APPENDIX G: PERFORMANCE MEASURES TECH MEMORANDUM

4/13/2010 v3

Technical Memorandum #2: Performance Measures

Metropolitan Highway System Investment Study

Parsons Brinckerhoff

TECHNICAL MEMORANDUM #2: PERFORMANCE MEASURES

Metropolitan Highway System Investment Study

INTRODUCTION

This memo provides a basis of understanding regarding recommended performance measures to be considered in the evaluation of the Metropolitan Highway System Investment Study (MHSIS) alternatives.

The framework for MHSIS performance measures provides evaluation guidance for corridor-based alternatives, including the designation, design, and components of management strategies upon the highway system. To measure the impact of the congestion management strategies, it is essential to make comparisons between alternatives and to a baseline – often know as a "build" and "no-build" concept comparison. This necessity lends itself to quantifiable measures of effectiveness that allow for comparability. Also important is establishing as many common measures as possible that can be used for all corridors and strategies, to enable comparison of findings across the concepts. As this effort will only examine two time points – 2030 and 2060 – the eventual strategy evaluation will lack the ability to track incremental performance over time. Thus, the performance measures may not represent cumulative costs and benefits over the life of the treatment.

TRANSPORTATION POLICY

The *2030 Metropolitan Transportation Plan* provides the policy basis for the analysis of the MHSIS. Within the Highway Vision component of the plan, the following is put forward as the regional guiding policies:

The region faces hard choices in addressing mobility, safety and preservation needs. To respond effectively, the region needs a transportation strategy that is realistic, innovative and focused on leveraging available dollars for the most benefit. The transportation system must optimize all available transportation modes – highways, transit and others – and coordinate them for maximum effect.

Adequate resources must be committed to the preservation and maintenance of the extensive highway system built over the last 50 years, including the bridge repair/replacement program mandated by the 2008 Legislature. It is also important, however, to improve the performance of the highway system in order to preserve essential regional mobility levels for the region's economic vitality and quality of life.

While traffic congestion impacts can and should be mitigated, physical, social and environmental constraints as well as the limited funds available for capacity expansion must be recognized.

Three major objectives to mitigate congestion on the region's roadway system and enhance its performance should be pursued:

- Increase the people-moving capacity of the metropolitan highway system while reducing future demand on the system.
- Manage and optimize, to the greatest extent possible, the existing system.
- Implement strategic and affordable capacity expansion projects.

In order to achieve the above objectives, this plan recommends the following strategies:

- Encourage the use of alternatives to the single-occupant vehicle and changes in travel patterns such as high-occupancy vehicle (HOV) and high-occupancy toll (HOT) lanes, bus-only and priced dynamic shoulder lanes, roadway pricing and other transit advantages.
- Implement low-cost/high-benefit highway construction improvements, including some capacity expansion projects, on a system-wide basis to improve traffic flow by removing bottlenecks, improving geometric design and eliminating safety hazards.
- Reassess the scope and cost of proposed major highway expansion projects to bring them more in line with projected highway revenues and to enhance Mn/DOT's ability to implement them.

In 2009, Mn/DOT and the Metropolitan Council will complete a Metropolitan Highway System Investment Strategy (MHSIS) to refine in greater detail this highway vision, identify low-cost/high-benefit projects along congested highway corridors and reassess major expansion projects. Also in 2009, Congress is expected to authorize a new six-year federal transportation funding bill, providing greater certainty about future highway funding levels. Additional infrastructure funds may also be included in an economic stimulus package.

The MHSIS, coupled with refined financial projections, will permit a better definition of the highway improvement projects to be implemented by 2030. The result of this analysis will be incorporated as an amendment to the Transportation Policy Plan in 2010.

Emerging needs in the developing portions of the region, including new principal and "A" minor arterials, new/rebuilt interchanges and new river crossings, must also be acknowledged in spite of current financial constraints.

