

4. STUDIES OF CONGESTION MANAGEMENT STRATEGIES

Defining, analyzing and assessing congestion management strategies are important components of the CMP. This chapter reviews performance measures adopted by the TPB and its subcommittees and the effectiveness of demand and operational management strategies. Several important studies of strategies are also documented in this chapter as examples.

4.1 Review of Performance Measures

4.1.1 INTRODUCTION TO PERFORMANCE MEASURES

A performance measure, or indicator, is a means to gauge and understand the usage of a transportation facility, or the characteristics of particular travelers and their trips. The performance measure/indicator may refer to a particular location or “link” of the transportation system.

Performance measures can be either quantitative or qualitative. It may refer to the experience of a traveler on a trip between a particular origin and a particular destination. It may summarize all trips or trip makers between a particular origin and destination pair. Or, it may describe the operation of one mode of transportation versus another.

Federal regulations¹ state that the CMP should include:

“Definition of congestion management objectives and performance measures to assess the extent of congestion and support the evaluation of the effectiveness of congestion reduction and mobility enhancement strategies for the movement of people and goods.”

The fields of transportation planning have typically used mode-specific performance measures or indicators to gauge conditions on the system. These include motor-vehicle specific performance measures such as traffic volumes, capacities, and level-of-service.

The TPB adopted a set of performance measures in the 1994 Congestion Management System (CMS) Work Plan. Since then, there has been an evolution towards more traveler-oriented metrics in conveying congestion and related information to the general public. Some of the measures are leveraged by emerging highway performance monitoring activities such as the I-95 Corridor Coalition Vehicle Probe Project that provides probe-based continuous monitoring.

In the Final Rule on "National Performance Management Measures; Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program" which became effective on May 20, 2017 [82 FR 22879]², FHWA established a set of performance measures for State departments of transportation (State DOT) and Metropolitan Planning Organizations (MPO) to use as required by Moving Ahead for Progress in the 21st Century Act (MAP-21) and the Fixing America's Surface Transportation (FAST) Act. The measures in the final rule will be used by State DOTs and MPOs to assess the performance of the Interstate and non-Interstate National Highway System (NHS) for the purpose of carrying out the National Highway Performance Program (NHPP); to assess freight movement on the Interstate

¹ Federal Register, Vol. 81, No.103, May 27, 2016.

² Docket No. FHWA-2013-0054, RIN 2125-AF54, Federal Register - Vol. 82, No. 11, Pg. 5970 - January 18, 2017: <https://www.gpo.gov/fdsys/pkg/FR-2017-01-18/pdf/2017-00681.pdf>.

System; and to assess traffic congestion and on-road mobile source emissions for the purpose of carrying out the Congestion Mitigation and Air Quality Improvement (CMAQ) Program.

4.1.2 MAP-21/FAST ACT PERFORMANCE MEASURES

The MAP-21 and FAST Acts transformed the Federal-aid highway program by establishing new requirements for performance management to ensure the most efficient investment of Federal transportation funds. Performance management increases the accountability and transparency of the Federal-aid highway program and provides a framework to support improved investment decision-making through a focus on performance outcomes for key national transportation goals. State DOTs and MPOs will be expected to use the information and data generated as a result of the new regulations to inform their transportation planning and programming decisions.

Performance measures in four areas, relevant to the congestion management process, were defined in the final rule on "National Performance Management Measures; Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program" are summarized in Table 4-1, including:

- percent of reliable person-miles traveled on the Interstate.
- percent of reliable person-miles traveled on the non-Interstate NHS.
- percentage of Interstate system mileage providing for reliable truck travel time (Truck Travel Time Reliability Index)
- annual hours of peak hour excessive delay per capita

TPB, in conjunction with state DOTs, works to analyze these measures and set associated targets.

