Lessons Learned for Transportation Agencies Preparing for MAP-21 Performance Management Requirements Related to Mobility and Reliability

by

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ABSTRACT
The Moving Ahead for Progress in the 21st Century Act (MAP-21) was signed into law by President Obama on July 6, 2012. MAP-21 establishes performance-based planning and programming to improve transportation decision-making and increase the accountability and transparency of the Federal highway programs (1). The Notice of Proposed Rulemaking (NPRM) will be released in the first quarter of 2014 related to measures and calculation procedures with the effective date for all measurement areas of spring 2015.

Because the NPRM will be out soon, it is timely for transportation agencies to begin to think about the benefits of having a set of performance measures for purposes other than satisfying MAP-21 requirements. Now is a great opportunity for transportation agencies to understand how performance management can improve their agency operations. The authors have experience with mobility analyses for a number of national, state, and local sponsors, which has provided them the opportunity to observe some common results as they relate to MAP-21’s upcoming requirements.

This paper has the objective of providing guidance and lessons learned related to calculating congestion-related performance measures and related considerations. This paper is intended to allay some fears and identify some opportunities brought by MAP-21 with a focus on those aspects of MAP-21 anticipated to have the closest association to mobility and reliability (e.g., system performance, congestion mitigation/air quality, freight). Researchers document results related to principles for selecting performance measures, typical performance measures, thresholds for delay, target setting (example in Figures 1 and 2), and measure calculation techniques.

INTRODUCTION
MAP-21 establishes performance-based planning and programming to improve transportation decision-making and increase the accountability and transparency of the Federal highway programs. Section 1203 (Performance Management) of MAP-21 establishes national performance goals for Federal highway programs (those most related to mobility are shown here) (1):

- Congestion reduction – To achieve a significant reduction in congestion on the National Highway System (NHS).
- System reliability – to improve the efficiency of the surface transportation system.
- Freight movement and economic vitality – To improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development.

On-line documentation of the Federal Highway Administration (FHWA) Office of Transportation Performance Management (TPM) indicates that the measure areas of “traffic congestion,” “on-road mobile source emissions,” “freight movement,” “performance of interstate system,” and “performance of non-interstate NHS” are all in “Implementation Status III,” indicating that the measures for these areas are still being considered (2). The schedule indicates that the Notice of Proposed Rulemaking (NPRM) will be released in the first quarter of 2014, which will then begin a 90-day comment period on the NPRM. The single effective data for all measurement areas is approximately spring 2015.

Because the NPRM and associated measures will be out soon, it is timely to begin to think about the benefits of having a set of performance measures for purposes other than satisfying MAP-21 requirements. Now is the time to consider the implications of choosing one
measure over another and how the performance measures can be calculated. To this end, this paper discusses:

- What are proven mobility and reliability performance measures?
- How should delay be defined?
- How should targets be set?
- How can/should the measures be computed?

**PAPER OBJECTIVE**

The authors have experience with mobility analyses for a number of national, state and local sponsors. These experiences have provided them the opportunity to observe some common results as they relate to MAP-21’s upcoming requirements. While the profession knows performance measures will result from the NPRM, now is an opportunity to investigate other performance measures that transportation agencies can calculate based upon the same data and similar methods.

To this end, this paper has the objective to provide guidance and lessons learned related to calculating congestion performance measures and related considerations (e.g., calculating delay, target setting), particularly in light of MAP-21 requirements. This paper is intended to allay some fears and identify performance measurement opportunities brought by MAP-21. Proven estimation methods are presented and there is discussion of some of the key issues related to using system performance measures.

While there are many aspects of the MAP-21 performance measure legislation and performance goals, this paper focuses on those areas anticipated to have the closest association to mobility and reliability aspects – system performance, congestion mitigation and air quality (CMAQ), and freight.

**LESSONS LEARNED RELATED TO MOBILITY PERFORMANCE MEASUREMENT AND MAP-21**

The transportation profession knows that performance measure requirements are coming from the NPRM as a result of MAP-21. This section of the paper discusses mobility and reliability performance measures and related guidance and lessons learned.

**What are Proven Mobility and Reliability Performance Measures?**

There are several keys to developing and applying mobility measures that are technically useful and generally understandable. Early research has demonstrated that travel time and speed-related measures can serve many different uses, communicate to many different audiences, and enhance the ability of project analysis techniques to determine the most appropriate set of policies, programs, and projects for a situation (3,4).

