

Understanding NPMRDS Usage for Certain Performance Data Needs

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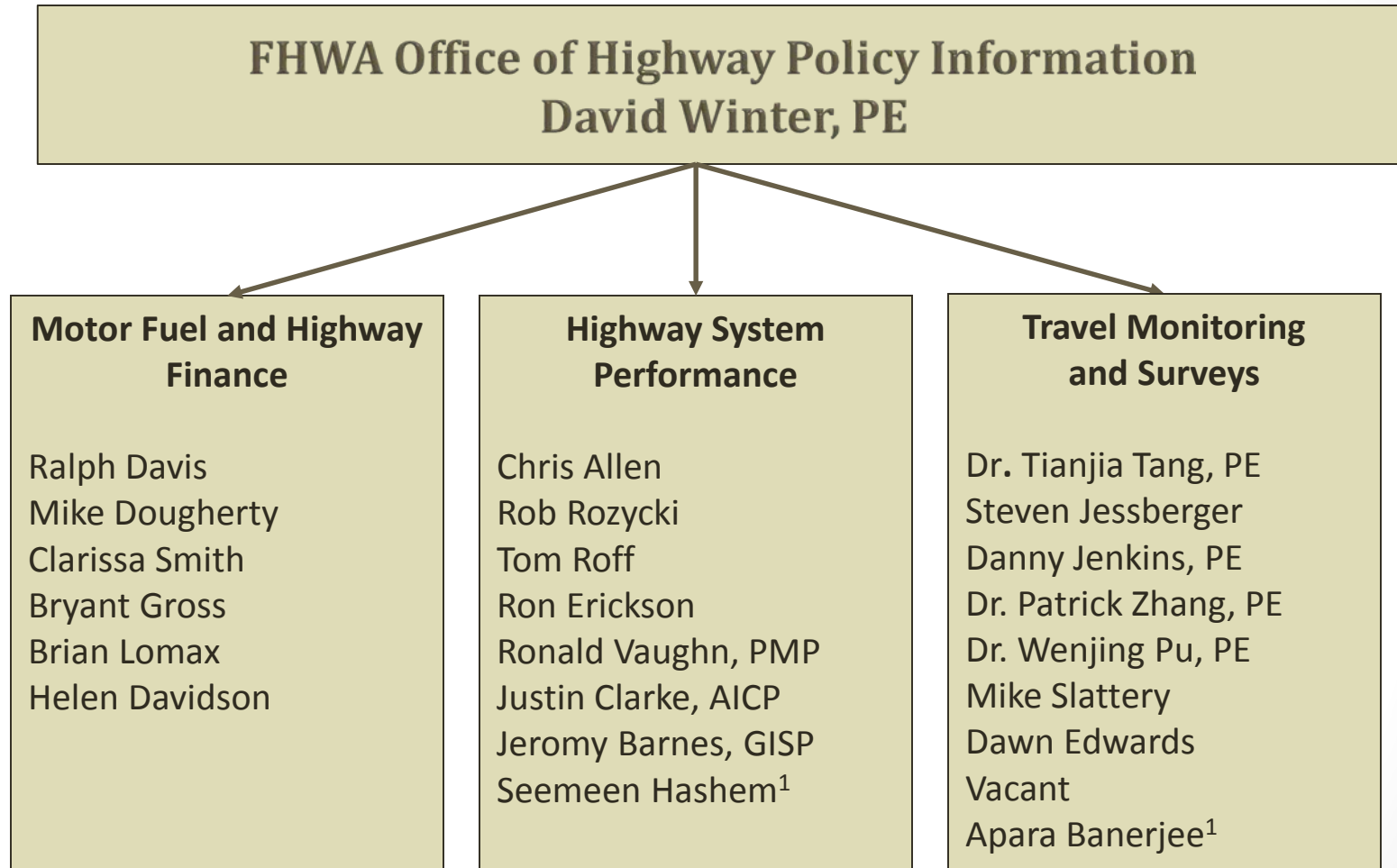
Highway Information Seminar

November 15, 2017

11/15/2017



Office Organizational Chart



1 – Indicates contractor



Outline

1. National Performance Management Research Data Set (NPMRDS)
2. NPMRDS for PM3 (System Performance, Freight, and CMAQ)
3. NPMRDS for Other Applications



What is NPMRDS?

- A package of vehicle probe data procured by FHWA
 - 1st procurement (NPMRDS v1): July 2013
 - 2nd procurement (NPMRDS v2): April 2017
- Archived travel time and speed; AADT (if available) is conflated from HPMS
- Resolution: 5-minute intervals on over 400,000 TMC segments
- Coverage: National Highway System, 26 border crossings
- Travel time and speed by vehicle type:
 - Passenger vehicles
 - Trucks
 - All (passenger vehicles and trucks)



NPMRDS: v1 vs. v2

	V1	V2
Data Vendor	HERE	UMD-INRIX-TTI-KMJ-IDAX
Temporal resolution	5-minute	5-, 10-, 15-, 60-minute
Epoch w/o obs.	Not included in the file	Has the option to include empty (null) values
TMC Path	Combined TMCs	Internal/External TMCs
Path Processing	No	Yes
GIS Shapefile	HERE LinkID TMC Look Up Table	TMC path 15 HPMS Data Items
Data Download	Multi-States/US; large files	Flexible, Customized selection
Temporal coverage	2011 – 1/31/2017	2/1/2017 – (up to 12/31/2021)



What's in the NPMRDS?

1. TMC Shapefile (each state is a separate file)
<https://npsmrds.ritis.org/analytics/shapefiles>
2. TMC Identification table (.csv)
3. Speed/travel time data table (.csv)



