# Approaches for Communicating Third Performance Management Rule Measures, Metrics, and Targets

## Final Report

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U.S. Department of Transportation
**Federal Highway Administration**

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| 16. Abstract<br>The Federal Highway Administration third performance management rule (PM3) measures support system performance, freight movement, and the Congestion Mitigation and Air Quality (CMAQ) Improvement Program. The PM3 measures include the National Highway Performance Program (NHPP) Travel Time Reliability (reliability) measures and the freight reliability measure. They also require applicable metropolitan planning organizations (MPOs) to measure two CMAQ traffic congestion measures—Annual Hours of Peak Hour Excessive Delay (PHED) per capita and Non-Single Occupancy Vehicle (Non-SOV) share—and CMAQ Total Emissions Reduction. Through the use of case studies, examples, and other research, this report describes practices to communicate PM3 measures, metrics, and targets. | | | |
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# SI* (MODERN METRIC) CONVERSION FACTORS

## APPROXIMATE CONVERSIONS TO SI UNITS

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| | | **LENGTH** | | |
| in | inches | 25.4 | millimeters | mm |
| ft | feet | 0.305 | meters | m |
| yd | yards | 0.914 | meters | m |
| mi | miles | 1.61 | kilometers | km |
| | | **AREA** | | |
| $in^2$ | square inches | 645.2 | square millimeters | $mm^2$ |
| $ft^2$ | square feet | 0.093 | square meters | $m^2$ |
| $yd^2$ | square yard | 0.836 | square meters | $m^2$ |
| ac | acres | 0.405 | hectares | ha |
| $mi^2$ | square miles | 2.59 | square kilometers | $km^2$ |
| | | **VOLUME** | | |
| fl oz | fluid ounces | 29.57 | milliliters | mL |
| gal | gallons | 3.785 | liters | L |
| $ft^3$ | cubic feet | 0.028 | cubic meters | $m^3$ |
| $yd^3$ | cubic yards | 0.765 | cubic meters | $m^3$ |
| | | **NOTE**: volumes greater than 1,000 L shall be shown in $m^3$ | | |
| | | **MASS** | | |
| oz | ounces | 28.35 | grams | g |
| lb | pounds | 0.454 | kilograms | kg |
| T | short tons (2,000 lb) | 0.907 | megagrams (or “metric ton”) | Mg (or “t”) |
| | | **TEMPERATURE (exact degrees)** | | |
| °F | Fahrenheit | 5 (F-32)/9<br>or (F-32)/1.8 | Celsius | °C |
| | | **ILLUMINATION** | | |
| fc | foot-candles | 10.76 | lux | lx |
| fl | foot-Lamberts | 3.426 | $candela/m^2$ | $cd/m^2$ |
| | | **FORCE and PRESSURE or STRESS** | | |
| lbf | poundforce | 4.45 | newtons | N |
| $lbf/in^2$ | poundforce per square inch | 6.89 | kilopascals | kPa |

## APPROXIMATE CONVERSIONS FROM SI UNITS

| Symbol | When You Know | Multiply By | To Find | Symbol |
|---|---|---|---|---|
| | | **LENGTH** | | |
| mm | millimeters | 0.039 | inches | in |
| m | meters | 3.28 | feet | ft |
| m | meters | 1.09 | yards | yd |
| km | kilometers | 0.621 | miles | mi |
| | | **AREA** | | |
| $mm^2$ | square millimeters | 0.0016 | square inches | $in^2$ |
| $m^2$ | square meters | 10.764 | square feet | $ft^2$ |
| $m^2$ | square meters | 1.195 | square yards | $yd^2$ |
| ha | hectares | 2.47 | acres | ac |
| $km^2$ | square kilometers | 0.386 | square miles | $mi^2$ |
| | | **VOLUME** | | |
| mL | milliliters | 0.034 | fluid ounces | fl oz |
| L | liters | 0.264 | gallons | gal |
| $m^3$ | cubic meters | 35.314 | cubic feet | $ft^3$ |
| $m^3$ | cubic meters | 1.307 | cubic yards | $yd^3$ |
| | | **MASS** | | |
| g | grams | 0.035 | ounces | oz |
| kg | kilograms | 2.202 | pounds | lb |
| Mg (or “t”) | megagrams (or “metric ton”) | 1.103 | short tons (2,000 lb) | T |
| | | **TEMPERATURE (exact degrees)** | | |
| °C | Celsius | 1.8C+32 | Fahrenheit | °F |
| | | **ILLUMINATION** | | |
| lx | lux | 0.0929 | foot-candles | fc |
| $cd/m^2$ | candela/m2 | 0.2919 | foot-Lamberts | fl |
| | | **FORCE and PRESSURE or STRESS** | | |
| N | newtons | 2.225 | poundforce | lbf |
| kPa | kilopascals | 0.145 | poundforce per square inch | $lbf/in^2$ |

*SI is the symbol for International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

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## LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| ACS | American Community Survey |
| CMAQ | Congestion Mitigation and Air Quality |
| DOT | department of transportation |
| EWGCOG | East-West Gateway Council of Governments |
| FHWA | Federal Highway Administration |
| GDOT | Georgia Department of Transportation |
| LOTTR | Level of Travel Time Reliability |
| MDOT | Michigan Department of Transportation |
| mph | miles per hour |
| MPO | metropolitan planning organization |
| NCHRP | National Cooperative Highway Research Program |
| NHPP | National Highway Performance Program |
| NHS | National Highway System |
| NJTPA | North Jersey Transportation Planning Authority |
| NPMRDS | National Performance Management Research Data Set |
| PHED | Peak Hour Excessive Delay |
| PM1 | first performance management rule |
| PM2 | second performance management rule |
| PM3 | third performance management rule |
| PMT | person-miles traveled |
| SOV | Single Occupancy Vehicle |
| TMC | Traffic Message Channel |
| TTTR | Truck Travel Time Reliability |
| VDOT | Virginia Department of Transportation |

## EXECUTIVE SUMMARY

The Federal Highway Administration (FHWA) has established performance measures in three rules under its Transportation Performance Management program. The third performance management rule, or PM3, focuses on system performance, freight movement, and the Congestion Mitigation and Air Quality Improvement Program (CMAQ). Many of the PM3 measures are new to agencies. As such, agencies may have less experience reporting the measures and explaining them to less technical stakeholders within their organizations. This report will discuss principles of good communication, as well as case studies, for presenting PM3 measures, metrics, and targets, beginning with a brief discussion of findings from a literature review and case study interviews.

State departments of transportation (DOTs) and metropolitan planning organizations (MPOs) could be most effective and engaging in communicating PM3 measures if they identify an audience, select or tailor messages that will be compelling for that audience, and make effective use of both written (e.g., fact sheets) and visual (e.g., graphics) communication tools with simple and recognizable visual cues, as well as local references as appropriate.

This report provides detailed discussions of how each category of measures and metrics can be communicated (including conceptual visualizations) and provides examples from MPOs and State DOTs as references for practitioners.

# CHAPTER 1. INTRODUCTION

This report identifies approaches that State departments of transportation (DOTs) and metropolitan planning organizations (MPOs) take for communicating to both internal and external audiences for the third performance management rule (PM3) measures, metrics, and targets. The findings in this report were gathered through a series of interviews and a nationwide literature review that included all of the State DOTs and the largest MPOs. The findings of this literature review informed the development of approaches for each category of measures, metrics, and targets. This report presents those approaches alongside general principles of good communication and applies them to PM3 measures, metrics, and targets.

Some findings of this research include the following:

- An agency looking to maintain credibility and public trust may find it a good practice to effectively communicate differences between delay and reliability, the causes of congestion, and the impact on or of potential investments.

- PM3 measures indirectly track system performance that can cause visceral frustration when performance is poor. Interviews with practitioners indicated that travelers who see a dashboard that visualizes their lived experience enjoy the satisfaction of being heard and understood. This ground-level connection with customers of all types is the purpose of strong communication for PM3 measures, metrics, and targets.

The PM3 measures, metrics, and targets will be discussed in the following chapters. As an introduction, the measures and metrics include:

- National Highway Performance Program (NHPP) reliability measures: two measures, one each covering the Interstate System and the non-Interstate National Highway System (NHS).[1]
  - Level of Travel Time Reliability—the metric that forms the basis for calculating the NHPP reliability measures
- Freight reliability on the Interstate System.[2]
  - Truck Travel Time Reliability (TTTR)—the metric that forms the basis for calculating the freight reliability measure
- CMAQ traffic congestion measures.[3]
  - Annual Hours of Peak Hour Excessive Delay (PHED) per capita.
  - Percent of Non-Single Occupancy Vehicle (Non-SOV) travel.
- CMAQ on-road mobile source emissions reduction measure.[4]

[1]For more details, see 23 CFR 490.507(a)(1) and (2)
[2]For more details, see 23 CFR 490.607
[3]For more details, see 23 CFR 490.707(a)
[4]For more details, see 23 CFR 490.807

## CHAPTER 2. SAMPLE COMMUNICATION APPROACHES

This chapter provides approaches for communicating PM3 measures, metrics, and targets, including those used by the Michigan DOT (MDOT), the North Jersey Transportation Planning Authority (NJTPA), and a pair of agencies in Virginia.