The overriding conclusion from any investigation of mobility measures is that there is a range of uses and audiences. No single measure will satisfy all the needs, and no single measure can identify all aspects of mobility—there is no "silver bullet" measure. Mobility is complex and in many cases requires more than one measure, more than a single data source, and more than one analysis procedure. Mobility measures, when combined in a process to uncover the goals and objectives the public has for transportation systems, can provide a framework to analyze how well the land use and transportation systems serve the needs of travelers and businesses and provide the basis for improvement and financing decisions (5). Table 1 identifies 12 basic principles for effective performance monitoring from recent work in the area.
TABLE 1  Basic Principles for Performance Monitoring
(Adapted from Reference 6)

<table>
<thead>
<tr>
<th>Principle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principle 1</td>
<td>Mobility performance measures must be based on the measurement or estimation of travel time.</td>
</tr>
<tr>
<td>Principle 2</td>
<td>Measure where you can – model everything else.</td>
</tr>
<tr>
<td>Principle 3</td>
<td>Multiple metrics should be used to report performance, especially for mobility.</td>
</tr>
<tr>
<td>Principle 4</td>
<td>Traditional Highway Capacity Manual (HCM)-based performance measures for mobility (V/C¹ ratio and level of service) should not be ignored but should serve as supplementary, not primary, measures of performance in most cases.</td>
</tr>
<tr>
<td>Principle 5</td>
<td>Both vehicle- and person-based performance measures of throughput are useful and should be developed, depending on the application.</td>
</tr>
<tr>
<td>Principle 6</td>
<td>Both quality of service (outcome) and activity-based (output) performance measures are required for congestion performance monitoring.</td>
</tr>
<tr>
<td>Principle 7</td>
<td>Activity-based measures should be chosen so that improvements in them can be linked to improvements in quality-of-service measures.</td>
</tr>
<tr>
<td>Principle 8</td>
<td>Customer satisfaction measures should be included with quality of service measures for monitoring freeway performance.</td>
</tr>
<tr>
<td>Principle 9</td>
<td>The measurement of travel time reliability is a key aspect of roadway performance measurement and reliability metrics should be developed and applied.</td>
</tr>
<tr>
<td>Principle 10</td>
<td>Three dimensions of mobility/congestion should be tracked with mobility performance measures: source of congestion, temporal aspects, and spatial detail.</td>
</tr>
<tr>
<td>Principle 11</td>
<td>Communication of performance measurement should be done with graphics that resonate with a variety of technical and nontechnical audiences.</td>
</tr>
<tr>
<td>Principle 12</td>
<td>Continuity should be maintained in performance measures across applications and time horizons; the same performance measures should be used for trend monitoring, project design, forecasting, and evaluations.</td>
</tr>
</tbody>
</table>

¹Volume-to-capacity

Note: the principles above were originally developed for freeway performance monitoring, but they are applicable to other geographies.

Table 2 describes key characteristics of a number of mobility and reliability performance measures. Equations and detailed descriptions of each particular measure are provided elsewhere (5, 7-11). The performance measures in bold in Table 2 are those that are most meaningful to individuals using the transportation system. To get the best picture of transportation system operation, individual measures and areawide measures in concert are most valuable. The middle column of Table 2 shows the various dimensions of congestion that are considered with each performance measure, and the last column of Table 2 identifies the geographic area that is addressed by each measure. All of the performance measures in Table 2 provide a measure of congestion intensity or “how bad is it?” that are measured as the difference between a baseline/reference condition and the conditions being analyzed. The “baseline/reference” is discussed further in the next section of this paper.
TABLE 2  Key Characteristics of Selected Mobility and Reliability Performance Measures
(Adapted from Reference 5)