Traffic Message Channel (TMC) Code

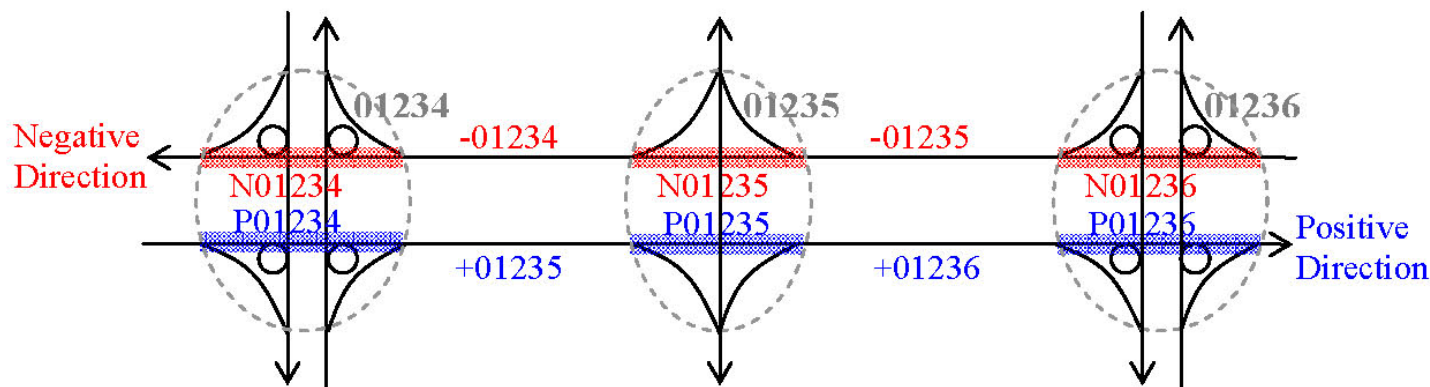
Country Code

Internal/External Path and Direction

125+05272

Location Table Name

Location ID



"P" = Northbound or Westbound, internal segments

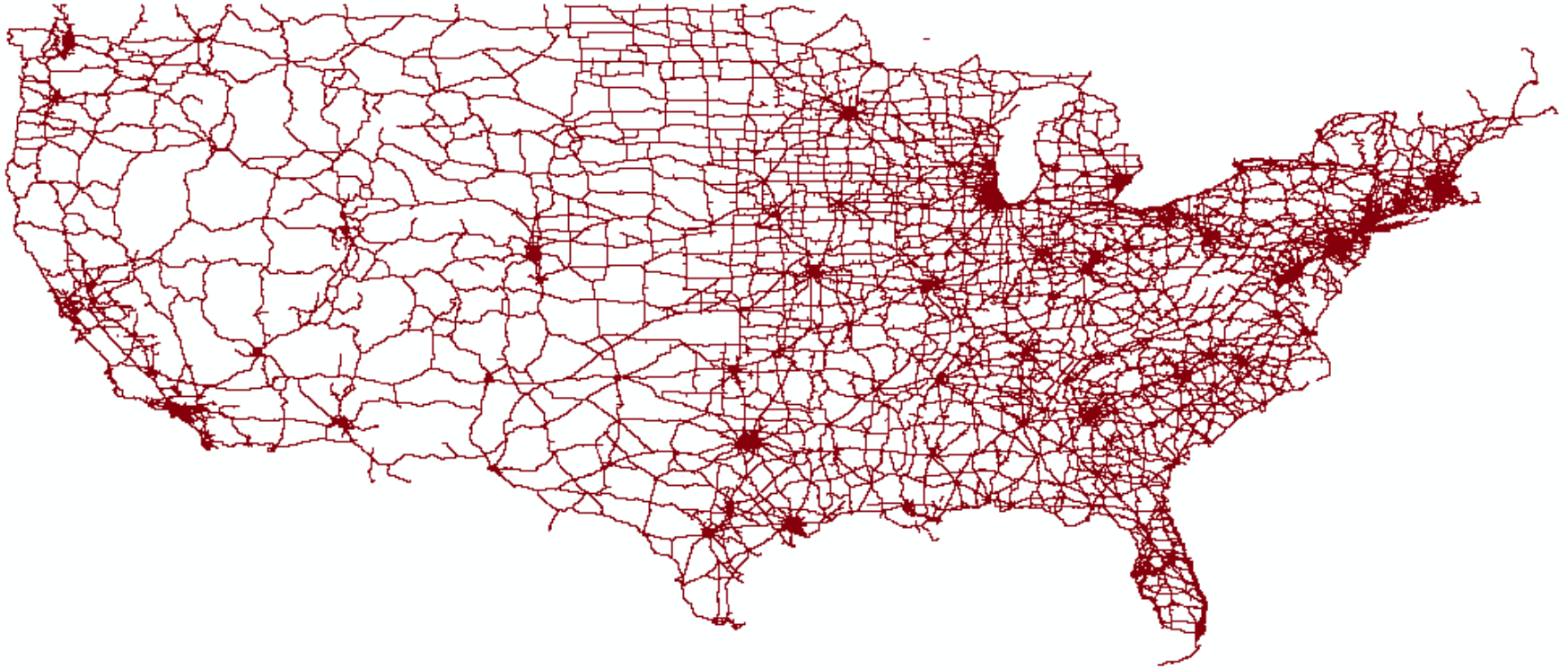
"N" = Southbound or Eastbound, internal segments

"+" = Northbound or Westbound, external segments

"-" = Southbound or Eastbound, external segments



TMC Shapefile



Note: Alaska, Hawaii, Puerto Rico have TMC shapefiles but not shown here.



TMC Identification table (.csv)

No.	TMC Original	No.	Conflated HPMS
1	datasource	18	border_set*
2	tmc	19	f_system
3	road	20	urban_code
4	direction	21	faciltype
5	intersection	22	structype
6	state	23	thrulanes
7	county	24	route_num
8	zip	25	route_sign
9	start_latitude	26	route_qual
10	start_longitude	27	altrtename
11	end_latitude	28	aadt
12	end_longitude	29	aadt_singl
13	miles	30	aadt_combi
14	road_order	31	nhs
15	timezone_name	32	nhs_pct*
16	tmclinear	33	strhnt_typ
17	frc	34	strhnt_pct*
		35	truck

* Not HPMS data item; included by vendor

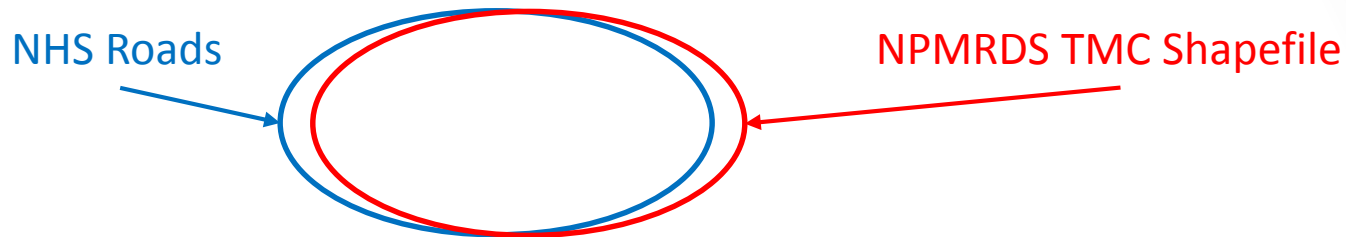


Speed/Travel Time Data (.csv)

Filed Name	Description
datasource	Indicates all vehicles, passenger vehicles, or trucks.
tmc_code	The unique 9-digit value identifying the TMC segment.
measurement_ts tamp	Date and time of data recorded.
speed	Observed average speed in mph for a time interval
average_speed	The historical average speed for the roadway segment for that hour of the day and day of the week in miles per hour.
reference_speed	The calculated "free flow" mean speed for the roadway segment in miles per hour. This attribute is calculated based upon the 85th-percentile point of the observed speeds on that segment for all time periods.
travel_time	Corresponds to the "speed" field; in minutes (or seconds)
data_density	Data density indicator, where: A = 1 to 4 reporting vehicles B = 5 to 9 reporting vehicles C = 10 or more reporting vehicles



NPMRDS Coverage for NHS



- NHS Roads not in TMC Shapefile
 - NHS roads not coded with TMC
 - NHS roads coded with TMC but not in TMC shapefile
- NPMRDS TMC Shapefile
 - Not NHS roads
 - NHS roads
 - A TMC is partially NHS
 - No speed/travel time data in a year
 - Few speed/travel time observations in a year



NPMRDS Supports Four PM3 Measures

- Reliability (2)
 - Percent of person-miles traveled on the Interstate that are reliable
 - Percent of person-miles traveled on the non-Interstate NHS that are reliable
- Freight (1)
 - Truck Travel Time Reliability (TTTR) Index
- CMAQ Peak Hour Excessive Delay (PHED)(1)
 - Annual Hours of PHED Per Capita