### MICHIGAN DEPARTMENT OF TRANSPORTATION

MDOT reports PM3 measures among other measures of delay and reliability at the corridor level in a Congestion and Reliability Performance Report subdivided by region.[5] The reports not only provide Level of Travel Time Reliability (LOTTR) maps for freeways and speed profiles over the day but also explain these measures graphically in an introduction. The reports are produced in collaboration with Wayne State University annually through a process that has been automated, with macros generating new reports when National Performance Management Research Data Set (NPMRDS) data is provided.

The content in the reports emerged from approximately 100 initial ways to slice and dice the data. Key measures were selected based on several desired qualities:

- Legibility to MDOT employees
- Accessibility to the public
- Ease of reproduction
- Importance of information

MDOT chose to pull some measures out of the report when the underlying data sources were changing too frequently. MDOT worried that if the answer to **Why did this number change?** was the fact that the data itself was in flux, it would undermine confidence in the entire report. MDOT also responded to the changes in underlying data by setting conservative performance targets.

Beyond the reports, MDOT uses LOTTR as a scoring metric for Transportation Systems Management and Operations and infrastructure project selection and post facto before-and-after analysis of project work. Some local governments and MPOs also use all three CMAQ measures in their investment strategies. Before-and-after project analysis using the PM3 measures allows staff to explain impacts in real terms. Previously, "money was always going toward roads." With these added metrics, staff can ask, **"Is this really the best project we could come up with?"**

MDOT has found that reliability and delay measures are easier to communicate to the public when they are at the project or corridor level, as any impact felt statewide would be too small in magnitude to be meaningful to most people. MDOT also has found that the public understands dollars and cents more readily than hours. When communicating internally, MDOT reported that the most frequent question is: **How will I be held responsible for this?**

[5]For more details, see https://www.michigan.gov/mdot/about/performance.

When the PM3 measures were first introduced, the responsible working groups generated short fact sheets on the measures that the interview participants still reference today to remind themselves how the metrics are calculated.

## NORTH JERSEY TRANSPORTATION PLANNING AUTHORITY

NJTPA personalized a PM3 metric with its 5-minute video explaining the PHED CMAQ traffic congestion measure in plain English.[6] NJTPA personalized PHED by directly connecting it to a hypothetical family's daily travel and using clear, effective visuals.

In general, NJTPA has folded PM3 measures into its internal planning and communications, reducing duplicative explanations to stakeholders, though the authority supplements its communications with other measures as needed. It is from NJTPA that the research team was cautioned on congestion as an inevitable consequence of a healthy economy: **It's not wasted money if it's supporting your economy.**

In addition to the PHED video, NJTPA also developed visualizations, a fact sheet on each measure, and slide decks to communicate PM3, including an online dashboard.[7] NJTPA encourages taking a less technical approach, assuming a less technically informed audience, and augmenting with detail when audiences can handle it. NJTPA also uses contextual details and trends to understand measures where a full-time series is not available: **Can we get an idea of where this might go?**

## VIRGINIA DEPARTMENT OF TRANSPORTATION AND VIRGINIA OFFICE OF INTERMODAL PLANNING AND INVESTMENT

Two agencies in Virginia—the Virginia DOT (VDOT) and the Virginia Office of Intermodal Planning and Investment (collectively to be referred to as *Virginia*)—have developed a complementary suite of measures to describe highway performance. The agencies have responded to their concerns with how to communicate around some elements of PM3 measures, including the dynamic nature of reliability over time (i.e., the fact that both the numerator and denominator are variables); the tendency of TTTR to identify the overnight hours as the "most congested" period on rural interstates (note that TTTR is the metric that is used in calculating the freight reliability measure); and the large amount of rural highway mileage in Virginia that the PM3 measures register as reliable, which is in disagreement with the VDOT's understanding of many Virginians' lived experience. All three concerns underpin key messages in chapter 3.

Virginia attempts to communicate the PM3 metrics—particularly TTTR—that are developed from multiple data sources (e.g., annual changes to roadway segmentation, also known as Traffic Message Channel [TMC], length in NPMRDS, 2-year lag for annual average daily traffic from the FHWA Highway Performance Monitoring System, and inaccuracy in speed limit records). The research team observes that Virginia reports the PM3 measures with error bars, but this can be confusing once a target is set because the target is not met when the top error bar passes it, and targets can be missed by small intervals when the margin of error is large.

[6]For more details, see https://www.youtube.com/watch?v=mXTGteSlVU8.
[7]For more details, see https://tpm.njtpa.org/rpm_dashboard.html.

The Virginia Office of Intermodal Planning and Investment leads quarterly meetings with MPOs to discuss Federal and non-Federal performance measures. Virginia holds training sessions for MPOs to walk them through how underlying assumptions impact results and estimates and to establish a consistent computational approach.

## EAST-WEST GATEWAY COUNCIL OF GOVERNMENTS

The East-West Gateway Council of Governments (EWGCOG), which is the MPO responsible for the St. Louis, MO metropolitan area, communicates the first performance management rule (PM1), second performance management rule (PM2), and PM3 measures to the public using its public-facing website. Within the system performance page, the MPO provides its PM3 measures in a simplified, infographic-type format, effectively communicating them to all types of audiences.[8] For instance, the use of histograms to visualize on-road mobile source emissions helps viewers understand the distribution of different emissions sources. Commonly known graphics, such as those of passenger vehicles and interstate and State highway symbols, help viewers recognize the data they are being presented.

Figure 1 presents similar graphics, placing various PM3 conditions and targets together with other PM3 measures.

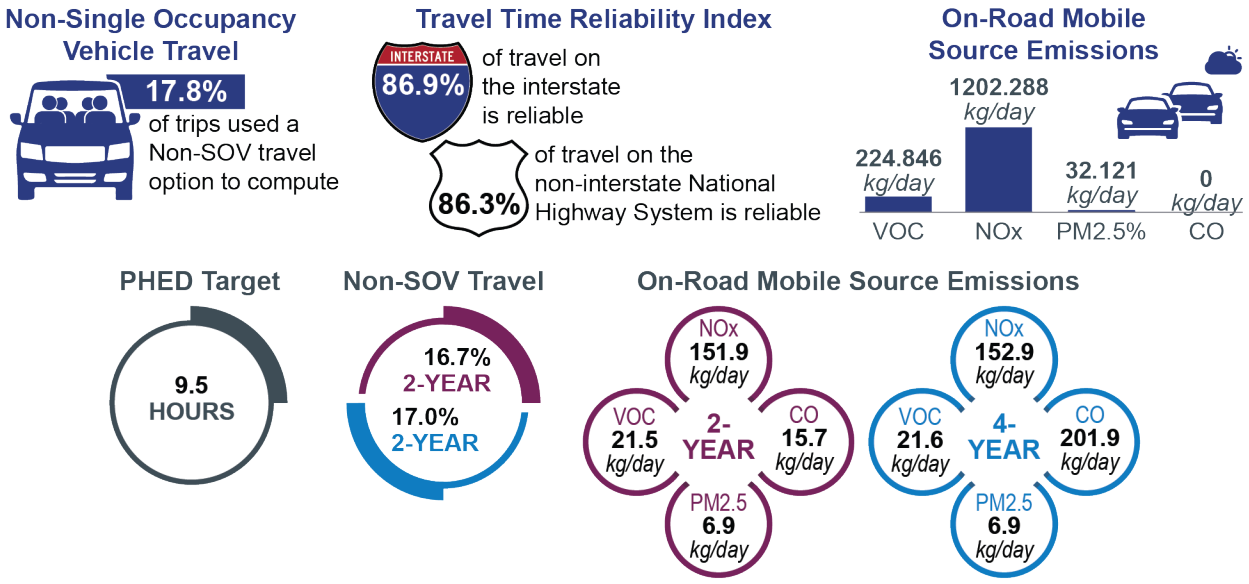



**Figure 1. Infographic. Metropolitan Planning Organizations system performance.**

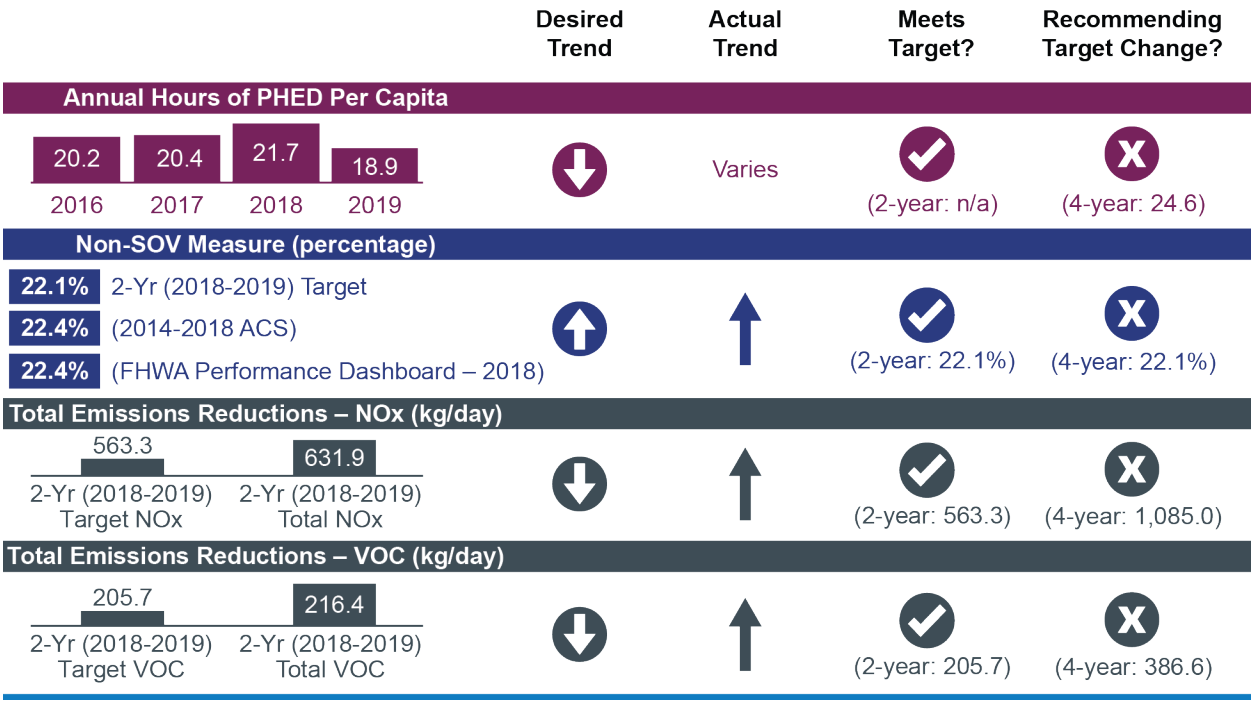
Source: Federal Highway Administration. Adapted from East-West Gateway Council of Governments.[9]