<table>
<thead>
<tr>
<th>Performance Measure (Units)¹</th>
<th>Congestion Component Addressed²</th>
<th>Geographic Area Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mobility Measures</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total delay (person-hours)</td>
<td>Extent, intensity</td>
<td>Region, sub-area, section, corridor</td>
</tr>
<tr>
<td>Delay per commuter (person-hours per commuter)</td>
<td>Extent, intensity</td>
<td>Region, sub-area</td>
</tr>
<tr>
<td>Delay per mile (person-hours per commuter)</td>
<td>Extent, intensity</td>
<td>Region, sub-area, section, corridor</td>
</tr>
<tr>
<td>Congested travel (vehicle-miles or hours per day)</td>
<td>Duration, extent, intensity</td>
<td>Region, sub-area</td>
</tr>
<tr>
<td>Percent of congested travel (percentage)</td>
<td>Duration, extent, intensity</td>
<td>Region, sub-area</td>
</tr>
<tr>
<td>Congested roadway (miles)</td>
<td>Extent, intensity</td>
<td>Region, sub-area</td>
</tr>
<tr>
<td><strong>Travel time index (unitless)</strong></td>
<td>Intensity</td>
<td>Region, sub-area, section, corridor</td>
</tr>
<tr>
<td><strong>Reliability Measures</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planning time index (unitless)</td>
<td>Intensity, variation</td>
<td>Region, sub-area, section, corridor</td>
</tr>
<tr>
<td>Buffer index (percentage)</td>
<td>Intensity, variation</td>
<td>Region, sub-area, section, corridor</td>
</tr>
</tbody>
</table>

¹Note: performance measures in **bold** are those that resonate for an individual using the system (whereas the other measures are typical for areawide monitoring efforts).

²Duration – length of time during which congestion affects the travel system; Extent – estimates the number of people or vehicles affected by congestion and by the distribution of congestion; Intensity – severity of congestion that affects travel is a measure from an individual traveler’s perspective (in concept, it is measured as the difference between a baseline/reference condition and the conditions being analyzed); Variation – describes the change in the other three elements.

Performance Measure Recommendations from AASHTO Task Force on Performance Measure Development, Coordination and Reporting
The American Association of State Highway and Transportation Officials (AASHTO) Standing Committee on Performance Management (SCOPM) Task Force on Performance Measure Development, Coordination and Reporting was recently charged to “assist SCOPM and AASHTO to develop a limited number of national performance measures and help prepare AASHTO members to meet new Federal performance management requirements” (12). The Task Force made recommendations in November 2012 to FHWA related to the establishment of national performance measures. The performance measures were in six performance management areas (safety, pavement condition, bridges, freight, system performance, CMAQ). Table 3 shows the measures recommended by the Task Force with a mobility and reliability component from the areas of freight, system performance and CMAQ (12).
TABLE 3 Recommended Task Force Measures Related to Mobility and Reliability (Adapted from Reference 12)

<table>
<thead>
<tr>
<th>Area of MAP-21</th>
<th>Recommended Measure</th>
<th>Measure Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freight</td>
<td>Annual Hours of Truck Delay (AHTD)</td>
<td>Travel time above the congestion threshold in units of vehicle-hours for trucks on the interstate highway system.</td>
</tr>
<tr>
<td></td>
<td>Truck Reliability Index (RI80)</td>
<td>Defined as the ratio of the 80th percentile travel time needed to ensure on-time arrival to the agency-determined threshold travel time (e.g., observed travel time or preferred travel time).</td>
</tr>
<tr>
<td>System Performance</td>
<td>Annual Hours of Delay (AHD)</td>
<td>Travel time above the congestion threshold (defined by the state departments of transportation [DOTs] and metropolitan planning organizations [MPOs]) in units of vehicle-hours of delay on interstate and national highway system (NHS).</td>
</tr>
<tr>
<td></td>
<td>Reliability Index (RI80)</td>
<td>Defined as the ratio of the 80th percentile travel time to the agency-determined threshold travel time.</td>
</tr>
<tr>
<td>CMAQ</td>
<td>Same AHD definition as above for “System Performance”</td>
<td>Same AHD definition as above for “System Performance.”</td>
</tr>
</tbody>
</table>

The AHTD and AHD measures in Table 3 recommended by the Task Force generally have the form and calculation procedures similar to the “total delay” mobility measure in Table 2. Likewise, the RI80 has a form similar to the planning time index shown in Table 2. Subsequent sections of this paper discuss the threshold setting for these measures in more detail.

A Word about Areawide vs. Individual Measures

To tell the complete mobility picture, measures that resonate to both individual travelers (bold in Table 2) as well as those that capture the overall system mobility levels are important. As an example, total delay (person-hours) for a transit or roadway section is the sum of time lost due to congestion. Total delay in a corridor or an urban area is calculated as the sum of individual section delays. The quantity is particularly useful in economic or benefit/cost analyses that use information about the mobility improvement. Delay can also be expressed per commuter to resonate with individual travelers, and it generally communicates better to non-technical audiences in this manner. Because speed data are typically collected at the section level, generating multiple performance measures at various geographies (link level to urban area level) is relatively straightforward. Performance measure calculations are described in a later section of this paper.