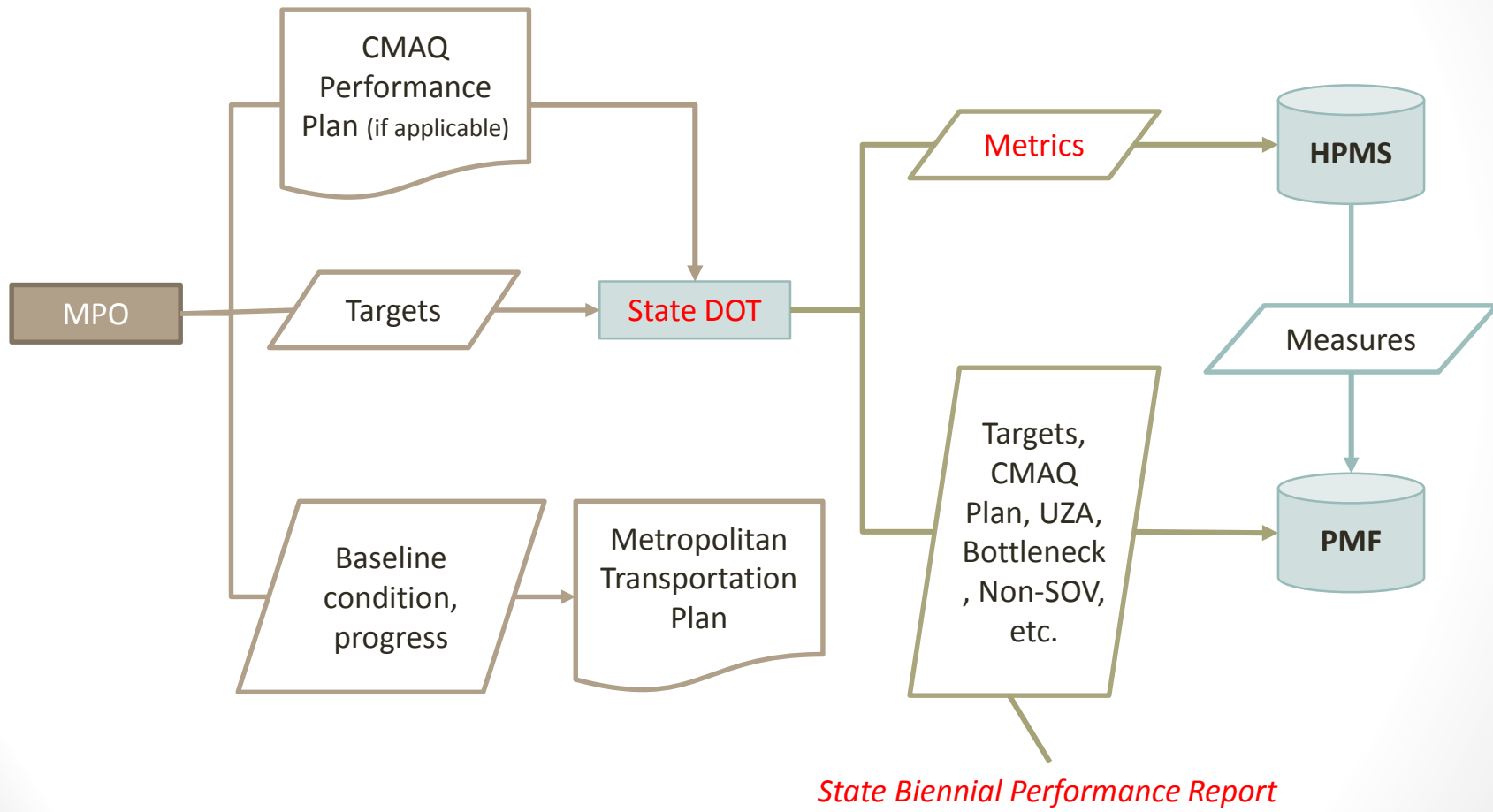


Summary of Travel Time Based 4 Measures

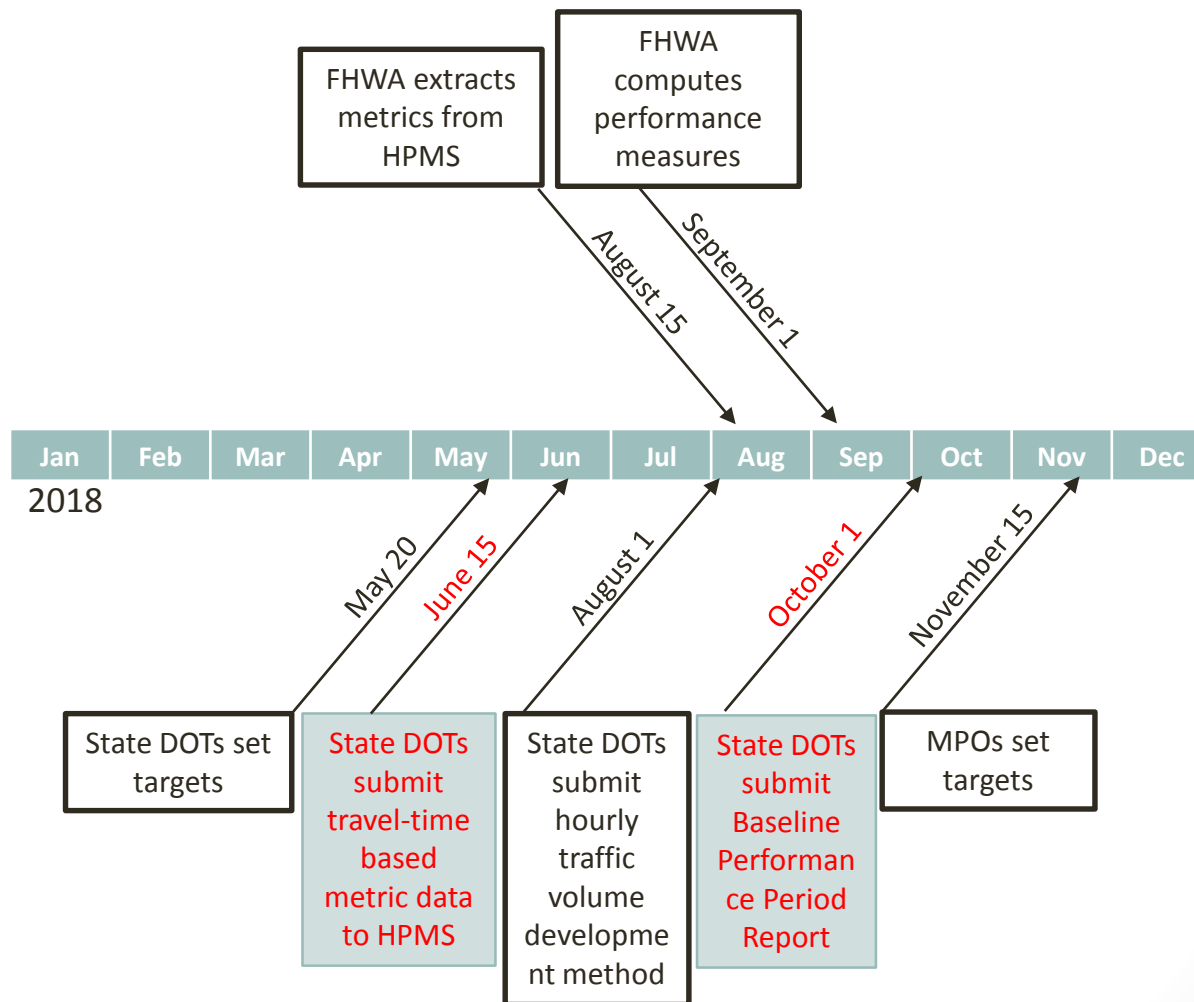
Measure	Applicability	If NPMRDS Used	Metrics to HPMS by 6/15/2018	State to Set Targets by 5/20/2018
Reliability – Interstate	Mainline Interstate	“All Vehicle”, 15-minute	LOTTR (=80 th TT/50 th TT)	2-year, 4 -year
Reliability – Non-Interstate NHS	Mainline non-Interstate NHS	“All Vehicle”, 15-minute	LOTTR (=80 th TT/50 th TT)	4-year
Freight	Mainline Interstate	“Truck” (use “All Vehicle” if “Truck” not available), 15-minute	TTTR = (95 th TT/50 th TT)	2-year, 4 -year
PHED	Mainline NHS in applicable Urbanized Area	“All Vehicle”, 15-minute	Total PHED in person-hours	4-year



MPO and State TPM Reporting



2018 Timeline



Travel Time Related Metrics to HPMS by June 15, 2018

Performance Measures	Segment-Level Performance Metrics	Number of Metrics*
Reliability (Interstate, non-Interstate NHS)	1. LOTTR 2. 80th Travel Time 3. 50th Travel Time 4. Directional AADT 5. Occupancy factor } x 4 time periods	14
Freight	1. TTTR 2. 95th Travel Time 3. 50th Travel Time } x 5 time periods	15
PHED	1. PHED	1

* There are other Metrics related data to be submitted to HPMS. Refer to *HPMS Field Manual Supplemental Guidance* for a full list.