GUIDING PRINCIPLES

The November 18th, 2009 document, *Metropolitan Highway System Investment Study: Policy Direction and Guiding Principles*, prepared by the Metro District of the Minnesota Department of Transportation (Mn/DOT) and the Metropolitan Council, served as the basis from which to develop the performance measures. That document reiterated a conclusion from the *Principal Arterial Study*: "a lower-cost/high-benefit approach may be an effective way to address specific problems and that pricing can provide an alternative to manage congestion and for managing congestion." From this conclusion, the MHSIS Project Management Team developed a series of guiding principles, leveraging policies as stated with the regional Transportation Policy Plan and Statewide Transportation Plan. In effect, these principles reorient the long range transportation plan towards projects that maximize the return on investment from existing infrastructure and strategically invest in new infrastructure to meet a constrained financing and construction environment.

The guiding principles applicable to the evaluation of alternatives are summarized as:

- *Utilize the most cost-effective operational and management techniques to optimize system performance*. In effect, this principle states that system and demand management strategies will be prioritized over new capacity for mobility improvement.
- *Managed lanes are a higher priority for improvement than general purpose lanes.* Where new capacity is to be provided on the highway system, management of that new capacity through managed lanes (either priced or non-priced) and/or transit advantage will receive priority over unmanaged capacity.
- *There are some areas where traditional capacity will not be added; this does not preclude management, operational and pricing solutions.* Demand and system management strategies may be considered for sections of the highway system even without a capacity addition.
- *Needed segments of general purpose lanes may be converted to managed lanes*. For the purpose of management continuity and system efficiency, some situations may require the conversion of general purpose capacity into managed capacity.
- *Highway improvements should enhance and support transit use where existing or planned express transit service exists.* The provision of transit advantage may include the conversion of right-side bus shoulder to left-side managed lanes.
- *Flexible design may be needed to accommodate an improvement or project within the existing right-of-way. Overall safety must be maintained or improved.* The need for flexible design is not a fatal flaw; rather, the burden is upon the project development to indicate safety has not been degraded as a result of the project.
- *Complete the six-lane beltway and unfinished connections to utilize existing and planned investments*. Although the region has a long-standing policy of a six-lane continuous beltway, segments of the beltway may be managed capacity.
- *Do not add inbound capacity outside the beltway that cannot be accommodated by projects or operational changes/strategies on, or within, the beltway*. This principle sets out to avoid demand / capacity imbalance, however existing imbalances may be alleviated by providing transit advantage and outbound capacity.
- *Manage access to Interregional Corridors (IRC's) or other Principal Arterials*. Signalized intersections may be modified or removed, and, access points may be reduced to improve efficiency.
- *Asymmetrical improvements may be considered*. The region may consider capacity expansion to facilities serving outbound throughput, when appropriate.

The Performance Measures

From the *Guiding Principles* document, the initial performance measures were derived for eventual use in the screening process. Whereas certain principles lend themselves to screening, prioritization, or scenario selection, certain guiding principles also inform the selection of performance measures. In turn, these performance measures can be detailed into measures of effectiveness.

The selection of performance measures is first dependent upon the overarching purpose of the MHSIS:

- Guide overall mobility decisions by giving direction to fully utilize all highway and modal investments, in a coordinated manner.
- Define the most cost-effective techniques and projects to optimize highway system performance for all users.

From this purpose, overarching goals are clarified for the selection of an MHSIS alternative:

- Develop a future transportation investment strategy that optimizes the investments already made in the region through the use of targeted capacity expansion coupled with multimodal system and demand management strategies. The intent is to better utilize lane capacity, paved shoulders, and right-of-way.
- Identify investment alternatives to improve metropolitan highway system performance and preserve mobility

Finally, specific guiding principles as identified above are used to inform the selected performance measures:

- Utilize the most cost effective operational, management and pricing techniques to optimize system performance. Management strategies, including pricing, High Occupancy Toll (HOT) lanes, High Occupancy Vehicle (HOV) lanes, Intelligent Transportation Systems (ITS), and ramp metering will be used to their fullest extent to improve mobility and relieve congestion before adding new capacity
- Managed and priced lanes are a higher priority for improvement than general purpose lanes. Capacity/mobility projects that contain an element of management or pricing will receive priority in selection. Projects that include transit or transit advantages (e.g.. bus only shoulders) will receive priority in selection