Index measures in Table 2 (e.g., travel time index, planning time index and buffer index) are readily scalable from a roadway link to a roadway section to an urban area by weighting index values by the person-volume on each smaller link of roadway. Index measures also have the added benefit of providing an intensity measure that is meaningful both to an individual traveler as well as for the system.

A Word about Reliability Measures

In addition to average mobility conditions, understanding the variability of the transportation system is critical. Table 2 lists two common performance measures for reliability – the planning...
time index and buffer index. The planning time index is a ratio of the 95th percentile travel time to the uncongested (free-flow) travel time. The buffer index is the difference between the 95th percentile travel time and the average travel time, divided by the average travel time, expressed as a percentage.

It is important to note that recent research described situations where the 95th percentile decreased less than the average travel time, which resulted in a higher buffer index from one year to the next, which was counterintuitive (13). The researchers suggested that the buffer index is too unstable for use as a primary reliability measure, but do acknowledge the buffer index provides useful secondary-metric information (13). Therefore, primary reliability measures in the form of the planning time index are generally preferred by the transportation industry. This is the case with the SCOPM Task Force-recommended RI80 reliability measures that take the general form of the planning time index.

How Should Delay be Defined?
A common question for performance monitoring is identifying when to start “counting” delay? All of the measures in Table 2 are intensity measures – they use existing conditions in comparison to a “baseline/reference” condition. There are a number of alternatives that can be used as the baseline/reference of when congestion starts. Examples include:

- Uncongested (or free-flow) speed (not to exceed posted speed);
- Posted speed;
- Maximum throughput; or
- Setting a threshold speed.

These four methods for threshold setting are described in this section of the paper. It should be noted that for any of the threshold-establishment methods described below, computerized analysis procedures should be modified so that a “negative delay” value is not included in the calculations.

Uncongested (or Free-Flow) Speed (Not to Exceed Posted Speed)
Uncongested (or free-flow) speed is the average speed that can be accommodated under relatively low traffic volumes (i.e., no vehicle interactions) on a uniform roadway segment under prevailing roadway and traffic conditions. It can be calculated or estimated in a number of ways, with a common approach being to use the 85th percentile speed in the off-peak period. The off-peak periods can be defined by time period (e.g., overnight—10 p.m. to 6 a.m., or midday—9 a.m. to 4 p.m.) or vehicle volume. Ideally, a continuous data source (e.g., ITS, Weigh in Motion [WIM], Automatic Traffic Recorder [ATR], private-sector speed data, etc.) could be used to identify the free-flow speed using at least one year of valid data. The use of a free-flow speed provides an automated and consistent method for computing delay and index values across different metropolitan areas.

As an example, the Texas A&M Transportation Institute’s (TTI’s) Urban Mobility Report (7) uses uncongested (free-flow) speeds as the threshold for when congestion begins. Anything below free-flow is congested. The use of uncongested conditions in this case provides an easy-to-communicate and consistent reference across urban areas of different population sizes to define the extent of the congestion problem. Certainly smaller urban areas have a different tolerance for congestion than larger areas. It is then the decision of members of the local community in those urban areas to identify what portion of the congestion problem will be addressed, which is part of the “target-setting” discussion in a later section of this paper. The use
of uncongested as the threshold also avoids the perception that an “arbitrary” threshold has been
selected at less than free-flow to “explain away the congestion.” For all of these reasons, the
uncongested speed is preferred by the authors as a baseline/reference condition for estimating
delay.

Posted Speed
The posted speed limit can also be used to compute delay and index measures. The posted speed
limit can be used when continuous data are not available for the mobility analysis. Posted speed
data are included in most roadway inventory files and should be readily available for analytical
procedures. Posted speed limits are an easy way to communicate a threshold and are more stable
than uncongested speeds. However, posted speed limits are sometimes set for public policy
reasons, rather than being tied to actual conditions. This fact makes comparisons between
regions and comparisons over several years difficult. Posted speed limits could go down,
reducing the apparent “delay,” and yet if peak-period speeds declined, which should show more
congestion, there could be less delay. Another consideration with using posted speeds is that
sometimes trucks and/or nighttime conditions have different posted speeds.