Data Requirements: Reliability

Relevant Data	Data Source(s)
• Travel times • NHS travel time segments	• National Performance Management Research Data Set (NPMRDS) , OR • Equivalent data set
• AADT/volumes • Annual traffic volume (AADT x 365)	• Highway Performance Monitoring System (HPMS)
• Occupancy factors	• Provided by FHWA, likely based on national surveys, OR • Other allowed data sources



Calculate LOTTR Metric

- Download “all vehicle” 15-minute travel time data from NPMRDS v2
- Group data into 4 time periods for each TMC
 - Weekday 6:00-10:00 am
 - Weekday 10:00 am-4:00 pm
 - Weekday 4:00-8:00 pm
 - Weekend 6:00 am-8:00 pm
- Rank travel times in each group to obtain 80th and 50th travel times for each TMC
- $\text{LOTTR} = 80^{\text{th}} \text{ travel time} / 50^{\text{th}} \text{ travel time}$ for each TMC



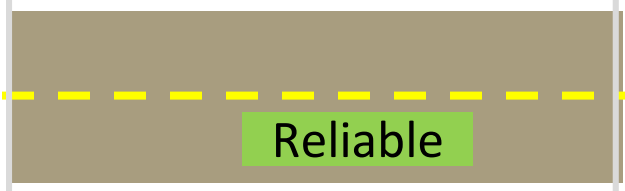
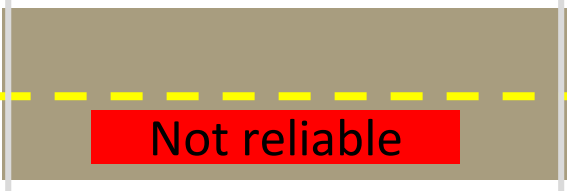
Level of Travel Time Reliability (LOTTR) Metric (Example)

$$\frac{\text{Longer Travel Time (80th)}}{\text{Normal Travel Time (50th)}} = \frac{\# \text{ seconds}}{\# \text{ seconds}} = \text{Level of Travel Time Reliability Ratio}$$

Level of Travel Time Reliability (LOTTR) (Single Segment, Interstate Highway System)		
Monday – Friday	6am – 10am	LOTTR = $\frac{44 \text{ sec}}{35 \text{ sec}} = 1.26$
	10am – 4pm	LOTTR = 1.39
	4pm – 8pm	LOTTR = 1.54
Weekends	6am – 8pm	LOTTR = 1.31
Must exhibit LOTTR below 1.50 during <u>all</u> of the time periods		Segment <u>is not</u> reliable



Calculating Travel Time Reliability Measures (Example)

		
Length	1.000 mi.	0.750 mi.
Annual Traffic Volume	2,000,000	3,500,000
	x	x
Occupancy Factor	x 1.3 persons/vehicle	x 1.7 persons/vehicle
Segment Total	Reliable: 2,600,000 person-miles	Unreliable: 4,462,500 person-miles
	$\frac{\Sigma \text{ (Reliable person-miles)}}{\Sigma \text{ (Total person-miles)}}$	

Measure: % of person-miles reliable, for full extent of the system



Data Requirements: Freight Reliability

Relevant Data	Data Source Options
• Truck travel times • Interstate travel time segments	• NPMRDS, <i>OR</i> • Equivalent data set



Calculate TTTR Metric

- Download “truck” and “all vehicle” 15-minute travel time data from NPMRDS v2
- **If “truck” speed is empty, use “all vehicle” value, if available**
- Group data into 5 time periods for each TMC
 - Weekday 6:00-10:00 am
 - Weekday 10:00 am-4:00 pm
 - Weekday 4:00-8:00 pm
 - Everyday Overnight 8:00 pm-6:00 am
 - Weekend 6:00 am-8:00 pm
- Rank travel times in each group to obtain 95th and 50th travel times for each TMC
- $TTTR = 95^{\text{th}} \text{ travel time} / 50^{\text{th}} \text{ travel time}$ for each TMC



Freight Reliability Metric (Example)

$$\frac{\text{Longer Truck Travel Time (95th)}}{\text{Normal Truck Travel Time (50th)}} = \frac{\# \text{ seconds}}{\# \text{ seconds}} = \text{Truck Travel Time Reliability (TTTR) Ratio}$$

Truck Travel Time Reliability (TTTR) (Single Segment, Interstate Highway System)		
Monday – Friday	6am – 10am	TTTR = $\frac{72 \text{ sec}}{50 \text{ sec}} = 1.44$
	10am – 4pm	TTTR = 1.39
	4pm – 8pm	TTTR = 1.49
Weekends	6am – 8pm	TTTR = 1.31
Overnight	8pm – 6am	TTTR = 1.20
Maximum TTTR		1.49



Calculating Freight Reliability Measure (Example)

$$\text{TTTR Index} = \frac{\sum \text{All segment length weighted TTTR}}{\sum \text{All segment lengths}}$$

Segment length (mi.)	0.500	0.500	1.000	1.000	5.000
	x	x	x	x	x
MaxTTTR	1.49	1.59	1.50	1.41	1.36
	=	=	=	=	=
Length-weighted TTTR	0.75	0.80	1.50	1.41	6.80

$$\text{TTTR Index} = \frac{11.25}{8.000 \text{ mi}} = 1.41$$

Measure: TTTR Index, full extent of the Interstate system



Applicability: PHED

- Areas with the following criteria:

Area Characteristics

- Designated urbanized area,
- Contains NHS mileage, **AND**
- Population over 200,000*



Nonattainment or Maintenance Area

- ozone (O₃),
- carbon monoxide (CO), **OR**
- particulate matter (PM₁₀ or PM_{2.5})

- **All MPOs and State DOTs** that have NHS mileage that overlaps with an applicable urbanized area must coordinate on a **single, unified target** and report on the measures.

** Phase In: For the first performance period only, the population criteria applies to urbanized areas with populations over 1 million.*



Data Requirements: PHED

Relevant Data	Data Source Options
• Urbanized Area Boundary	• US Decennial Census • HPMS
• Reporting Segment Length	• NPMRDS, OR • Equivalent data set
• Travel Time in 15-minute intervals	• NPMRDS, OR • Equivalent data set
• Hourly Traffic Volume	• Hourly continuous traffic volume counts, OR • Derived from AADT reported to the HPMS
• Annual Vehicle Classification for Buses, Trucks, and Cars	• Annual traffic volume counts, OR • AADT, AADT single unit, and AADT combination as reported to the HPMS
• Annual Vehicle Occupancy	• Data provided by FHWA, OR • Alternative estimate that is more specific



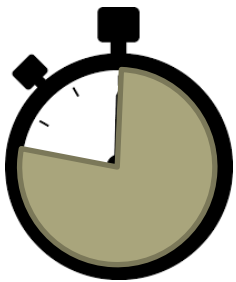
Calculate PHED Metric

- Download “all vehicle” 15-minute travel time data from NPMRDS v2
 - Only for Peak Period (weekday 6-10 am; weekday 3-7 pm or 4-8 pm)
- Determine threshold for excessive delay for each (TMC) segment
 - 20 mph, or 60% of posted speed limit, whichever is greater
 - Covert threshold speed to threshold travel time
- Calculate travel time segment delay
 - NPMRDS travel time – threshold travel time (≥ 0)
- Convert the travel time segment delay to person-hours
 - Hourly volume $\div 4$ (to get vehicle hours of delay)
 - Average Vehicle Occupancy (to get person-hours of delay)
 - Weighted average of occupancy factors for cars, buses, and trucks