Objective #1: Increase the people-moving capacity of the metropolitan highway system

Performance Measure Category: Person Throughput

Person throughput is an important measure of mobility and congestion reduction. Person throughput refers to the number of persons traversing the corridor on both transit and in private vehicles. Increases in the number of persons using a corridor would imply that the operations and management strategies evaluated were effective in serving more persons who are not serviced in the corridor because of the congestion that is present in a no-build context. The identified measures of effectiveness for person throughput are:

- Person Miles Traveled (PMT) by facility and/or lane type
- Vehicle Miles Traveled (VMT) by facility and/or lane type

The identified mechanism for assessing person throughput performance will be the calculated outcomes from the travel demand model for PMT and VMT.

Performance Measure Category: Transit Mode Split

A desired outcome of the MHSIS is to increase the use of transit relative to the private auto, leading to a mode shift to transit. Mode shift may result from potential users being attracted to transit, or from increased transit use among occasional users. Thus, the central transit evaluation issue is the identification and measurement of mode shift. In theory, a mode shift to transit should then facilitate higher transit ridership, reduced levels of traffic congestion, more efficient use of existing road capacity, net reduction in greenhouse gas emissions and fuel consumption. and potentially higher levels of person throughput. The identified measures of effectiveness for transit mode shift are:

- Change in treatment corridor mode share
- Change in regional mode share

The identified mechanism for assessing transit mode share performance will be the calculated outcomes from the travel demand model for capacity improvements and from the FHWA Intelligent Transportation Systems Deployment Analysis System (IDAS) model for active traffic management / ITS improvements.

Objective #2: Manage and optimize, to the greatest extent possible, the existing system

Performance Measure Category: Facility Performance

Facility performance partially represents the spatial extent of congestion relative to person trips. For example, the ratio of PMT to VMT provides a measure of trip distribution. Coupled with the percentage of freeway lane miles at degraded levels of service, provides an evaluation of the facility's attraction of users and distribution to competitive alternatives (both modal and route alternatives). With managed lanes comprising a significant investment, average speeds will be delineated to the extent possible by lane type. The identified measures of effectiveness for facility performance are:

- Ratio of PMT / VMT
- Lane miles by volume / capacity exceeding 0.95
- Average speed by facility / lane type

The identified mechanism for assessing facility performance will be the calculated outcomes from the travel demand model for the first two measures. Average speed will be assessed using the travel demand model for traditional improvements and IDAS for active traffic management.

Objective #3: Accommodate future demand within the metropolitan highway system

Performance Measure Category: Peak Period Vehicle Traffic Volumes

Related to the facility performance measure is the total vehicular demand for metropolitan highway capacity. Recognizing the metropolitan highway system provides abundant capacity and only suffers a shortage in the peak periods, this measure identifies the success of alternatives in shifting demand from the peak period. The identified measures of effectiveness for peak period vehicle traffic volumes are:

- Change from baseline in peak hour volumes
- Change in peak period VMT

The identified mechanism for assessing peak period traffic performance will be the calculated outcomes from the travel demand model.

Performance Measure Category: Temporal Extent of Congestion

The temporal extent of congestion refers to how many hours in the day the corridor is operating under congested conditions. As freeway corridors have varying levels of operations and management strategies deployed across treatment sections, this will affect the percentage of VMT experiencing congestion on the metropolitan system. The intent of the evaluation will be to identify the level of success the strategies have upon treatment corridors to this objective. The identified measures of effectiveness for temporal extent of congestion are:

- Number of hours per day facilities are operating with congestion
- Percent change in number of freeway links operating with congestion
- Percent change in non-freeway corridors operating with congestion
- Percent change in VMT during congested conditions
- Percent change in VHT during congested conditions

The identified mechanism for assessing temporal extent of congestion will be the calculated outcomes from the travel demand model.