Maximum Throughput
Another approach is to select a percentage of the uncongested (free-flow) or posted speed. The
logic often cited for this approach is that travel so close to uncongested conditions or posted
speeds does not constitute delay. Another related suggestion is that the agency does not have
available resources to mitigate congestion back to uncongested/free-flow conditions during the
peak period as that is unrealistic. To address these concerns, the idea of using the speed at
maximum volume throughput has been put forth in these cases (e.g., 70 to 85 percent of posted
speeds or uncongested speeds). When a maximum throughput speed is used based upon a
percentage of posted speed, the issues identified for posted speeds above remain relevant.

Setting a Threshold Speed
A final alternative is to simply select a particular speed threshold for an areawide or statewide
analysis. In its simplest form, a speed for arterials (e.g., 20 mph) and freeways (e.g., 35 mph)
could be established. Another alternative is that threshold speeds could vary spatially (i.e.,
downtown different than the suburbs) by functional classification. Yet another form of threshold
setting would be tying the thresholds to Highway Capacity Manual (HCM) level-of-service
(LOS) thresholds.

Impact of Threshold Selection on Project Prioritization
It is important to remember one important aspect of performance monitoring – to identify the
most congested roadway segments and the effect of congestion-mitigating projects and
programs. Interestingly, the threshold selection issue does not appear to cause great difference in
the relative congestion rankings in real-world situations. Recent research found that the rankings
of congestion measures for freeway segments hold steady across congestion threshold speeds
ranging from 60 mph to 30 mph and for several congestion measures (including delay per mile,
travel time index and planning time index). Therefore, from a project prioritization perspective,
the congestion threshold did not ultimately “change the prioritization” answers (14).
How Should Targets be Set?
Under MAP-21, state DOTs and metropolitan planning organizations (MPOs) are required to set targets for the required performance measures that result from FHWA’s NPRM. Target-setting has been a point of concern voiced by state DOTs and MPOs in light of MAP-21. Under MAP-21, states are required to submit biennial reports on progress toward achieving the targets for each of the required measures.

How Much Congestion is OK?
Analyses of system adequacy, the need for improvements, or time-series analyses conducted in an area or for a specific corridor can benefit from comparison to a target condition. Uncongested (free-flow) conditions will not be the goal of most large urban transportation improvement programs. The use of a target can improve the guidance provided to system planners and engineers. If the targets are a product of public discussion, they will illustrate the balance that the public wishes to have between road space, social effects, environmental impacts, economic issues, and quality of life concerns.

Areas or system elements where the performance is worse than the target can be the focus of more detailed study. A corridor analysis, for instance, might indicate a problem with one mode, but the solution may be to improve another mode or program that is a more cost-effective approach to raising the corridor value to the target. The amount of corridor or areawide person-travel that occurs in conditions worse than the locally determined targets can be used to monitor progress toward transportation goals and identify problem areas.

As an example, Table 4 shows performance measure target values based on intersection density that were established for an arterial mobility performance measurement analysis in Minneapolis-St. Paul, Minnesota. The target values reduce the prevailing speed during light traffic by a specified percentage given the intersection density of the arterial street. The target values inherently capture the fact that some of the congestion on the downtown arterials streets is acceptable. This is reflected in comparison of Figure 1 (annual delay per mile) and Figure 2 (delay computed based on the target values in Table 4). For example, Figure 2 shows that many of the congested downtown arterial streets in Figure 1 are not showing up as undesirably congested in Figure 2.

**TABLE 4  Performance Measure Target Values Based on Intersection Density**  
(Adapted from Reference 15)

<table>
<thead>
<tr>
<th>Intersection Density (intersections per mile)</th>
<th>Target Value = Percent of Prevailing Light Traffic Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 2</td>
<td>100</td>
</tr>
<tr>
<td>2 to 4</td>
<td>90</td>
</tr>
<tr>
<td>4 to 8</td>
<td>85</td>
</tr>
<tr>
<td>More than 8</td>
<td>75</td>
</tr>
</tbody>
</table>

Note: To determine actual target speed, the percentage value is multiplied by the prevailing speed in light traffic, which is calculated from measured traffic speed data during daytime hours.
FIGURE 1 All Directional Arterial Segments by Annual Delay Per Mile (Daytime Light Traffic) (Adapted from Reference 15).
FIGURE 2 All Directional Arterial Segments by Annual Delay Per Mil. (Target Values based upon Intersection Density) (Adapted from Reference 15).
Target values should be developed with input from citizens, businesses, decision makers, and transportation professionals. The target values represent the crucial link between, 1) the vision that the community has for its transportation system, land uses, and its “quality of life” issues and 2) the improvement strategies, programs, and projects that government agencies and private sector interests will implement. The values are desirably the result of a process that is integrated with the development of the long-range plan, but they must be reasonable and realistic since overstatement or understatement could distort congestion assessment.

