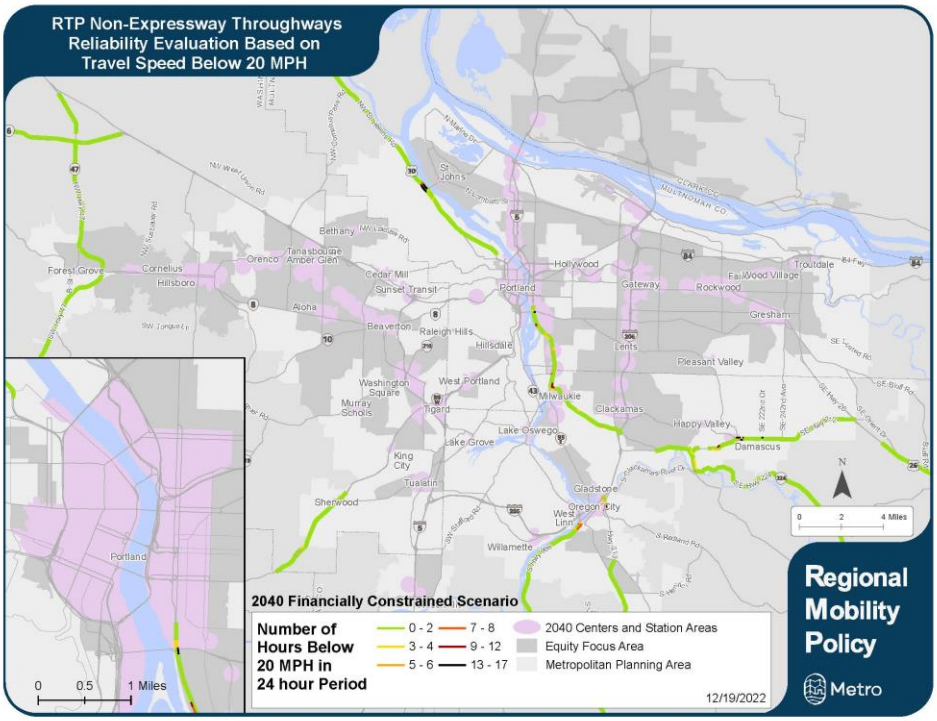
An updated target based on travel speed ensures all agencies recognize the identified needs and better aligns with observed congested locations than v/c. Important considerations to know about the proposed reliability target for ODOT expressways designated as throughways in the RTP include:

- 35 mph **is not a performance target** for the management or operations of the freeways, it is a threshold to identify need.
- 35 mph **is not a daily average** target speed for the freeways, it is a target applied on an hourly basis;
- If hourly average speeds fall below 35 mph for four hours in a day, **it does indicate the system is failing at that location**. 35 mph was chosen to protect the long-term reliability of travel time on the system. Once the system falls below 35 mph small incidents can cause a significant breakdown in throughput.

Step Five: Potential Travel Speed Threshold Considerations for Non-Expressway Throughways

Further refinement of the threshold was completed by reviewing ODOT expressways designated as throughways in the 2018 RTP separately from non-expressway ODOT highways designated as throughways in the 2018 RTP. For non-expressway throughways, the presence of traffic signals and non-motorized modes creates more friction and delay for vehicles, resulting in recommending a lower average travel speed threshold for identifying hours of poor reliability. The following map shows hours operating unreliably for RTP non-expressway throughways based on a 20 mph travel speed threshold (for more than 4 hours per day) using output from the 2040 financially constrained model scenario. Hours poor reliability based on 20 mph for non-expressway throughways are most similar to the hours of poor reliability based on a v/c of 0.90, similar to the 35 mph threshold on expressways designated as throughways in the RTP. The map indicates that in the 2040 Financially Constrained model scenario, the traffic signals along many of the non-expressway throughways have poor reliability 3-4 hours per day with many locations having poor reliability more than 9 hours per day.

Reliability Evaluation for RTP Non-Expressway Throughways Based on Average Hourly Travel Speed Below 20 MPH – 2040 Financially Constrained Metro Model Scenario



Attachments

Attachment A: INRIX Graphics

The attachment includes:

- I-205 Northbound
    - Hours per day not meeting the speed threshold – July 11 through July 15, 2021
    - Travel speeds – Thursday, July 14, 2021
- I-205 Southbound
    - Hours per day not meeting the speed threshold – July 11 through July 15, 2021
    - Travel speeds – Thursday, July 14, 2021
- I-5 Northbound
    - Hours per day not meeting the speed threshold – July 11 through July 15, 2021
    - Travel speeds – Thursday, July 14, 2021
- US-26 Eastbound
    - Hours per day not meeting the speed threshold – July 11 through July 15, 2021
    - Travel speeds – Thursday, July 14, 2021

Attachment B: Speed Reliability Evaluation Maps

The attachment includes:

- Metro Regional Travel Demand Model Segmentation
- Example excerpt of the Reliability Evaluation calculations based on speed
- 2040 Financially Constrained Scenario
    - RTP Expressway Throughways Reliability Evaluation Based on Travel Speed Below 40 MPH
    - RTP Expressway Throughways Reliability Evaluation Based on Travel Speed Below 35 MPH
    - RTP Expressway Throughways Reliability Evaluation Based on Travel Speed Below 30 MPH
    - RTP Expressway Throughways Reliability Evaluation Based on V/C Ratio Greater than 0.90
    - RTP Expressway Throughways Reliability Evaluation Based on V/C Ratio Greater than 0.95
    - RTP Non-Expressway Throughways Reliability Evaluation Based on Travel Speed Below 20 MPH
    - RTP Non-Expressway Throughways Reliability Evaluation Based on VC Ratio Greater than 0.90
- 2015 Base Year
    - RTP Expressway Throughways Reliability Evaluation Based on Base Year 2015 Travel Speed Below 35 MPH
- 2040 No-Build Scenario
    - RTP Expressway Throughways Reliability Evaluation Based on No-Build 2040 Travel Speed Below 35 MPH