Table 4-1 Performance Measures in the final rule on "National Performance Management Measures; Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program"

Areas	Measures	Metrics	Equations	Thresholds	Time Periods (in a Calendar Year)	Geographic Areas	Data	Target Scope
Performance of the Interstate	Percent of the Interstate System providing for Reliable Travel	Level of Travel Time Reliability (LOTTR)	80 th TT / 50 th TT	Reliable: LOTTR < 1.50	6:00 am-10:00 am, M-F 10:00 am-4:00 pm, M-F 4:00 pm-8:00 pm, M-F 6:00 am-8:00 pm, S-S	Interstate	1) Travel Time Data Set; 2) Reporting segments	Statewide target; MPO-wide target
	Percent of the Interstate System where peak hour travel times meet expectations	Peak Hour Travel Time Ratio (PHTR)	Longest PHTT / Desired PHTT in that hour the longest PHTT occurred	Meet expectation: PHTR < 1.50	Could be any one of the 6 peak hours: 6:00 am-9:00 am, 4:00 pm-7:00pm in non-Federal holiday weekdays	Interstate in urbanized area with population over 1 million	1) Travel Time Data Set; 2) Reporting segments; 3) Desired Peak Period Travel Time	A single urbanized area target
Performance of the Non-Interstate NHS	Percent of the non-Interstate NHS providing for Reliable Travel	Level of Travel Time Reliability (LOTTR)	80 th TT / 50 th TT	Reliable: LOTTR < 1.50	6:00 am-10:00 am, M-F 10:00 am-4:00 pm, M-F 4:00 pm-8:00 pm, M-F 6:00 am-8:00 pm, S-S	Non-Interstate NHS	1) Travel Time Data Set; 2) Reporting segments	Statewide target; MPO-wide target
	Percent of the non-Interstate NHS where peak hour travel times meet expectations	Peak Hour Travel Time Ratio (PHTR)	Longest PHTT / Desired PHTT in that hour the longest PHTT occurred	Meet expectation: PHTR < 1.50	Could be any one of the 6 peak hours: 6:00 am-9:00 am, 4:00 pm-7:00pm in non-Federal holiday weekdays	Non-Interstate NHS in urbanized area with population over 1 million	1) Travel Time Data Set; 2) Reporting segments; 3) Desired Peak Period Travel Time	A single urbanized area target
Freight movement on the Interstate System	Percent of the Interstate System Mileage providing for Reliable Truck Travel Time	Truck Travel Time Reliability	95 th Truck TT / 50 th Truck TT	Reliable: Annual Average Truck Travel Time Reliability < 1.50	24/7/365	Interstate	1) Travel Time Data Set; 2) Reporting segments	Statewide target; MPO-wide target
	Percent of the Interstate System Mileage Uncongested	Average Truck Speed	Arithmetic mean of Truck Speeds (leading to inconsistency between average speed and average travel time)	Uncongested: Truck Speed > 50 mph	24/7/365	Interstate	1) Travel Time Data Set; 2) Reporting segments	Statewide target; MPO-wide target
Traffic Congestion	Annual Hours of Excessive Delay per Capita	Vehicle-hours of delay per capita	Delay * volume	Delay occurs if speed < 35 mph on Interstate (FC1), freeways and expressways (FC2); and < 15 mph on principal arterials (FC3) and all other NHS	24/7/365	NHS in nonattainment or maintenance urbanized area with population over 1 million	1) Travel Time Data Set; 2) Reporting segments; 3) Hourly traffic volume	A single urbanized area target

4.1.3 TRAVELER-ORIENTED CMP PERFORMANCE MEASURES

Since the TPB development of the CMP performance measures in 1994 (see Section 4.1.4), there has been an evolution towards more traveler-oriented metrics in conveying congestion and related information to the general public. Some of the measures are leveraged by emerging highway performance monitoring activities such as the I-95 Corridor Coalition's Vehicle Probe Project that provides probe-based continuous monitoring. Earlier in this report, the following four measures were used, with the first two quantifying congestion and the latter two travel time reliability. The 2010 [Strategic Plan for the Management, Operations and Intelligent Transportation Systems \(MOITS\) Program](#)³ adopted Travel Time Index, Buffer Time Index and Planning Time Index as three regional indices of travel conditions and traveler's experience.