[8]For more details, see https://www.ewgateway.org/transportation-planning/long-range-planning/lrp-performance-dashboard/performance-dashboard-reg-summary/system-performance-measure/.

[9]Ibid.

## GEORGIA DEPARTMENT OF TRANSPORTATION

The Georgia DOT (GDOT) presents its PM3 measures and targets through performance period progress reports, the results of which are summarized on FHWA's State Performance Dashboards web site.[10] One approach GDOT uses is to visualize their measures and targets via scorecards. A version of how these scorecards can be used is shown in figure 2 using GDOT data. The scorecard presents various PM3 targets and measures simultaneously. Certain design choices, such as the use of checkmarks and directional arrows, provide viewers with an easier understanding of trend directions and goal-setting progress. Combined with the use of histograms to show the data behind the measures, the scorecards incorporate good visualization principles to communicate progress on PM3 measures. Aside from an improved understanding of overall performance, the inclusion of targets and forecast trends can inform future target setting and transportation investment prioritization.




ACS = American Community Survey; n/a = not applicable; Non-SOV = non-single occupancy vehicle; VOC = volatile organic compounds.

**Figure 2. Chart. Summary and scorecard—Congestion Mitigation and Air Quality Improvement Program performance measures.**

Source: Federal Highway Administration; Data from State Performance Dashboard - Georgia.[11]

[10]FHWA State Performance Dashboard – Georgia; https://www.fhwa.dot.gov/tpm/reporting/state/state.cfm?state=Georgia.

[11]Ibid.

## ADDITIONAL APPROACHES

In addition to the three case studies above, the following examples may be useful for agencies looking to communicate PM3 measures:

- **The OKI (Ohio–Kentucky–Indiana) Plan, developed by the Kentucky Transportation Cabinet, Ohio DOT, and Indiana DOT,** which discusses concepts of congestion before defining, discussing, and visualizing all the PM3 measures.[12]

- **The Florida DOT Source Book,** which is an interactive online dashboard that includes many performance measures, including planning time index (the 95th percentile travel time divided by the free flow travel time on a segment), vehicle-hours of delay, and person-hours of delay.[13] While none of these measures are included in PM3, the structure of the dashboard—which includes key messages, methodology, visualizations, definitions, and a link to download the underlying data—could be applied to PM3 measures.

- **The Washington State DOT Multimodal Mobility Dashboard,** which includes the PM3 NHPP reliability measure, the percentage of person-miles traveled (PMT) that are reliable, reported at both the statewide level and broken down by region and by road.[14]

- **Iowa DOT System Performance and Freight Measures,** which offers a detailed methodology for PM3 measures on NHPP reliability and freight reliability and discusses ways in which they can and cannot be used.[15]

- **Utah DOT Highway Reliability Dashboard,** which visualizes and defines PM3 measures of NHPP reliability and freight reliability, built in Microsoft® Power BI®.[16]

- **Capital District Transportation Committee Freight Performance Measure Factsheet,** which includes information on the establishment of targets and the New York State DOT's target-setting process, historical data, and initial targets.[17] In discussing its process for setting targets, the agency describes various data challenges and their solutions, as applicable, as well as the process for setting baselines and calculating targets.

[12]For more details, see https://2050.oki.org/congestion-management-system-performance/.
[13]For more details, see www.fdotsourcebook.com/.
[14]For more details, see https://wsdot.wa.gov/about/data/Multimodal-mobility-dashboard/default.htm.
[15]For more details, see https://iowadot.gov/systems_planning/fpmam/2018-2021-System-Performance-Freight-Targets.pdf.
[16]For more details, see https://www.cdtcmpo.org/what-we-do/performance-management.
[17]For more details, see https://www.cdtcmpo.org/images/perf_meas/Freight_TTTR-Fact-Sheet-5-18-FINAL.pdf.

- **The EWGCOG System Performance Report,** which visualizes and discusses all PM3 measures.[18]

[18]For more details, see https://www.ewgateway.org/transportation-planning/long-range-planning/lrp-performance-dashboard/performance-dashboard-reg-summary/system-performance-measure/.

## CHAPTER 3. PRINCIPLES OF GOOD COMMUNICATION

Communicating complex messages or information can be difficult. A number of non-regulatory National Cooperative Highway Research Program (NCHRP) reports—including 20–24 (124),[19] NCHRP 226 (Vizguide),[20] and 20–24 (93),[21]—provide insights into how a practitioner could communicate effectively:

- Identify a nugget of truth that it is crucial to communicate
- Identify the audience
- Identify a messenger with credibility for the audience
- Develop a message that efficiently conveys both the nugget of truth and why this audience should care about it
- Communicate the message clearly and memorably, whether in writing, verbally, or visually
- Repeat the message as necessary to ensure that it sticks

State DOTs and MPOs may find themselves communicating about PM3 measures, metrics, and targets to three key audiences:

- **Technical Advisers and Colleagues.** Those with working knowledge of data and trends in reliability and delay, including other measures and metrics based on these datasets, may question the utility of statewide metrics. Alternatively, they may be excited by the potential of the underlying data to provide insight on network performance and demand; and data from the NPMRDS can be used to develop corridor-level metrics, assess peaking, or identify key bottlenecks on a relatively brief time delay.

  Practitioners can connect with these advisers and colleagues about these measures by visualizing the data in different ways (e.g., by corridor, by time of day, or in key bottlenecks) and placing the reported measure in the context of the greater business intelligence provided by the data. State DOTs can collaborate with MPOs and other regional stakeholders to share NPMRDS data and their visualizations. Both State DOTs and MPOs can use this data to demonstrate the value-add of investments or to prioritize projects and size capital programs.

  This audience may ask: **What do we need to know about these numbers?**

- **Executives and Knowledgeable Decisionmakers.** Reporting targets and measure results is part of the Federal requirements (*See* 23 U.S.C. 150). Reporting targets, annual metrics and

[19]For more details, see https://www.tam-portal.com/document/performance-management-reporting-peer-exchange-final-report-nchrp-project-20-24-task-124-2/.
[20]For more details, see https://vizguide.tpm-portal.com/.
[21]For more details, see https://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-24(93)B02_FR.pdf.

measure results can lead to questions. For example, MDOT reported a common question from people who look at annual metric trends: "Why did this number change?" Practitioners should be prepared to explain year-over-year changes in the metrics with expertise; the cause could be real or artificial (e.g., improvement in the collection of underlying data).

The data underlying the PM3 measures can be a valuable communication tool with legislators, stakeholders, and the public when used in a variety of ways. The same data used to compute statewide reliability can be visualized on corridors. The same data used to compute statewide freight reliability can be used to map key freight corridors, nodes, and bottlenecks, thereby making the case for investments.

This audience may ask: **How will I be held responsible for these numbers?**

- **Lay Decisionmakers and the Public,** for whom it is important to personalize the measures. Practitioners can explain the measures to them in terms of the day-to-day experience of the audience.

  This audience may ask: **What do these numbers mean to me?**

# CHAPTER 4. APPROACHES FOR COMMUNICATING PM3 MEASURES, METRICS, AND TARGETS

This chapter presents key messaging and approaches for communicating with specific audiences about PM3 measures, metrics, and targets.

## RELIABILITY

PM3 measures of reliability include NHPP reliability and freight reliability. PM3 metrics for reliability include LOTTR and TTTR (see more below). The two NHPP reliability measures include one that covers the interstate system and the other that covers the non-interstate NHS. The NHPP reliability measures are the percentages of PMT statewide that are reliable based on the results of the LOTTR calculation. LOTTR is the ratio of the 80th percentile travel time to the 50th percentile travel time over the course of a year. Average travel time data are collected every 15 minutes during all time periods other than 8 p.m. to 6 a.m. local time, and a segment of the highway system is reliable if all the periods have LOTTRs that are less than 1.50. PMT for a segment is computed by multiplying the annual average daily traffic on a segment by vehicle occupancy and length.