PHED Metric (Example)

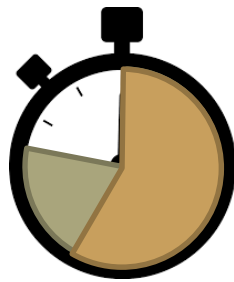
0.500 Mile Reporting Segment



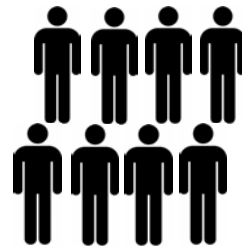
Average of
105 seconds
for a 15-min.
segment per
vehicle



Excessive
Delay
Threshold:
72 seconds



$105 - 72 =$
33 seconds



500,000 people
traveling during
peak hours
(per mode)



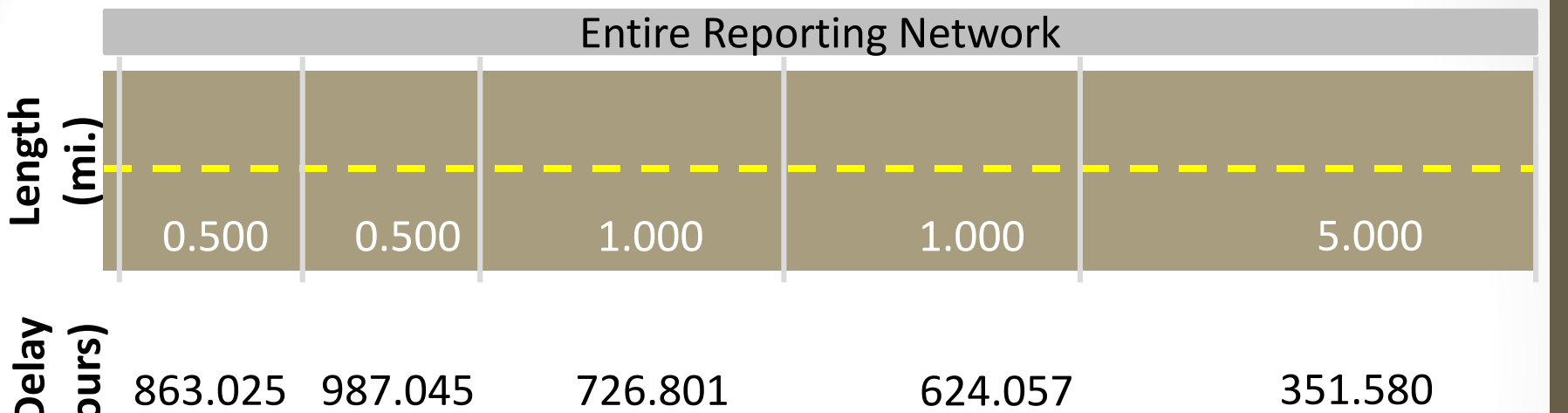
= 863.025
person-hours
For all **peak**
periods in a full
calendar year



***HPMS Submittal:** Starting in 2018, State DOTs report PHED metric for each reporting segment by June 15 of each year, for the previous year's measures



Calculating PHED Measure (Example)



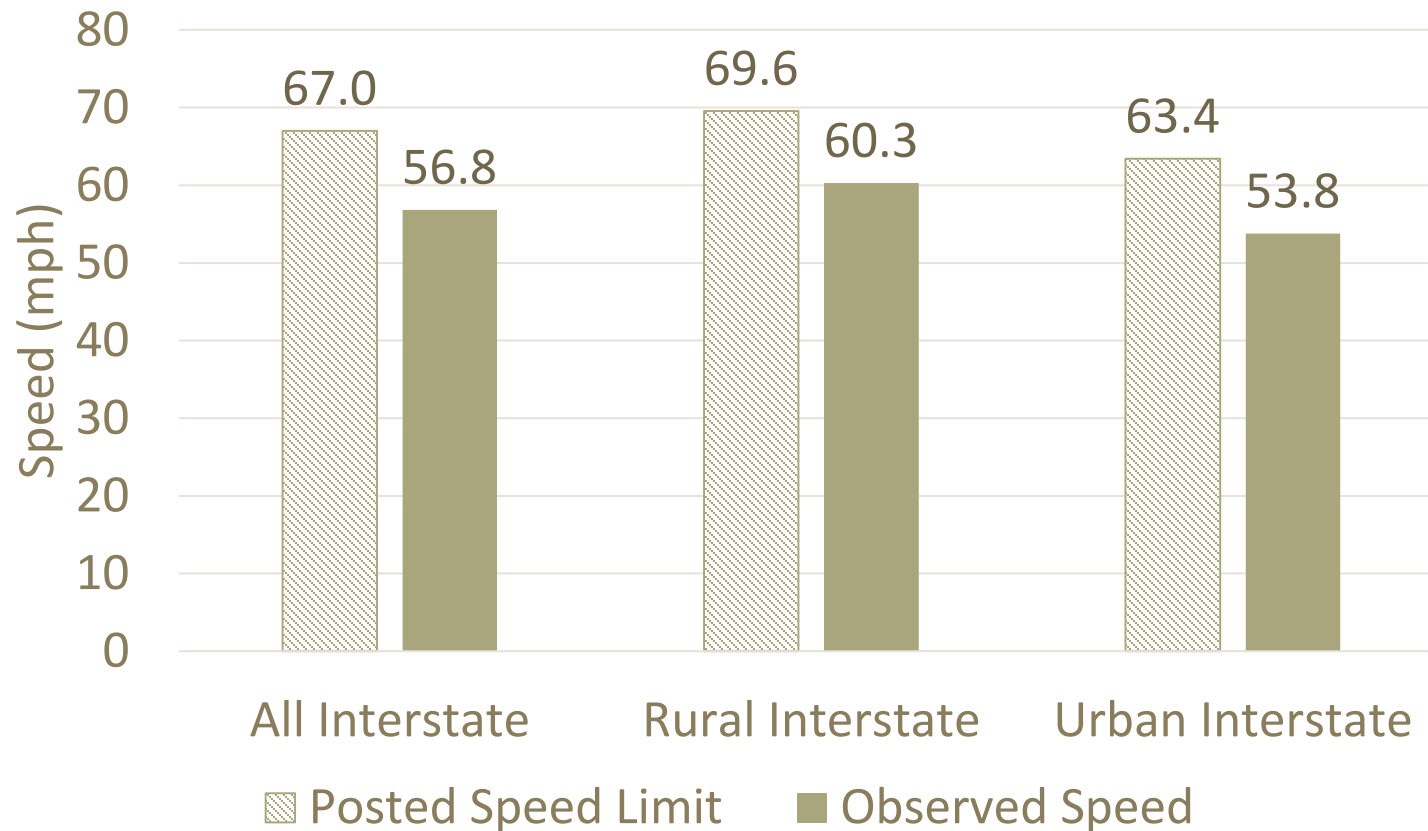
$$\frac{4.46\text{M person-hours excessive delay}}{1.05\text{M urbanized area population}}$$