4.1.3.1 Travel Time Index (TTI)

TTI is defined as the ratio of actual travel time to free-flow travel time, measures the intensity of congestion. The higher the index, the more congested traffic conditions it represents, e.g., TTI = 1.00 means free flow conditions, while TTI = 1.30 indicates the actual travel time is 30% longer than the free-flow travel time. For more information, please refer to [Travel Time Reliability: Making It There On Time, All The Time](#), a report published by the Federal Highway Administration and produced by the Texas Transportation Institute with Cambridge Systematics, Inc. This report uses the following method to calculate TTI:

- 1) Download INRIX 5-minute raw data from the I-95 Traffic Monitoring website (<http://i95.inrix.com>) or the VPP Suite website (<https://vpp.ritis.org>).
- 2) Aggregate the raw data to monthly average data by day of the week and hour of the day. Harmonic Mean was used to average the speeds and reference speeds (Harmonic Mean is only used here; other averages used are all Arithmetic Mean). For each segment (TMC), the monthly data have 168 observations (7 days in a week * 24 hours a day) in a month.
- 3) Calculate $TTI = \text{reference speed} / \text{speed in the monthly data}$. If $TTI < 1$ then make $TTI = 1$. If constraint $TTI \geq 1$ was not imposed, some congestion could be cancelled by conditions with $TTI < 1$.
- 4) Calculate regional average TTI for the Interstate system, non-Interstate NHS, non-NHS, and all roads for AM peak (6:00-10:00 am) and PM Peak (3:00-7:00 pm) respectively, using segment length as the weight.
- 5) Calculate the average TTI of the AM Peak and PM Peak to obtain an overall congestion indicator.

4.1.3.2 Planning Time Index (PTI)

PTI is defined as the ratio of 95th percentile travel time to free flow travel time, measures travel time reliability. The higher the index, the less reliable traffic conditions it represents, e.g., PTI = 1.30 means a traveler has to budget 30% longer than the uncongested travel time to arrive on time 95% of the times (i.e., 19 out of 20 trips), while TTI = 1.60 indicates that one has to budget 60% longer than the uncongested travel time to arrive on time most of the times. For more information, please

³ COG/TPB, <http://www1.mwcog.org/transportation/activities/operations/plan/MOITS-Strategic-Plan-Executive-Summary-2010-06-16.pdf>

refer to [Travel Time Reliability: Making It There On Time, All The Time](#), a report published by the Federal Highway Administration and produced by the Texas Transportation Institute with Cambridge Systematics, Inc. This report uses the following method to calculate PTI:

- 1) Calculate TTI = reference speed / speed in the monthly data obtained in step 2 of the above TTI methodology. Do not impose constraint $TTI \geq 1$, since the purpose of this calculation is to rank the TTIs to find the 95th percentile, not to average the TTIs.
- 2) Calculate monthly average PTI: including sorting the data obtained in step 1 by segment, peak period, and month, finding the 95th percentile TTI and this TTI is PTI by definition, and averaging the PTIs using segment length as the weight to get regional summaries (for the Interstate system, non-Interstate NHS, non-NHS, and all roads for AM peak (6:00-10:00 am) and PM Peak (3:00-7:00 pm) respectively).
- 3) Calculate yearly average PTI: including sorting the data obtained in step 1 by segment and peak period, finding the 95th percentile TTI and this TTI is PTI by definition, and averaging the PTIs using segment length as the weight to get regional summaries.
- 4) Calculate the average PTI of the AM Peak and PM Peak to obtain an overall travel time reliability indicator.

4.1.4 HOW PERFORMANCE MEASURES/INDICATORS WERE SELECTED FOR THE 1994 CMS WORK PLAN

In 1993, the CMS Task Force undertook discussion of performance measures/indicators because of the emphasis in federal CMS guidance on this issue, culminating in the publication of performance measures in the 1994 CMS Work Plan⁴. The efforts at the beginning of the process involved a literature search and brainstorming process. An array of possible performance measures were developed based on materials from an FHWA instructional course on CMP. The CMP Task Force worked with these draft lists, adding, deleting, and changing the performance measures to suit the needs of the Washington region. The result was a stratified list of CMP performance measures.