NHPP reliability are statewide measures reported to FHWA, and it is useful for comparison across years and regions. States use the NHPP reliability measures to set 2- and 4-year targets. The LOTTR metric, on the other hand, can provide agencies with more detailed information on their systems' performance. This insight could include assessing NHPP reliability on corridors or segments of corridors down to the level of one or several TMCs. The granular nature of NPMRDS data also allows organizations to analyze LOTTR across seasons, across periods of the day, or in a histogram to visualize the overall distribution across days.

Key messages for PM3 measures of reliability are as follows:

- **The two NHPP reliability measures are statewide measures, and they are useful as part of a trend analysis over time or to compare between States.** While the measure is based on data that can be compiled at the corridor level and compared across corridors or days or weeks, the Federal measure is intended to allow Congress to compare States with the national average and assess the impact of its investments in the transportation network.

- **LOTTR is a ratio of two variable values—the 80th percentile and 50th percentile travel times.** LOTTR measures the variability of travel times on a corridor over a period of time, and the higher the variability, the less reliable. If these values are close together (technically LOTTRs below 1.5), as they would be if a road is operating reliably, LOTTR can be low even where the base congestion level is significant.

Because NHPP reliability measures are presented as statewide percentages, it may be challenging for the traveling public to understand. The audience for NHPP reliability includes

internal State DOT and MPO staff, managers, stakeholders, board members, and legislators. State DOTs are required to report on reliability[22], so it falls on them to be the messengers.

**Table 1. Communicating reliability to different audiences.**

| Audience | Messages |
|---|---|
| Technical Advisers and Colleagues | NHPP reliability measures the extent of users' unexpected variability in travel times: the greater the variability, the more time necessary to plan a trip. The PM3 NHPP reliability measure is the percentage of PMT statewide that are reliable based on the results of the LOTTR metric calculation.<br>The base congestion level is not correlated directly to NHPP reliability. It is important to understand that an LOTTR has both a variable numerator and a variable denominator. Consequently, corridors where congestion is more prevalent may have low LOTTRs even if congestion is severe. For example, in an extreme case, it is possible that consistently congested corridors may be reliable (do not exceed the 1.50 threshold). |
| Executives and Knowledgeable Decisionmakers | LOTTR may be a difficult metric for the public to grasp, as it is a ratio dependent on statistical principles (i.e., percentiles). The 80th percentile is most simply explained as representing longer travel times that occur on a road segment, while the 50th percentile represents normal travel times on a segment. |
| Decisionmakers and the Public | The NHPP reliability measures are most useful for consistent national reporting. In contrast, the LOTTR metric provides more-useful, detailed, and local information.<br>NHPP reliability in general represents how much extra time you need to plan for when making a trip. If it takes you 30 minutes to make a trip on a typical day, but once per week it takes you an hour, you will need to plan 30 minutes extra into your trip if you want to be guaranteed to make it in time. LOTTR represents the additional time needed to make a trip versus the normal travel time. In this case, the LOTTR would be 60 minutes divided by 30 minutes, or 2.0. |

NHPP reliability can be visualized through a line chart over time—potentially with contextual data—as shown in the concept in figure 3.

[22] For more details, see 23 CFR 490.105.

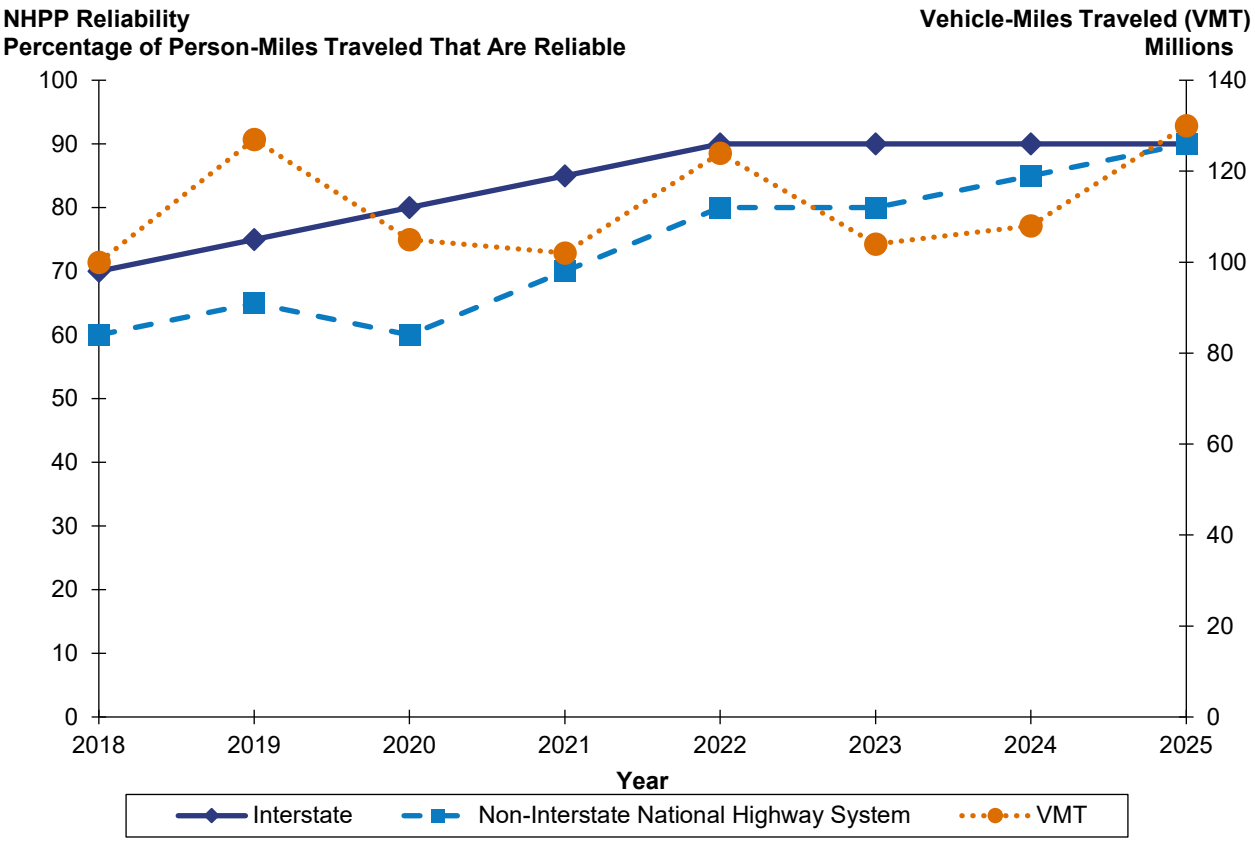



**Figure 3. Chart. Conceptual line chart of National Highway Performance Program (NHPP) reliability, with vehicle-miles traveled shown for context.**

Source: Federal Highway Administration.

LOTTR can be visualized in many ways. It can be mapped as shown in figure 4, charted by time of day as in figure 5, or displayed in a histogram as in figure 6. Note that in these figures, the time periods for which LOTTR is calculated do not correspond to the federally defined time periods but have been selected for an agency's own use.

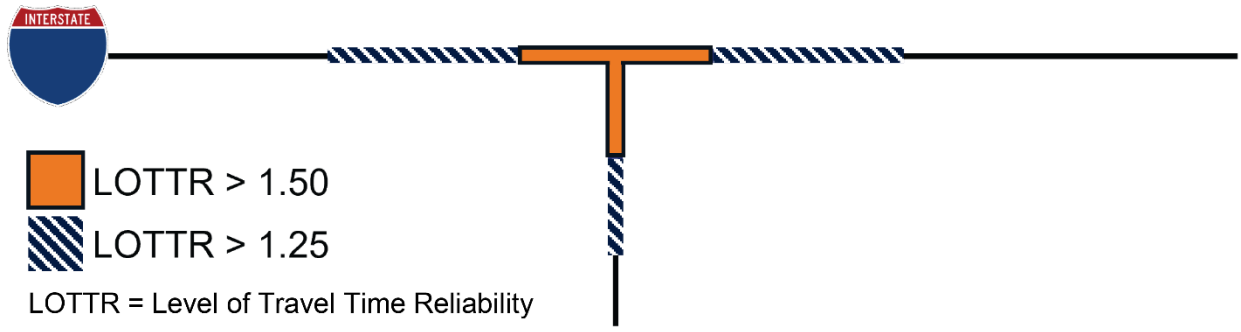



**Figure 4. Diagram. Conceptual heatmap of Level of Travel Time Reliability on highway segments.**

Source: FHWA.