= 4.3 hours per capita

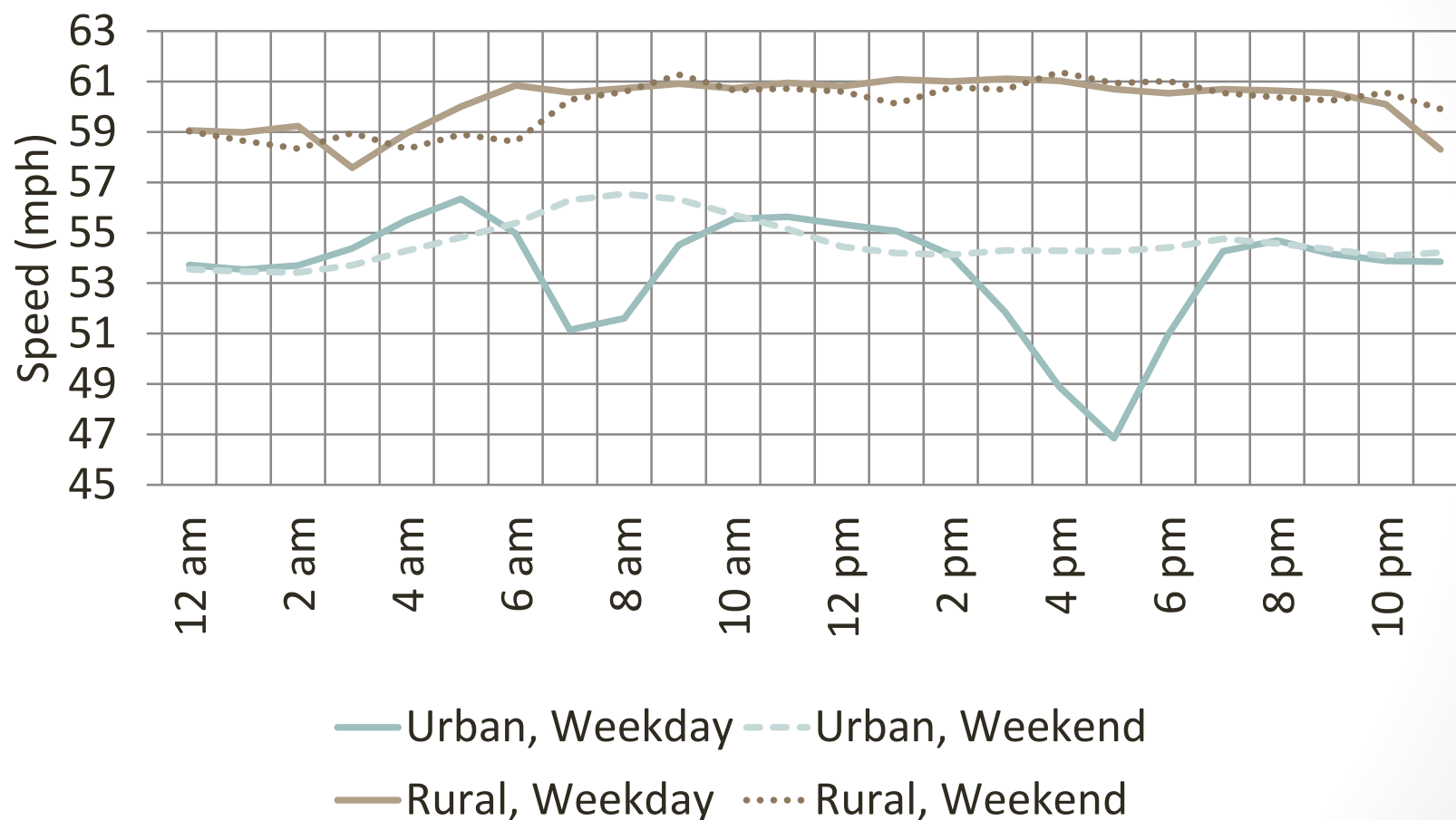
Measure: Peak hour excessive delay per capita



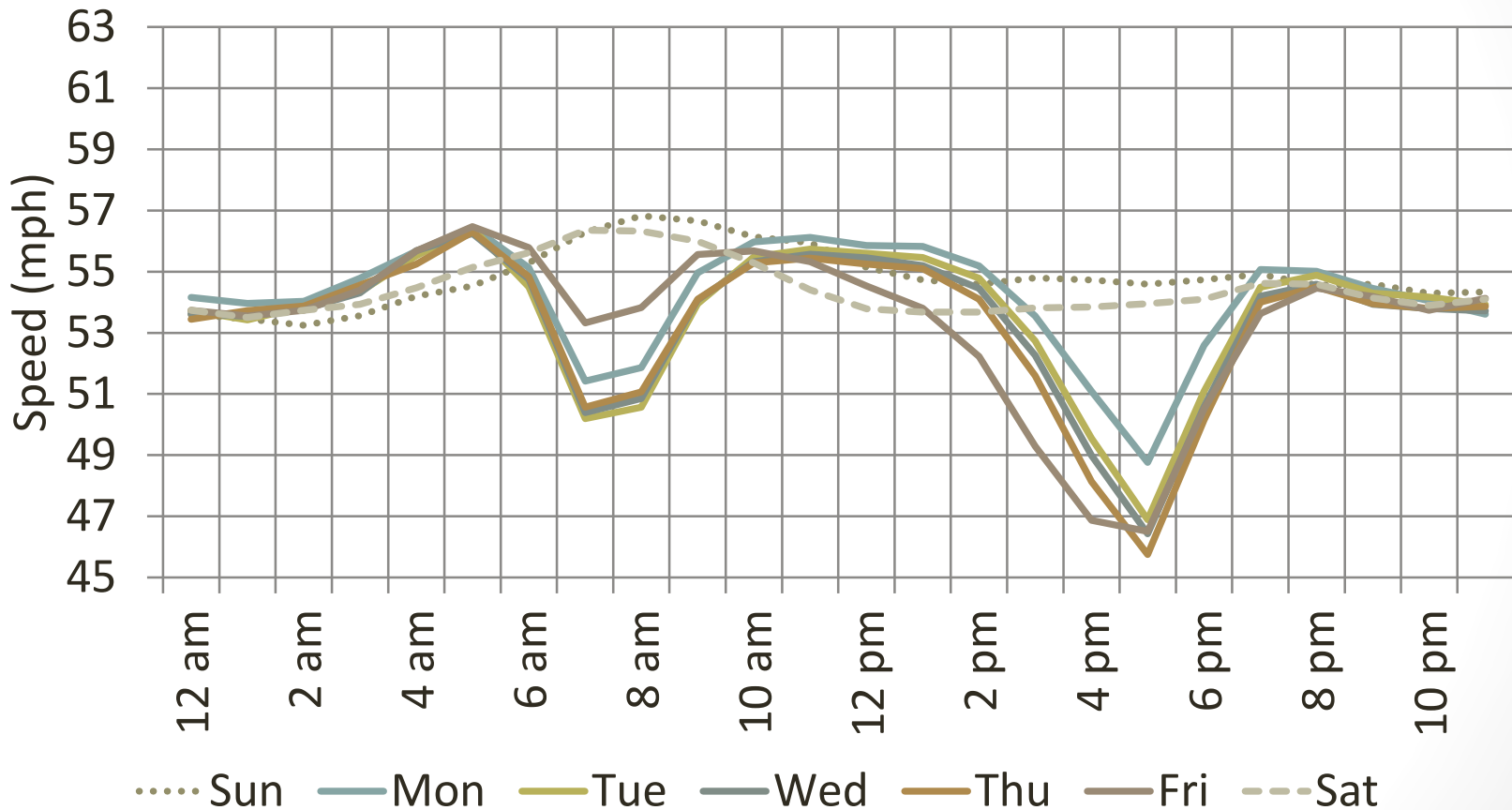
2016 Interstate Speed Profiles: Average Speed