Early in the process, the CMS Task Force was already aware of the gap between the intermodal, locally focused performance measures/indicators available and the multi-modal, wide-area scope desired for congestion management. Other issues were raised, as well, which set the tone of the discussion. The following were taken into consideration:

- Can the particular performance measure/indicator (or the data needed to feed it) be forecast by known tools and capabilities?
- Traditional congestion indicators tended to be precise in scale, addressing a particular link or intersection on the transportation system, yet modeling or forecasting capabilities tended to be rough in scale, forecasting at best, a regional or sub-regional scale. Post processing forecast data would improve the precision at a corridor level. The choice of performance measures may lead or bias the investigator toward only certain kinds of solutions, and eliminate others that may actually be worthy. This was a particular concern expressed by elected officials on the TPB.

⁴ CMS Work Plan for the Washington Region, approved by the TPB on September 21, 1994.

- The CMP tries to have a layman's term, "congestion" apply to a technical process. Congestion could be characterized by crowdedness, by delay, or by decreases in traffic speeds. Conversely, crowdedness, delay, and slowing are not all the same phenomenon not always experienced, and not always tantamount to congestion.
- Level of Service appeared to be the most promising alternative to using delay. It has been used frequently in the past, and there is a level of understanding and buy-in from regional decision makers and the public. Level-of service does have some drawbacks, including not being multi-modal. Even though LOS E and F are considered as congested, in urban areas some levels of congestion is considered acceptable. In addition, it is difficult to distinguish from the varying severities of Level of Service "F."

The solution proposed and adopted instead was to choose a whole list of indicators, and apply them where and when relevant. The CMS Task Force reviewed over 100 different performance measures in use or suggested for use by States and localities around the country. This list was then narrowed to a manageable few. Some of the major criteria used to rate the utility of prospective performance measures were the following:

- Had to be clear and understandable.
- Had to be sensitive to modes.
- Had to be sensitive to time.
- Based on readily available data.
- Can be forecast.
- Able to gauge the impact of one or more congestion management strategies.

4.1.5 SELECTED CMP PERFORMANCE MEASURES FROM THE 1994 CMS WORK PLAN

4.1.5.1 Summary List

Following is a list of performance measures selected:⁵

- *Data for Direct Assessment of Current (or future background) Conditions:*
 - Traffic volumes
 - Facility capacity
 - Speed
 - Vehicle density
 - Vehicle classification
 - Vehicle occupancy
 - Transit ridership
 - Accident/Incident data
- *Calculated performance measures/indicators for congestion assessment:*
 - Volume-to-capacity (V/C) ratio
 - Level of Service
 - Person miles of travel/vehicle miles of travel
 - Truck hours of travel
 - Person hours of delay/vehicle hours of delay
 - Modal shares
 - Safety considerations
 - Vehicle trips

⁵ As originally identified in the 1994 CMS Work Plan for the Washington Region.

- Emissions reduction benefits

4.1.5.2 Descriptions of the Performance Measures

Direct Assessment

- *Traffic volumes* – number of vehicles crossing a certain point, usually expressed for an average weekday. This indicator would be applicable in corridors or spot locations, and of interest in the assessment of most CMP strategies.
- *Facility capacity* – Typically for highways, and expressed in terms of the number of passenger car equivalents that can pass over a certain point in an hour, given the geometric characteristics and environment of the highway.
- *Speed* – Defined as the average running speed of motor vehicles traversing a section of roadway. Speed as an indicator is applicable in corridors or spot locations, and is of interest in the assessment of most CMP strategies.
- *Vehicle density* – Described as passenger-car-equivalents per lane per mile. It is of interest for highway-oriented CMP strategies such as traffic operations and HOV facilities.
- *Vehicle classification* – Entails determining the proportion of vehicle traffic type passing a given point. Can be passenger cars, trucks, buses, or other vehicle types. It is applicable to spot locations, and is of interest in the assessment of most CMP strategies.
- *Vehicle occupancy* – average number of persons per motor vehicle for a given location. It is applicable region-wide, or on a corridor or spot basis. Can be used in the comparison of corridors.
- *Transit ridership* – average daily volume of passengers on given transit lines or facilities. It is of interest in the assessment of the following CMP strategies: Transportation Demand Management (TDM), transit, congestion pricing, and growth management.
- *Accident/Incident data* – average number of accidents per million vehicle miles of travel by different facility types. Higher accident rates is an indirect indication of congestion.