Urban areas should approach the use of targets with a corridor and system strategy. The target value may be developed for every mode or facility as a way to identify individual performance levels, but the key application will be as a corridor or system target. Individual facility “deficiencies” can be addressed through improvements to that mode or route or by other travel mode improvements, strategies, or policies. For example, the freeway mainlanes may not satisfy the target value, but if managed lanes are successful in moving a large number of people at high speeds, person-hours of delay may achieve the target value.

Understanding Congestion Solutions and the Relationship to Target Setting

Local target setting and policies can encourage or promote the use of specific congestion-mitigating solutions in different areas of a particular urban area. There is no single solution to congestion for a given urban area. Typical congestion solutions include diversified development patterns, reducing construction delays, providing commute and travel options, improving system efficiency and building more capacity (7). While potential congestion solutions vary by urban area, it also varies within an urban area.

The bar heights in the simplifying example in Figure 3 illustrate the amount of road and transit capacity additions, greater efficiency (e.g., signal improvements, incident clearance), and travel options (e.g., telecommuting, flexible work hours). The example shows how the mix of congestion-mitigating solutions varies geographically across an urban area with two loop roads. If one uses recent trends, the mix might be further defined as more transit capacity additions than roads in the downtown area, and more road additions than transit in the outer suburbs.

The Figure 3 example points to the role for local target setting and policies that can encourage the use of specific congestion-mitigating solutions in different areas of a metropolitan region to reflect community goals and objectives. Higher congestion levels may be deemed “acceptable” in a downtown area where trips are shorter and more travel options are available, than in suburban areas where people may be forced to travel long distances between homes they can afford and the job they have been able to get.
The Role of the Economy

One repeated concern among transportation professionals is that their system is being graded while there are many factors that influence the traffic demand that are beyond their control – the primary factor being the economy. Should places that have a growing economy be penalized because they do not meet their target due to increased economic vitality? Likewise, should places that have lost population, and have subsequently had drops in congestion levels, be rewarded with funds for reaching their congested targets? Having a target that is normalized by the economic output (e.g., % change in delay / % change in gross metropolitan product) may be helpful. An example of the target is for delay to increase slower than the economic output of the region. State DOTs and MPOs can set their own target for a metro area.

How Can/Should the Measures be Computed?

“How will we possibly estimate the required performance measures?” is a typical concern for those preparing for the anticipated MAP-21 requirements. Related to this concern, state DOTs and MPOs are not certain they have available data to fully drive the measures or are not aware of where to get the necessary data.

Performance measurement primarily includes speed and volume data as input. Depending upon the specific measure, information about the number of commuters, vehicle occupancy, or other roadway inventory information is also necessary. The following is a hypothetical “Q&A” to help transportation professionals better understand the available resources and methods for developing the types of performance measures that are anticipated from the MAP-21 requirements.

Where Does the Data Come from?

State DOTs and MPOs will have some information in-house – roadway inventories of volume data, including trucks (e.g., Highway Performance Monitoring System data) and perhaps speed information from selected instrumented locations. Speed data may also be already “in-house”
from a private-sector company. Knowledge about the number of commuters, vehicle occupancy, and other roadway inventory information also facilitate performance measurement.

At the time this paper was written, FHWA had just announced the acquisition of a National Performance Management Research Data Set (NPMRDS) for use to support its Freight Performance Measures (FPM) and Urban Congestion Report (UCR) programs (16). In a memorandum dated July 19, 2013 and sent to FHWA Division Administrators the FHWA Office Operations requested that the data be shared with State DOTs and MPO partners as part of the acquisition. The memo indicates that the NPMRDS provides three data sets of average travel times in 5-minute bins for all NHS facilities in the United States (freight only, passenger-only, and “all traffic” sets) (16).

The NPMRDS will facilitate speed data collection for many transportation analysis needs. If the NPMRDS data are not appropriate for a particular analysis, a request for proposals (RFP) could be issued for the provision of a speed dataset for specific needs.