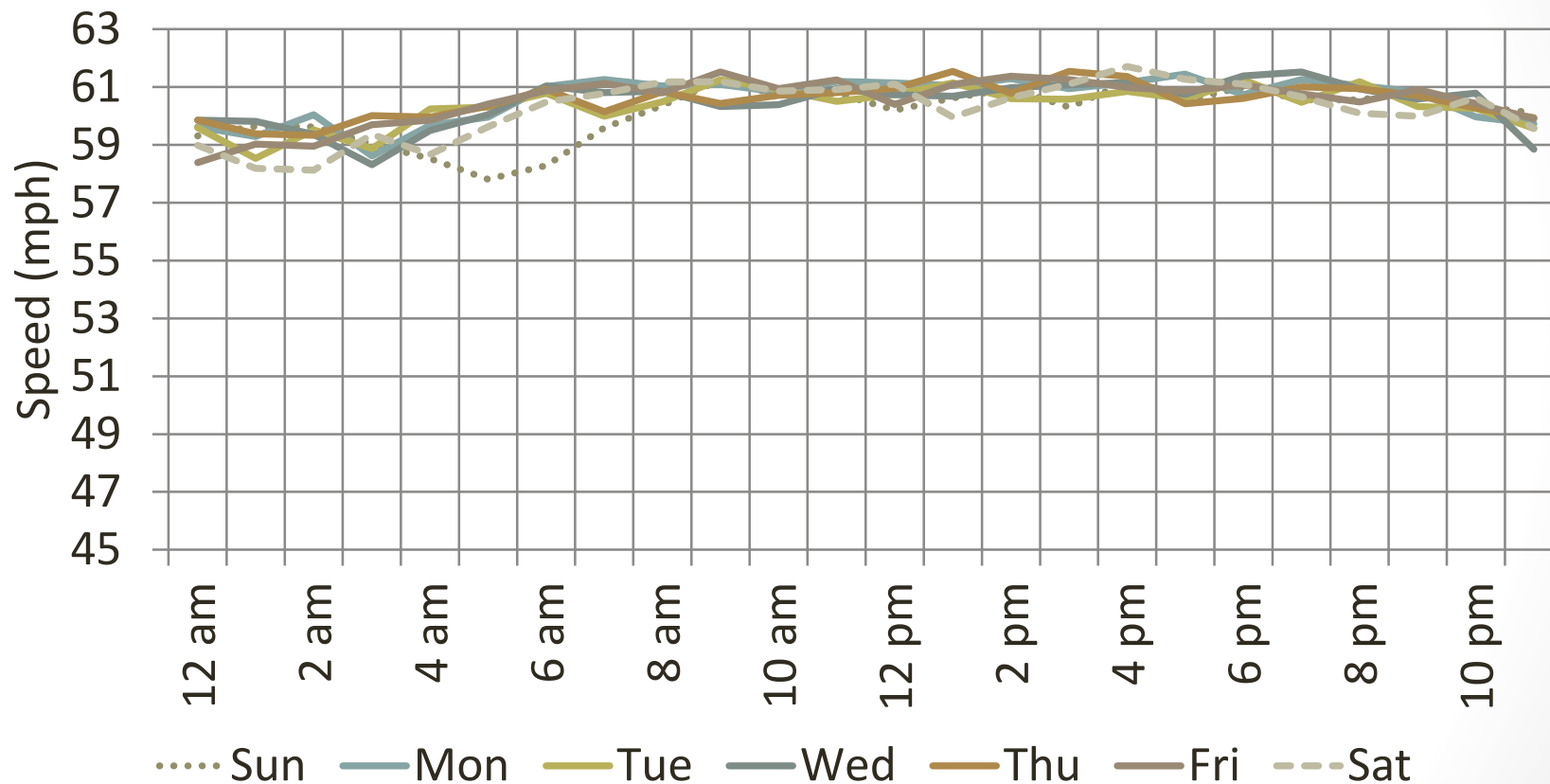
Speed by Hour of the Day



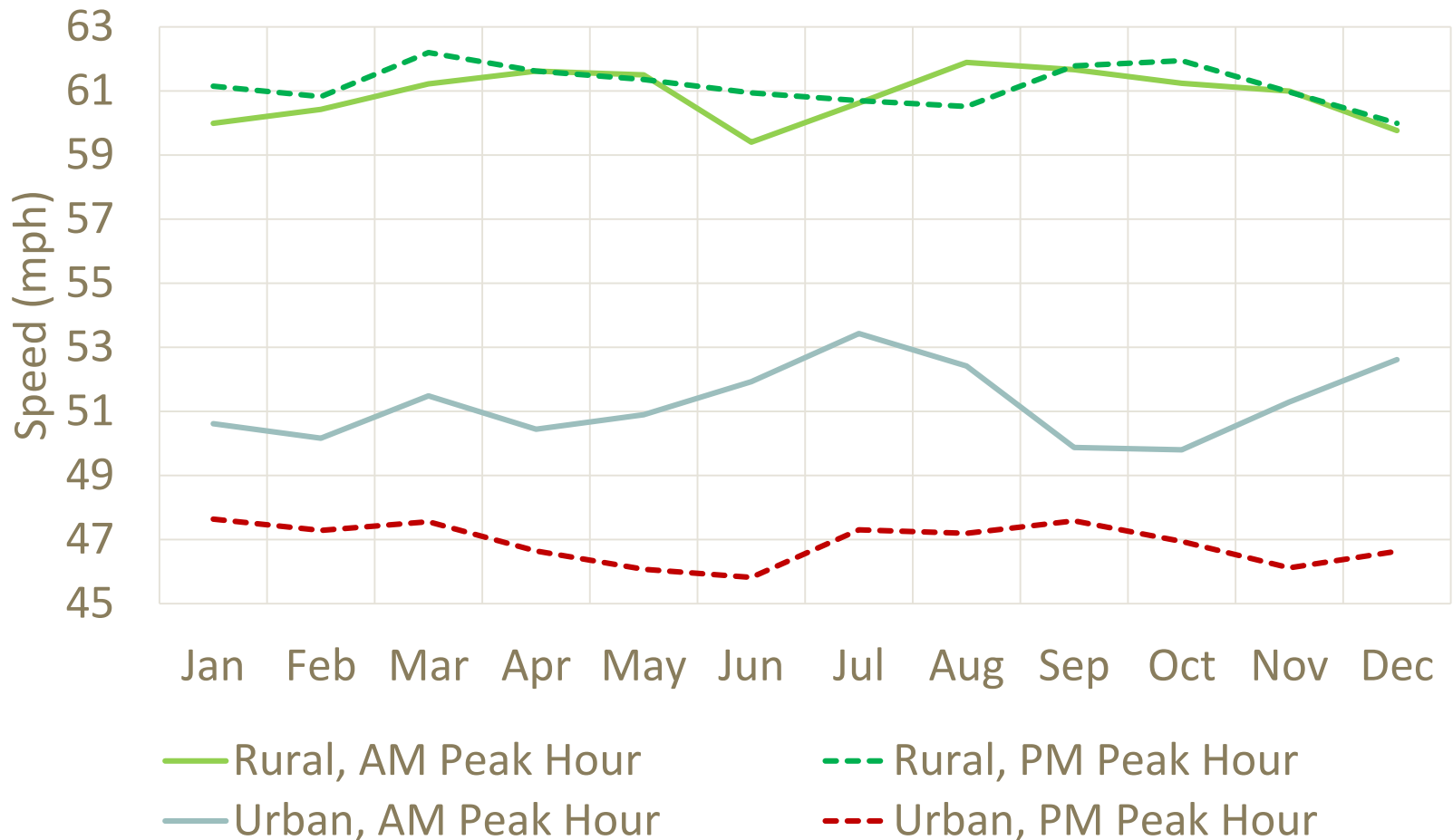
Hourly Speed Pattern by Day of the Week - Urban