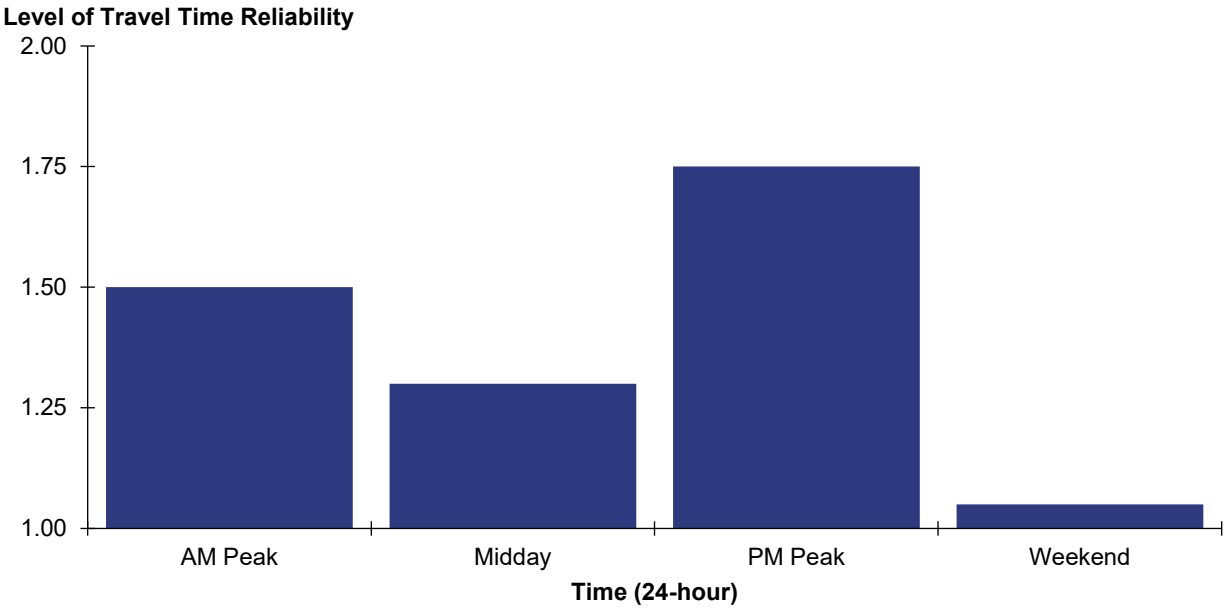



**Figure 5. Chart. Conceptual chart of Level of Travel Time Reliability on a highway segment by time of day.**

Source: Federal Highway Administration.

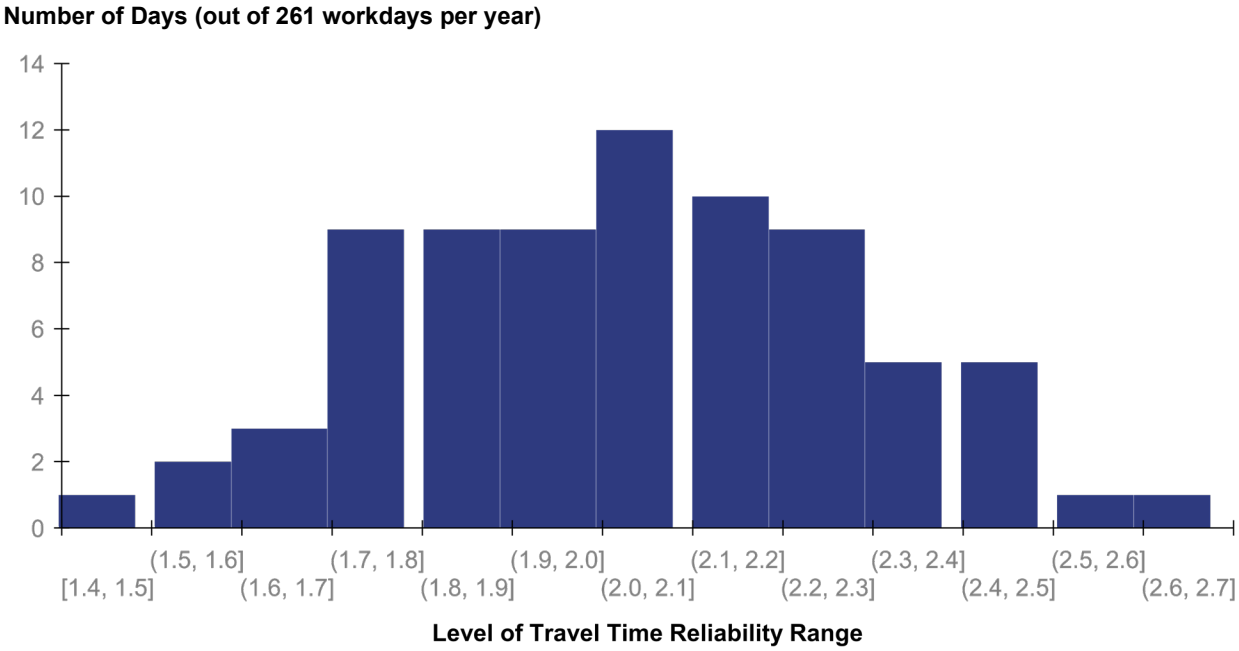



**Figure 6. Chart. Conceptual histogram of Level of Travel Time Reliability for the PM peak hour.**

Source: Federal Highway Administration.

## FREIGHT

There are a number of approaches for communicating the PM3 measure for freight reliability and its associated metric, TTTR. TTTR is the ratio of the 95th percentile travel time to the 50th percentile travel time for trucks on a segment or the longest travel time versus normal travel time.

Freight reliability is derived from TTTR for five time periods on Interstate segments: a.m. peak, midday, p.m. peak for weekdays, weekends, and overnight for all days. The measure is a weighted average of the interstate system by length, wherein a segment's highest value across the five periods is multiplied by the segment's length. The sum of all of these across the interstate system is divided by the system's total length. Freight reliability is a statewide measure reported to FHWA, which means that it is useful for comparisons across years and regions.

TTTR can be used by State DOTs and MPOs in many ways: to assess Travel Time Reliability on corridors or segments of corridors down to the level of a TMC or several TMCs. The granular nature of NPMRDS data also allows organizations to analyze TTTR across seasons, across periods of the day, or in a histogram to visualize the overall distribution across days.

Key messages for freight reliability and TTTR are the following:

- **The TTTR metric measures variability in travel times.** When there is less variability, the better the freight reliability—meaning, less delay that freight travelers will need to plan for.

- **TTTR is a ratio of two variable values: the 95th percentile (longest) and the 50th percentile (normal) truck travel times.** TTTR measures the reliability of travel time on a corridor and the extra time a truck driver needs to build into the day to account for variability in travel time. If these values are close together, as they would be if a road is frequently highly congested, TTTR can be low even where congestion is significant.

- **Freight reliability is not a measure of the interstate system at its most congested but at its most unreliable.** The measure is a length-weighted sum of TTTR by Interstate segment, as measured in the worst of five periods of the day: AM peak, midday, and PM peak for weekdays, all day for weekends, and overnight over all days. The period with the worst TTTR will vary by segment. On less congested segments, it may occur overnight if trucks reduce speed in darkness.

**Table 2. Communicating freight reliability to different audiences.**

| Audience | Messages |
|---|---|
| Technical Advisers and Colleagues | Despite the similar nature of the abbreviations, truck travel time reliability (TTTR) and level of travel time reliability (LOTTR) are very different. TTTR focuses on freight travel times only (when available), while LOTTR includes all vehicles. TTTR uses the 95th percentile (longest travel time) in the numerator, while LOTTR uses 80th percentile (longer travel time) in the numerator. LOTTR uses the 80th percentile because this is a better level to determine operational solutions that will work. Freight, in contrast, focuses on just-in-time deliveries, so it is important to know what the most-variable times will be.<br>TTTR—and thereby freight reliability—has both a variable numerator and a variable denominator. This means that on corridors where congestion is more prevalent, TTTR may be low even if congestion is severe. On the other extreme, as was shown in figure 5, it is possible on shorter segments for periods of light congestion (i.e., very short travel times) to have a TTTR that exceeds periods of high congestion (i.e., longer travel times) because the ratio of the two shorter times will be higher. This issue will not appear if TTTR is used on its own but will appear during period comparisons for the statewide freight reliability measure. |
| Executives and Knowledgeable Decisionmakers | Explain the measure and the metric in the simplest way possible. The performance measure related to freight movement on the interstate uses truck travel time data (when available) to calculate the TTTR for the interstate system. This measure can be used to identify and quantify major freight truck bottlenecks along interstate highways.[1] The freight measure is weighted by the worst TTTR metric for each interstate segment weighted by segment length. |
| Decisionmakers and the Public | Explain the measure using day-to-day examples such as: think of a run you make frequently: how long does it usually take, and what is the longest it takes? You (or your employer) plan extra time into the schedule to accommodate this potential scenario. TTTR represents this extra time and cost. |

[1]https://www.fhwa.dot.gov/tpm/videos/docs/Travel%20Time%20Reliability%20and%20Freight%20Reliability%20Performance%20Measures.pdf. Freight reliability and TTTR can be visualized in the same ways as general reliability (figure 3, figure 4, figure 5, and figure 6). In addition, it may be helpful to visualize TTTR in the five required time periods, as shown in figure 7. Note that in this case, TTTR is highest on the segment overnight, even though the travel times are lower than during the day.