Objective #4: Increase trip reliability

Performance Measure Category: Travel Time Reliability

Travel time reliability is a key metric for operational and management strategies, yet it remains an elusive metric for estimation and quantification. In order to represent travel time reliability, the MHSIS will use the travel time index as a means of assessing the collective effectiveness of the strategies at reducing congestion between treatment corridors. The travel time index is the ratio of the average peak period travel time as compared to a free-flow travel time. The free-flow travel time for each road section is the 15th percentile travel time during traditional off-peak times (i.e., weekdays between 9 am and 4 pm, between 7 pm and 10 pm; and weekends between 6 am and 10 pm). For example, a value of 1.20 means that average peak period travel times are 20% longer than free flow travel times. Coupled with a calculation of variability, this provides an approximation of reliability. The identified measures of effectiveness for travel time reliability are:

- Variability of trip travel time by facility / lane type
- Change in travel time index (total travel time compared to a free-flow travel time) of travelers

The identified mechanism for assessing travel time reliability will be calculated as follows:

- Variability will be calculated by the change in the percent of lane miles with a volume / capacity ratio in excess of 0.95 for traditional improvements by facility type (data from demand model), and, the IDAS model for ITS/ATM treatments
- The travel time index will be calculated from travel demand model data as the total vehicle hours traveled (VHT) as a ratio of free flow system VHT.

OBJECTIVE #5: REDUCE TRAVEL TIME

PERFORMANCE MEASURE CATEGORY: TRAVEL TIME SAVINGS

Travel time is strongly influenced by the speed that the vehicle is able to travel, as well as any delays experienced due to bottlenecks or other queues caused by congestion. Generally, travel times are measured for specific points on a section of roadway and can be collected separately for different types of facilities (e.g., general purpose lanes versus managed lanes, freeway versus arterial). The MHSIS will evaluate the travel time savings by examining changes in travel times before (no-build) and after (treatment) the strategies have been applied to treatment corridors. The identified measures of effectiveness for travel time savings are:

- Corridor-based travel time by facility / lane type, normalized by traveler
- Percent changes in travel time by treatment corridor
- Differentiation of travel time by mode

The identified mechanism for assessing travel time savings will be the calculated outcomes from the travel demand model for capacity improvements and from the IDAS model for active traffic management / ITS improvements.

COMBINATION OF MEASURES

The following table illustrates the combined measures as identified above.

<table>
<tr><th>OBJECTIVES</th><th>PERFORMANCE CATEGORIES</th><th>MEASURES OF EFFECTIVENESS</th></tr>
<tr><td rowspan="4">Increase the people-moving capacity of the metropolitan highway system</td><td rowspan="2">Person Throughput</td><td>Person Miles Traveled by facility / lane type</td></tr>
<tr><td>Vehicle Miles Traveled by facility / lane type</td></tr>
<tr><td rowspan="2">Transit Mode Split</td><td>Change in treatment corridor mode share</td></tr>
<tr><td>Change in regional mode share</td></tr>
<tr><td rowspan="3">Manage and optimize, to the greatest extent possible, the existing system</td><td rowspan="3">Facility Performance</td><td>Ratio of PMT / VMT (mode distribution)</td></tr>
<tr><td>Lane miles at volume / capacity > 0.95</td></tr>
<tr><td>Average speed by facility / lane type</td></tr>
<tr><td rowspan="4">Accommodate future demand within the metropolitan highway system.</td><td rowspan="2">Peak Period Vehicle Traffic Volumes</td><td>Change from baseline in peak hour volumes</td></tr>
<tr><td>Change in peak period VMT</td></tr>
<tr><td rowspan="2">Temporal Extent of Congestion</td><td>Hours per day operating with congestion</td></tr>
<tr><td>Change in freeway links operating with congestion</td></tr>
</table>

		Change in non-freeway corridors operating with congestion
		Change in VMT during congested conditions
		Change in VHT during congested conditions
Increase trip reliability	Travel Time Reliability	Variability of travel time by facility / lane type
		Change in travel time index (total travel time compared to a free-flow travel time) of travelers
Reduce travel time	Travel Time Savings	Corridor-based travel time by facility / lane type
		Change in travel time by treatment corridor
		Differentiation of travel time by mode