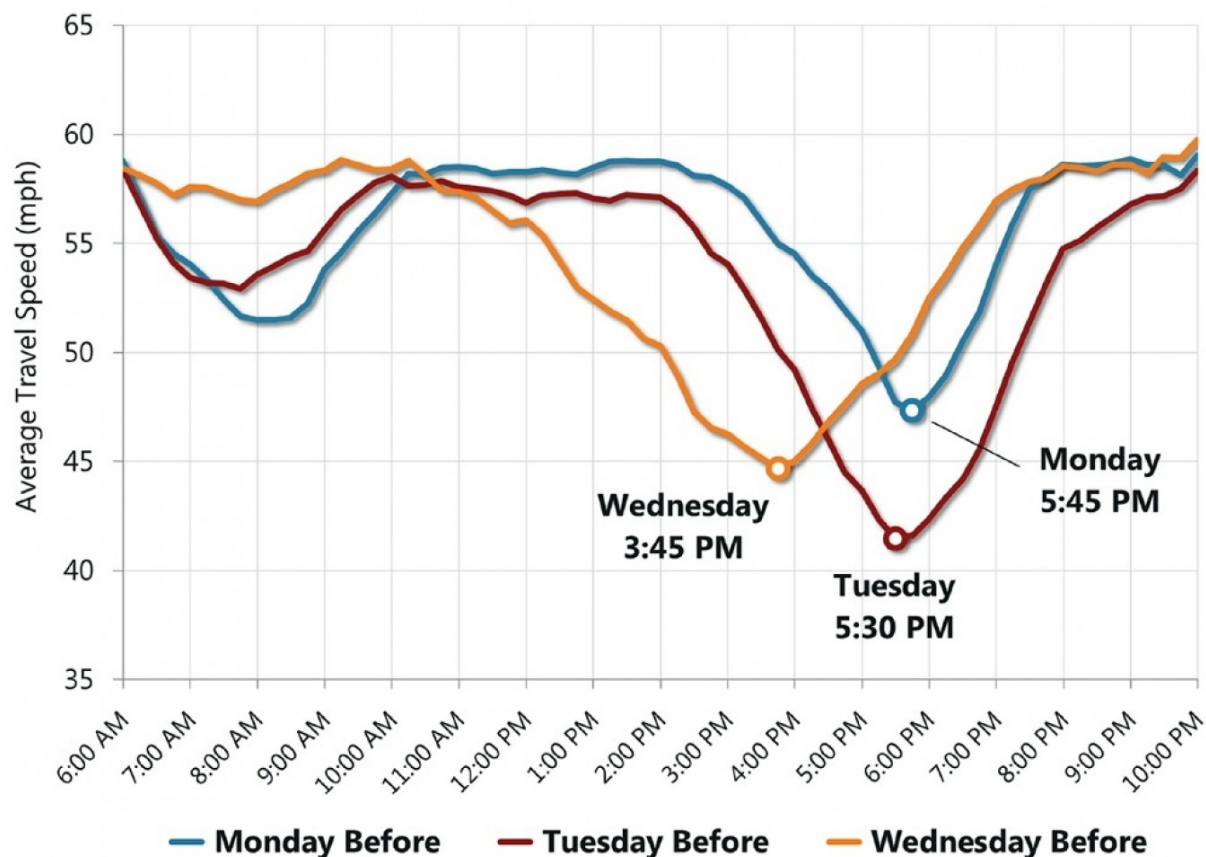
Hourly Speed Pattern by Day of the Week - Rural



Peak Hour Speed by Month



Traffic before Thanksgiving

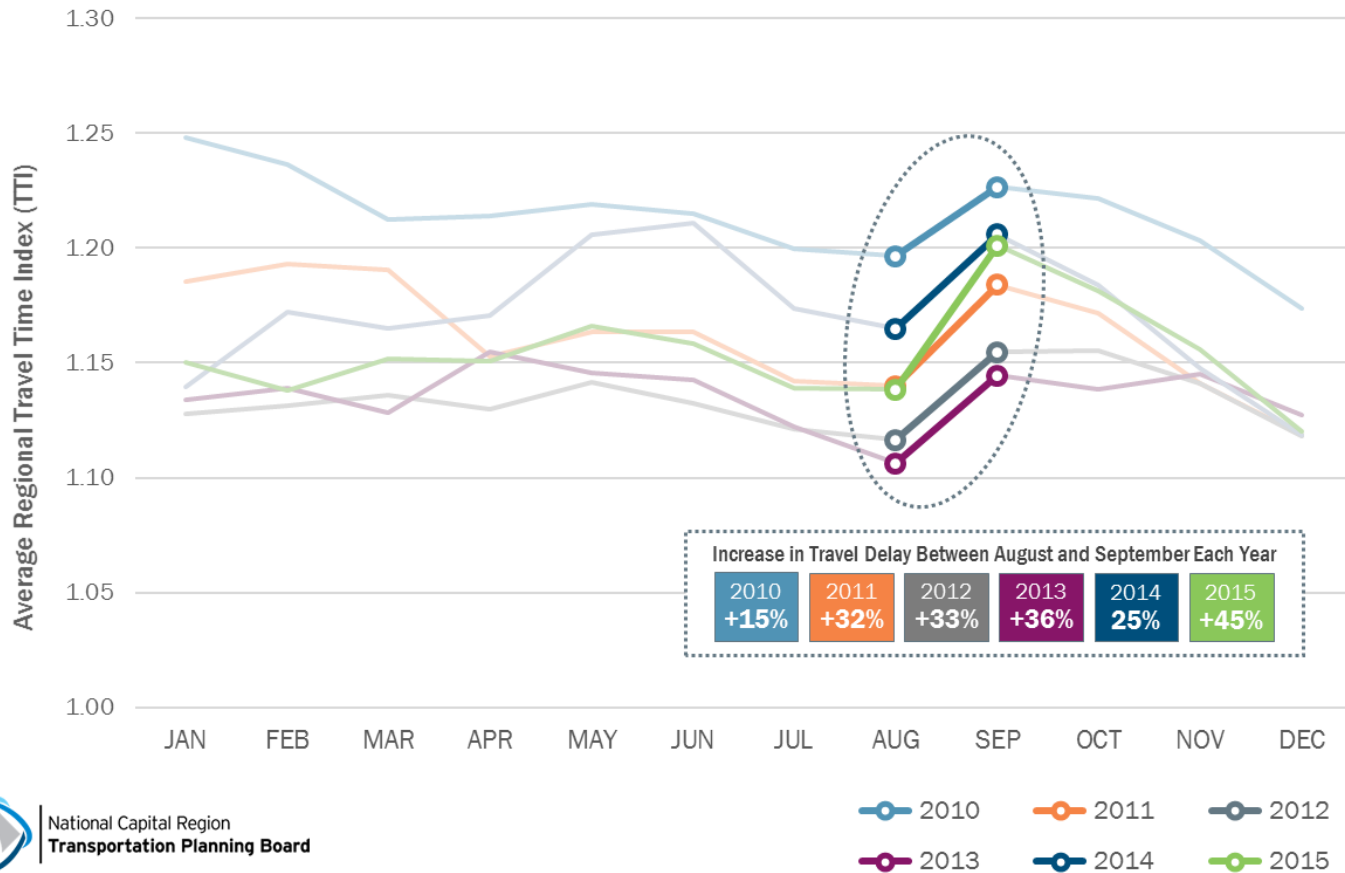


Source: MWCOG

https://www.washingtonpost.com/news/dr-gridlock/wp/2016/11/22/tuesday-wednesday-afternoons-worst-for-thanksgiving-traffic/?utm_term=.5553a12ac244



Morning Travel Delay Consistently Jumps by 15-45% Between August and September Each Year



Questions and Comments

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