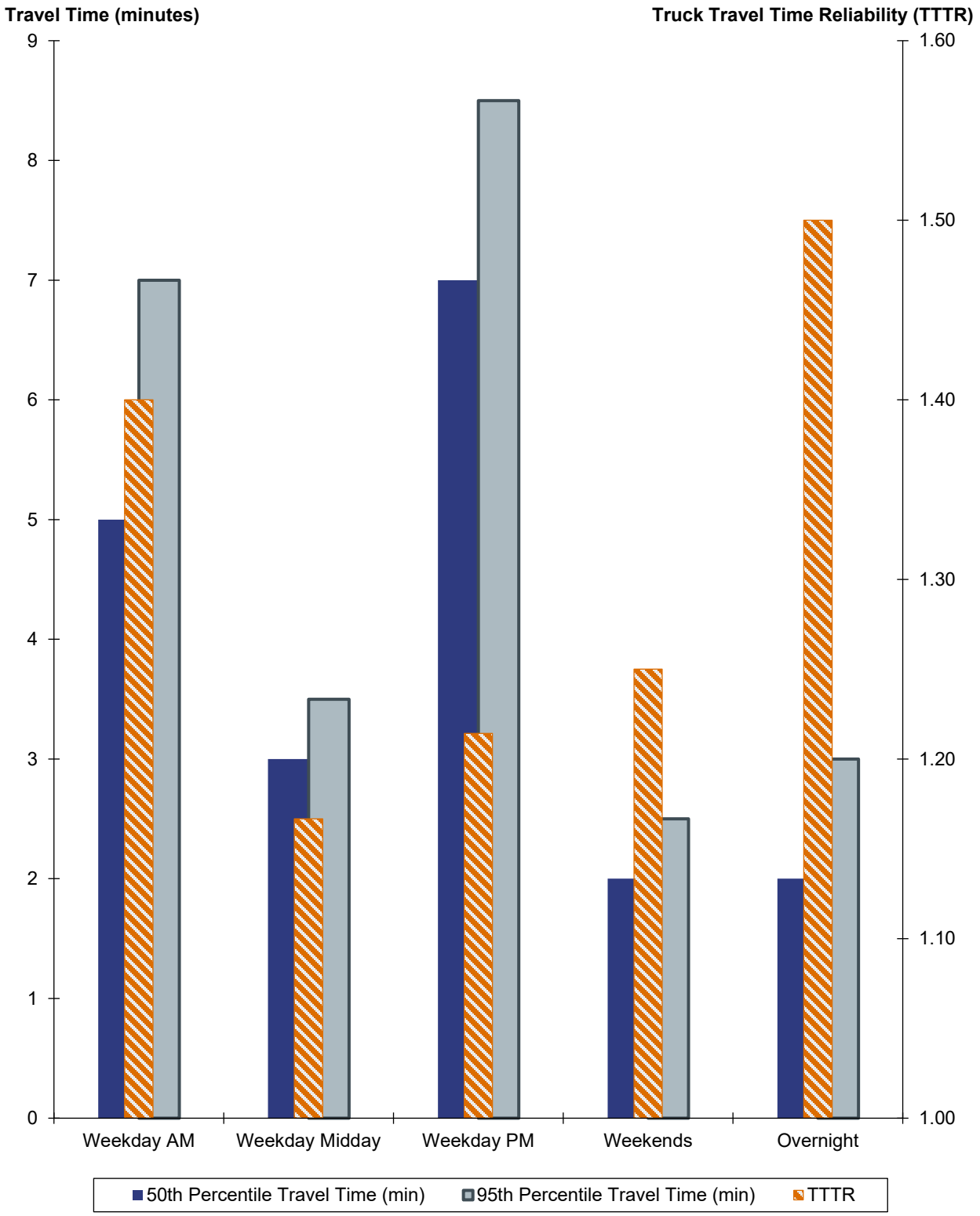



**Figure 7. Chart. Example bar chart showing Travel Time and Truck Travel Time Reliability (TTTR).**

Source: Federal Highway Administration.

## PEAK HOUR EXCESSIVE DELAY

This section discusses approaches for communicating the PM3 measure for CMAQ traffic congestion, annual hours of PHED per capita, and the related metrics, excessive delay, and total excessive delay.

The first step in calculating the measure of excessive delay is the difference between observed travel time and either (a) travel time at 20 mph or (b) 60 percent of the travel time at the posted speed limit, whichever is greater for each segment of the NHS in an urbanized area. The total excessive delay metric is the product of excessive delay, average daily traffic, and average vehicle occupancy (to get units of person-hours). The reported PHED measure divides the total excessive delay for a.m. and p.m. peak periods by the population for a given urbanized area to get hours per capita.

Excessive delay and total excessive delay can be used by State DOTs and MPOs in a variety of ways at the corridor, regional, or statewide level. As an example, total excessive delay can be multiplied by a value of time to monetize excessive delay.

Key messages related to PHED and total excessive delay include the following:

- **Excessive delay means travel times that are longer than normal.** More specifically, it means that travel times exceed a specific travel time threshold (the greater of either (a) 60 percent of the posted speed limit or (b) 20 mph).

- **The cost of congestion can be balanced against economic benefits.** In other words, congestion can be a sign of a healthy, growing economy. Agencies mentioned that total excessive delay is one of the most accessible real-world expressions of congestion, and using value of time, it can be monetized, making it even more powerful for decisionmakers focused on return on investment. With that said, some agencies have preferred to express the value of time spent in excessive delay as a cost to balance against the benefits of economic growth rather than as a wasted value.

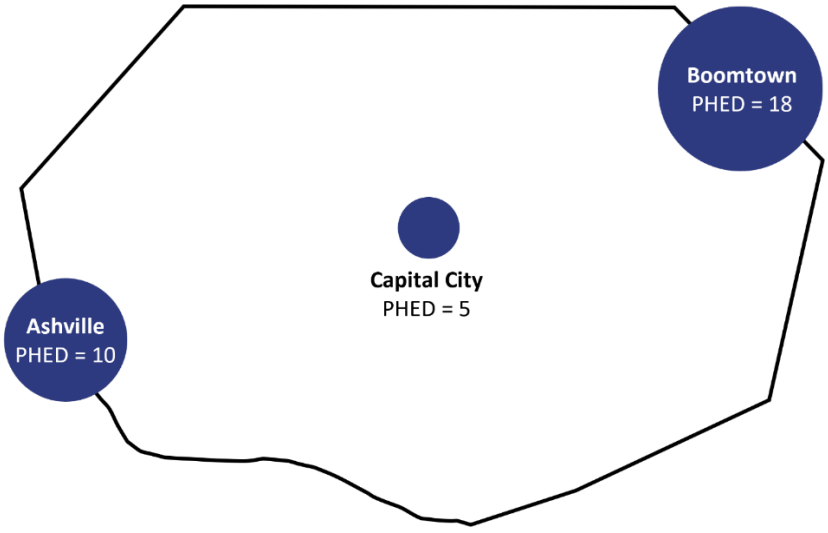
**Table 3. Communicating excessive delay to different audiences.**

| Audience | Messages |
|---|---|
| Technical Advisers and Colleagues | Technical staff may find visualizations of excessive delay as useful ways of understanding the nature and causes of delay along specific National Highway System (NHS) corridors. As a result, visualizations can help technical staff identify targeted investments that can decrease the amount of excessive delay. |
| Executives and Knowledgeable Decisionmakers | Because PHED is an understandable concept to the layperson, it may garner the most questions from the public. One important concept for decisionmakers to understand in responding to questions is that excessive delay is not the same thing as perceived delay. In some areas, |

| Audience | Messages |
|---|---|
| | not being able to drive at free-flow speeds may feel like rush hour, but on a 65-mph road, a 40-mph flow does not represent excessive delay.<br>It also is important to note that PHED includes only NHS roads. Delay experienced on local and connector roads does not count toward the metric. |
| Decisionmakers and the Public | Example: In a two-person household, Daniel drives to and from work and drops off and picks up his toddler, Katy, at daycare on the way.<br>• Daniel and Katy represent two person-trips. Their trip in each direction takes 36 minutes, of which 6 are spent on local streets and 30 are spent on a major highway with a 65-mph speed limit.<br>• Of the 30 minutes of the trip on the major highway, 17 are spent traveling at 65 mph or higher, 8 are spent traveling at 40 mph or higher, and 5 are spent traveling at less than 39 mph (60 percent of the speed limit).<br>Daniel and Katy experience 5 minutes of excessive delay per trip. Two trips per day and two people in the car gives their family unit 20 person-minutes per day. Following this routine 240 days per year gives them 80 person-hours per year, or 20 hours of PHED.[1] |

[1]Adapted from New Jersey Transportation Planning Authority resource "Peak Hour Excessive Delay per Capita (PHED)." https://www.youtube.com/watch?v=mXTGteSlVU8.

PHED can be displayed as a line chart over time in figure 3. Because it is a per-capita measure, it also can be compared apples to apples across MPOs in a map like the one shown in figure 8 (for a hypothetical State with multiple large urban regions).

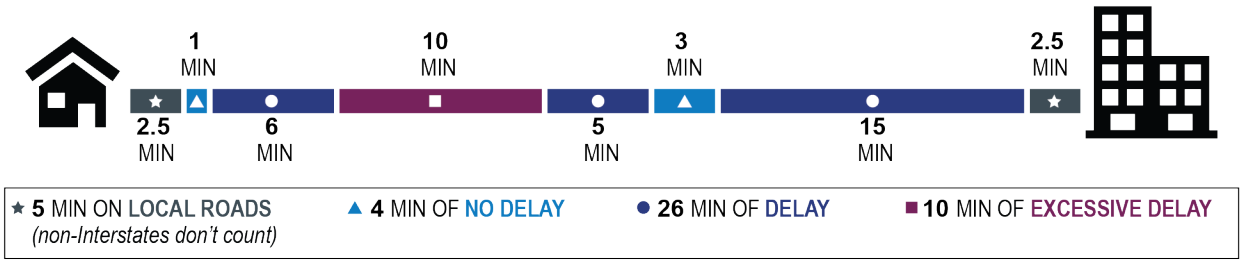



(PHED = Peak Hour Excessive Delay)

**Figure 8. Diagram. Regional statewide Peak Hour Excessive Delay graphic with area proportional to the amount of Peak Hour Excessive Delay.**

Source: Federal Highway Administration.