How Do We Know if the Data Are Good Enough?
Several research organizations and state DOTs have conducted evaluations of the private-sector speed datasets and found them to be very useful for performance measurement.

How Would the Measures be Calculated?
The speed data from the private company would be matched to the geographic-information system (GIS)-mapped FHWA Highway Performance Monitoring System (HPMS) dataset. Daily volume can be decomposed to 15-minute or hourly volume and then used to calculate delay. These methods have been performed and documented elsewhere for Texas A&M Transportation Institute’s Urban Mobility Report (7) and also for the development of the 100 Most Congested Roadways list for the Texas Department of Transportation (TxDOT) (17). For the interested reader, the matching process to combine daily volumes to the 15-minute speeds through a process called “conflation” is documented elsewhere (17).

What Road Systems Would be Measured?
Freeways, major arterials and minor arterials – and different congestion thresholds might be appropriate for each system. And this would be consistent with also including non-motorized and transit systems for a set of multimodal performance measures.

What Time Period?
Peak periods of 3 or 4 hours in the morning and evening would be sufficient to encompass the congested periods in almost all regions. Metro areas might be encouraged to measure other times in certain locations of significant congestion or reliability problems.

What Will This Look Like When It’s Done?
One approach for mobility analyses of this type is to process them in statistical software such as SAS® and then export the data to an Excel® sheet for review, additional post-processing, or graphic creation. Imagine an Excel® sheet with mobility and reliability measures across the top of the columns and rows representing aggregated statistics by spatial context as desired (e.g., links, longer segments of roads, urban area, or statewide). Alternatively, the performance measures can be output in a visual (GIS) format such as Figure 1 for the roadways of interest.
CONCLUSIONS AND DISCUSSION

With the signing of MAP-21 in July 2012, and its focus on performance measurement, staffs of many state DOTs and MPOs are concerned about what will be required of them. This paper provides discussion of several of the common concerns, and opportunities, related to anticipated MAP-21 congestion and system performance requirements based largely on the authors’ experiences working closely with state DOTs and MPOs. The following topical conclusions are made.

- Principles for selecting successful mobility and reliability performance measures – there are industry-proven principles and methods for selecting and implementing performance measures. The principles are documented in Table 1 and this paper highlights the key considerations for selecting successful measures.

- Performance measures – With the NPRM and associated measures anticipated soon, it is timely for agencies to begin to think about the benefits of having a set of performance measures for purposes other than satisfying MAP-21 requirements. There are a number of previous efforts that have successfully implemented the types of performance measures anticipated in the MAP-21 requirements and/or valuable as part of a set of agency measures. Some of the efforts are referenced in this paper, and some typical measures are highlighted in Table 2.

- Delay thresholds – a number of baseline/reference conditions have been used to define “when does congestion start?” This paper describes several possible thresholds, along with their key advantages and disadvantages. Using a form of uncongested (free-flow) speed is preferred by the authors because it is easy-to-communicate, provides a consistent measurement across locales of varying congestion levels, and has a number of other benefits explained in the paper.

- Target setting – successful performance measure target setting should be made based upon input from citizens, businesses, decision-makers, and transportation professionals. Areas or system elements where the performance is worse that the target can be the focus of more detailed study. An example is shown in Figures 1 and 2.

- Performance measurement calculation techniques – Calculating the performance measures typically requires speed and volume data as input, as well as knowledge of the number of commuters, vehicle occupancy, and other roadway inventory information. There are a number of proven analytical methods for using existing data sources and/or obtaining data and then computing performance measures similar to those anticipated from the MAP-21 requirements.

- Get started – Some state DOTs/MPOs may feel their available data, purchased data, measures, and/or procedures are not “perfect,” and subsequently, may be leery about moving forward with performance measurement activities. It is important that transportation professionals not let “perfect” be the enemy of good. Getting started with what they can do now is important – data and procedures can evolve as available data are improved and procedures are refined.

Future MAP-21 requirements should be embraced as an opportunity to improve system management and communication with the public. It is clear from the law’s language that failing to meet MAP-21 performance targets will not result in the restriction of Federal aid. The authors believe that FHWA’s ultimate goal is to see progress by state DOTs and MPOs in coordinating and using performance measures to inform decision-making and provide taxpayers accountability of public resources.
REFERENCES