Visualizing areas of excessive delay along a corridor, as in figure 9, may be helpful to personalize the excessive delay metric.




(MINS = Minutes)

**Figure 9. Infographic. Excessive delay map for a hypothetical trip.**

Source: Federal Highway Administration.

Both PHED and total excessive delay also can be presented in column charts as shown in figure 3 and histograms as shown in figure 4.

## NON-SINGLE OCCUPANCY VEHICLE SHARE

This section discusses approaches for communicating the PM3 measure for CMAQ traffic congestion, non-SOV share. The non-SOV share measure represents the share of travel that is not SOV trips. The base source of this information is American Community Survey (ACS) Journey to Work data. Agencies are also permitted to use their own travel surveys or count data to produce the measure. The measure includes non-SOV modes such as walking, bicycling, and public transportation and those who telecommute (i.e., work from home).

Key messages related to the non-SOV share measure include the following:

- **The data source for non-SOV share is the ACS Journey to Work data.** The ACS, while conducted by the U.S. Census Bureau, does not include all Americans, since roughly 3.5 million households respond annually. Because this may not be enough of a sample to ensure coverage of smaller geographies, multiple years of ACS data are often used at once; the non-SOV share measure uses 5-year-rolling-average data from ACS. Journey to Work surveys collect information on travel from home to work. Related questions include travel time, means of transportation, time of departure for work, vehicles available, expenses associated with the commute, and geographic location of the workplace.

**Table 4. Communicating Non-Single Occupancy Vehicle (SOV) share to different audiences.**

| Audience | Messages |
|---|---|
| Technical Advisers and Colleagues | Non-SOV share is a regionwide measure, and because it is usually sourced from the American Community Survey (ACS), it should not be viewed at the corridor level. It may add insight to place non-SOV share in the context of transit ridership and investment, bicycle and pedestrian usage rates and investment, or telecommuting rates (available from ACS). |
| Executives and Knowledgeable Decisionmakers | The non-SOV share measure represents the share of travel that is not SOV trips. Similar to communications with technical advisers and colleagues, it may be helpful to contextualize this value with information on transit ridership and investment, bicycle and pedestrian usage rates and investment, or telecommuting rates. |
| Decisionmakers and the Public | Moving this measure may rely greatly on transportation demand management approaches; many investments such as transit, high-quality sidewalks, or bike lanes improve quality of life while providing incentives not to drive alone.<br>There are many benefits to reducing SOV use: reduced congestion, improved air quality, and improved health. |

One effective method of displaying non-SOV share is in a pie or donut chart displaying the observed quantity of each mode type. Non-SOV share also can be visualized in a line chart over years (figure 10).

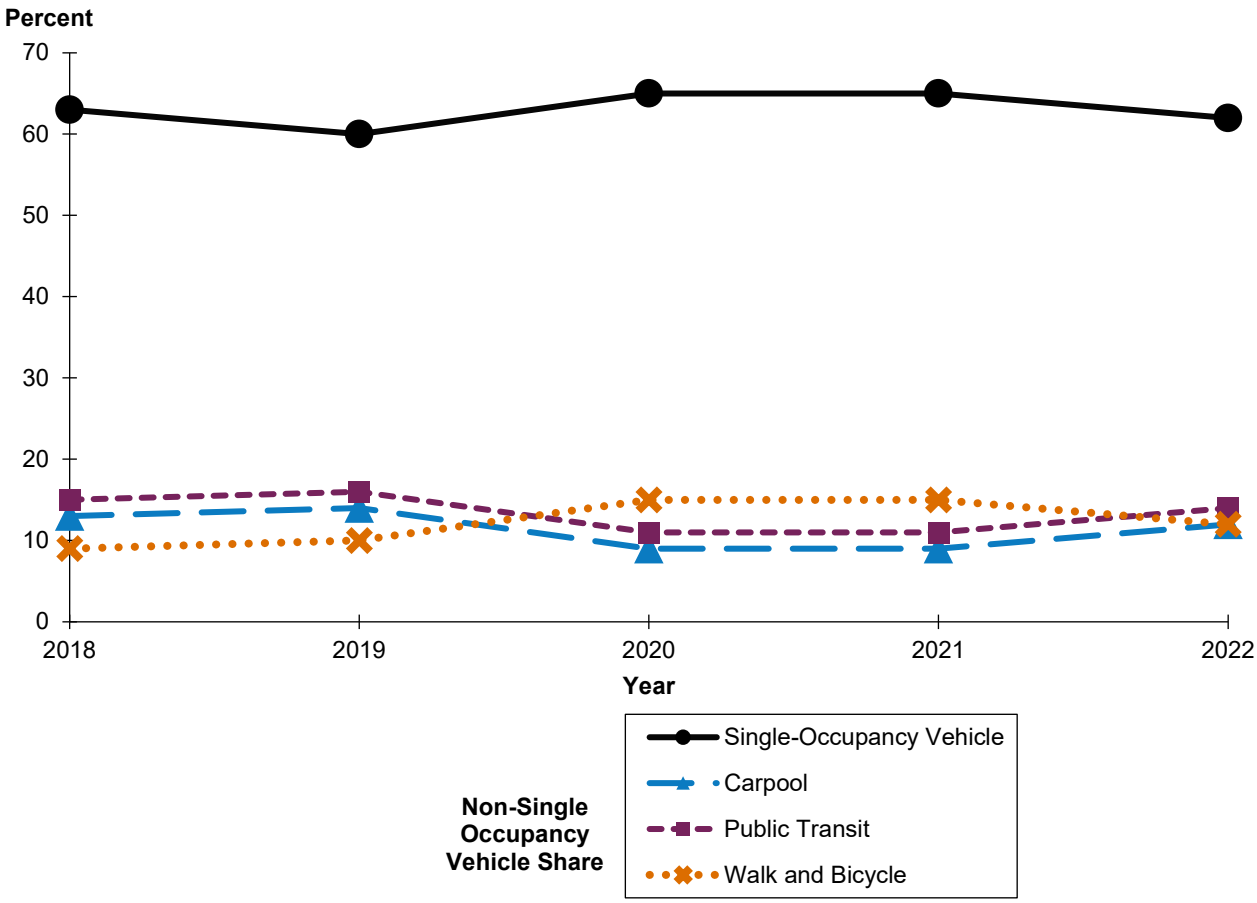



**Figure 10. Chart. Non-Single Occupancy Vehicle share line chart example.**

Source: Federal Highway Administration.

## CONGESTION MITIGATION AND AIR QUALITY (CMAQ) TOTAL EMISSIONS REDUCTION

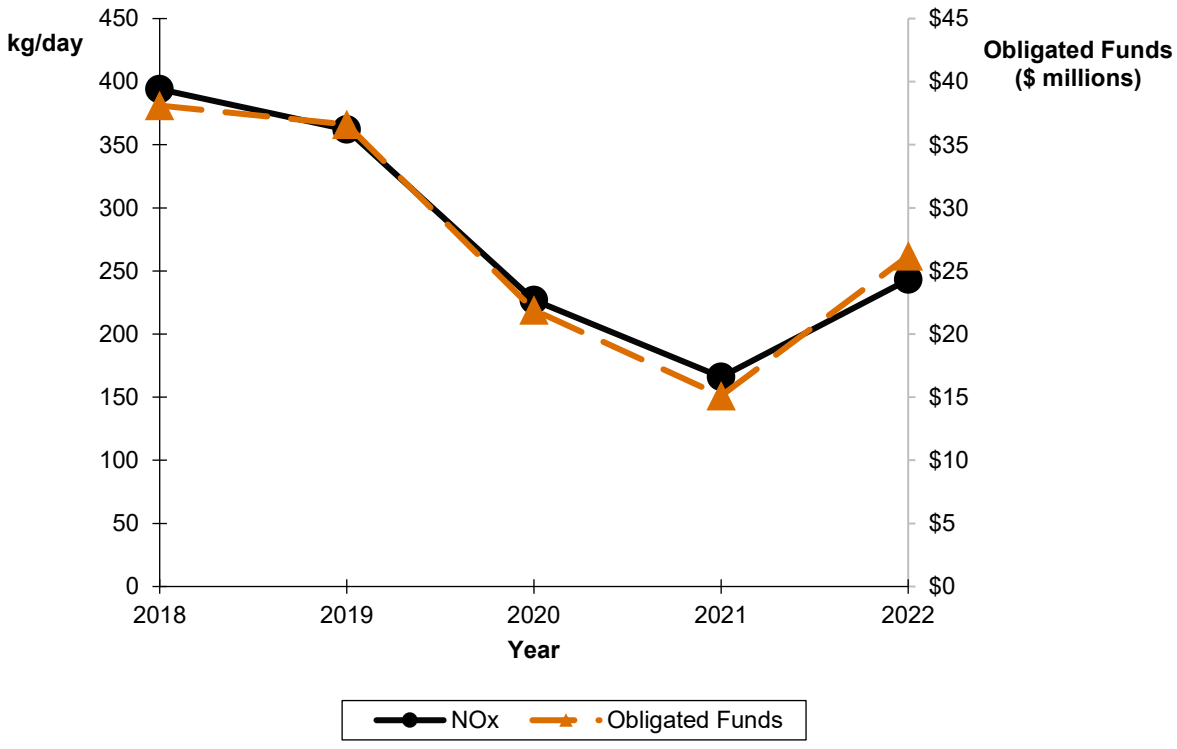
This section discusses approaches for communicating the CMAQ total emissions reduction measure. The measure consists of the 2- and 4-year cumulative reported emission reduction for CMAQ-funded projects for applicable pollutants and precursors:

- Particulate matter under 2.5 micrometers (PM2.5)
- Particulate matter under 10 micrometers (PM10)
- Carbon monoxide (CO)
- Volatile organic compounds (VOCs)
- Nitrogen oxide (NOx)

**Table 5. Communicating Congestion Mitigation and Air Quality (CMAQ) total emissions reduction to different audiences.**

| Audience | Messages |
|---|---|
| **Technical Advisers and Colleagues** | The measure records all emissions reduced by a project in the first year the project is obligated. |
| **Executives and Knowledgeable Decisionmakers** | This measure may not reflect overall environmental impact. This limited scope is reflected both in the senses (1) that the measure captures only emissions reduction from CMAQ projects and (2) that the reduction is recorded all at once and only once—the first year the project is obligated. |
| **Decisionmakers and the Public** | The measure includes only emissions reduced due to projects funded with CMAQ funds provided to States. While this provides valuable insight in assessing the benefits of CMAQ, it should not be misconstrued as a measure of overall emissions reduction from a metropolitan planning organization's overall improvement program. |

CMAQ total emissions reduction can be visualized as a line chart with funding on a second axis for context (as shown in figure 11). Note that because of scale differences among pollutants, it may be desirable to show only one pollutant per chart.




NOx = nitrogen oxide.

**Figure 11. Chart. CMAQ total emissions reduction line chart example.**

Source: Federal Highway Administration.

It may also be useful to create a map comparing regions across a State or to break down total emissions reduction across projects receiving CMAQ funds by using a treemap (figure 12).

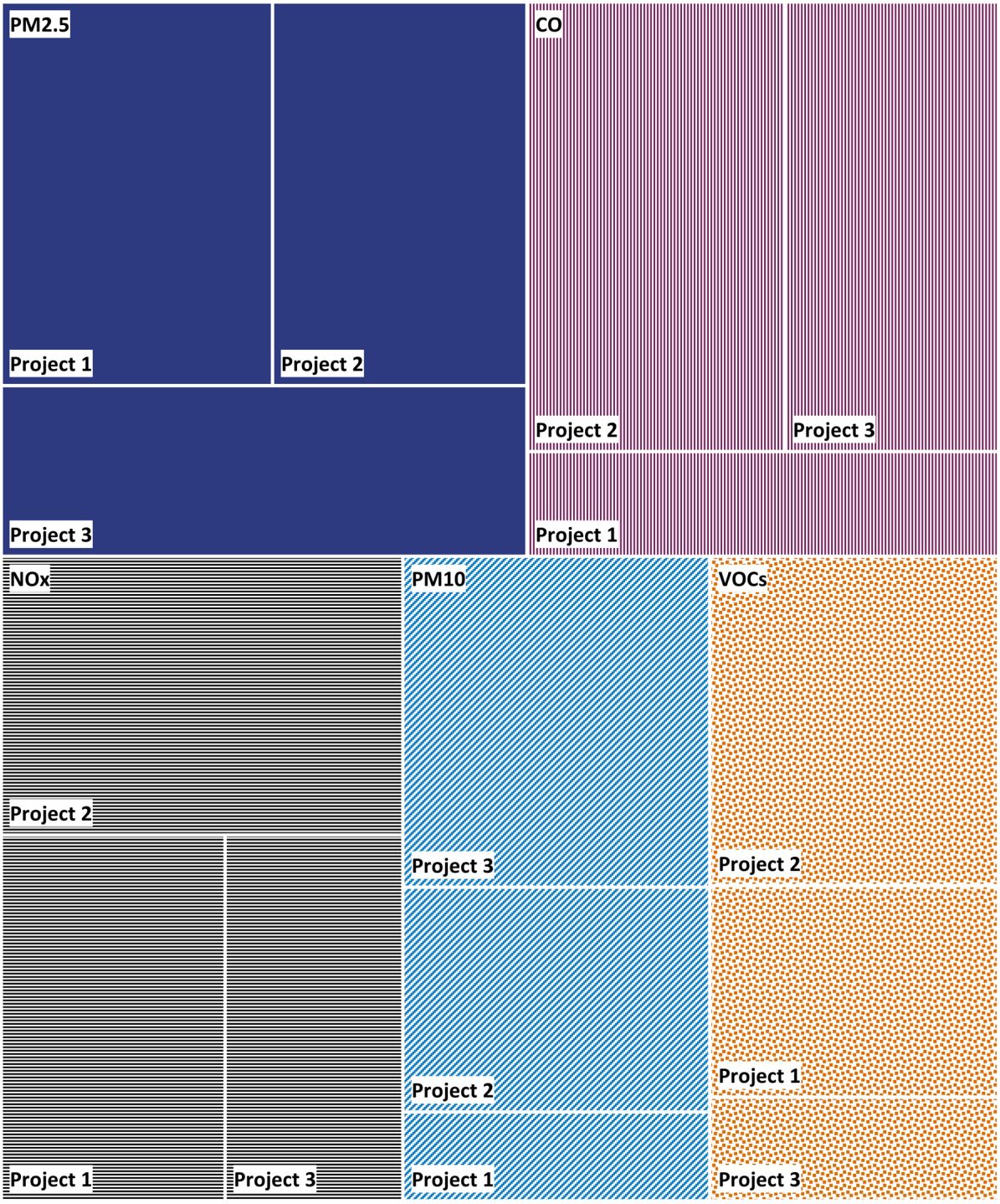



**Figure 12. Chart. Example of a "treemap" chart that displays Congestion Mitigation and Air Quality (CMAQ) emissions reduction by project and pollutant/precursor.**

Source: Federal Highway Administration.

# CHAPTER 5. CONCLUSIONS

Through discussion with State DOT and MPO practitioners, a number of strategies have been identified for communicating PM3 measures with three key audiences: technical advisers and colleagues, executives and knowledgeable decisionmakers, and lay decisionmakers and the public. State DOTs and MPOs can communicate PM3 measures together to enhance insight and engagement. Showing various metrics together can provide more understanding of overall network performance.

## COMMUNICATING WITH TECHNICAL ADVISERS AND COLLEAGUES

Explaining the usefulness of statewide measures (trend analysis, reporting to Congress), along with recognizing that other measures and metrics are useful, is an important message to data analysts. They may be excited by the potential of the underlying data used in PM3 measures to provide insight on network performance and demand: average travel time data from NPMRDS can be used to develop corridor-level metrics, assess peaking, or identify key bottlenecks on a relatively short time delay.

One effective approach to communicating with this group is to visualize the data in different ways (e.g., by corridor, by time of day, or in key bottlenecks) and place the reported measure or metric or target in the context of the greater business intelligence provided by the data. State DOTs can collaborate with MPOs and other regional partners to share NPMRDS data and visualizations thereof. Both State DOTs and MPOs can use this data to demonstrate the value-add of investments or to prioritize projects and size capital programs.

## COMMUNICATING WITH EXECUTIVES AND KNOWLEDGEABLE DECISIONMAKERS

Important questions for executives and knowledgeable decisionmakers about PM3 (or any other required reporting measure) are: **How will I be held responsible for this?** and **Why did this number change?** Practitioners should be prepared to explain year-over-year changes in the metrics with expertise; the cause could be transportation related or another external (to transportation) source.

The data underlying the PM3 measures can be a valuable communication tool with legislators, stakeholders, and the public when used in a variety of ways. The same data that a practitioner can use to compute statewide reliability can also be visualized on corridors. The same data that a practitioner can use to compute statewide freight reliability can also be used to map key freight corridors, nodes, and bottlenecks, thereby making the case for investments.

## COMMUNICATING WITH LAY DECISIONMAKERS AND THE PUBLIC

For lay decisionmakers and the public, it is important to personalize the measures by explaining them in terms of the day-to-day experience of the audience. For instance:

- Reliability reflects the extra time a traveler needs to build into your schedule to account for the longer or longest travel time you think might occur, whether that's the 80th percentile (worst in a week) or the 95th percentile (worst in a month).

- TTTR has a direct connection to freight carriers' and truck drivers' costs. The extra time they need to build into their schedules to account for the worst travel time costs money and potentially additional business over time. Having access to accurate data on both travel time and reliability can significantly benefit the transportation industry.

- PHED and delay generally are accessible metrics for a lay audience. The challenge is communicating what delay is considered excessive. A demonstration that reflects a real-world daily experience can be particularly useful. In addition, delay can be monetized using value of time, though some practitioners resist doing so because congestion can be considered as reflective of a strong and growing economy, and the value of time spent in traffic may not be entirely wasted.

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