Calculated

- *Volume-to-Capacity (V/C) Ratio* – ratio of demand flow rate at a given level of vehicle capacity for a roadway. Calculated from available highway data according to national standards in the Highway Capacity Manual. V/C Ratio was analyzed in the 2008-2030 Plan Performance evaluation.
- *Level of Service* – rating of the quality of service provided by a roadway under a given set of operating conditions. A roadway is classified with a letter “A” through “F” with “A” being the least congestion and “F” being the most congested. For LOS F conditions density/speed is used as an indication of the severity of the F. This performance measure is currently used in the Freeway Monitoring Program.
- *Person Miles of Travel/Vehicle Miles of Travel* – sum of all miles of travel by all vehicles for a given area or facility for a given period of time, factored by the vehicle occupancy to gauge person movement.
- *Modal Shares* – indicate the apportioning of person trips among possible transportation modes: single-occupant vehicle (SOV), high-occupancy vehicle (HOV), transit, non-motorized, or other modes of transportation.
- *Safety Considerations* – include empirical or sketch planning evaluation of safety or hazard issues in a given congestion situation or in consideration of potential congestion management strategies.

- *Vehicle Trips* – number of motor vehicle trips from a given origin to a given destination, which may be stratified by mode purpose, time period, vehicle type, or other classifications.
- *Emissions Reductions Benefits* – reductions in criteria pollutant emissions based on reductions in vehicle miles of travel or vehicle trips. Currently, this performance measure is used when analyzing the TERMS for the region.

Other Performance Measures for Consideration

There are a number of performance measures that would be beneficial to congestion management, but the data availability is too limited for use in the CMP. Some of these include:

- *Bicycle usage and pedestrian counts*
 - Very little data on these have been collected in the region, but would be beneficial in areas such as bicycle and pedestrian planning and growth management.
- *Number of congested intersections*
 - Will give an indication of the extent and severity of congestion. Possible sources include traffic volumes, Data Clearinghouse information, and traffic operations models.
- *Hours per day of congestion*
 - Will directly address the need to gauge the extent of congestion on the transportation system. This indicator is dependent upon having travel volumes by time of day.
- *Percent person miles of travel by congestion level*
 - Will allow comparison of the extent of congestion among CMP locations.
- *Percent delay*
 - The total delay (in minutes) divided by the designated threshold (meaning expected, ideal, or free-flow) travel time. For example, a percent delay of 25% would mean that travel time on a certain segment of the transportation system is taking 25% longer than it would be expected to under non-congested conditions.
- *Average duration of incidents*
 - Could be incidents, special events, infrastructure or equipment failures, or other unusual circumstances that lead to a one-time-only or occasional increase in traveler delay.
- *Truck and freight movement involvement with congestion*
 - Impact of truck and freight movement on congestion. Currently the region does not have much data on hand in this area.
- *Percent of person miles of travel by transit load factor*
 - This is the transit analog of highway congestion as described by Level of Service. Load factor indicates the crowdedness of the transit vehicles, thus providing an overall indication of crowdedness on the portion of the transportation system.
- *Person volume-to-person capacity ratio*
 - Used to develop a Level of Service for transportation corridors by taking the sum of automobile and transit capacities. Levels of service are then determined with reference to volume-to-capacity standards.

4.2 Review of Congestion Management Strategies

4.2.1 INTRODUCTION

Federal regulations state that the CMP should include:

“Identification and evaluation of the anticipated performance and expected benefits of appropriate congestion management strategies that will contribute to the more effective use and improved safety of existing and future transportation systems based on the established performance measures. The following categories of strategies, or combinations of strategies, are some examples of what should be appropriately considered for each area:

- (i) Demand Management measures, including growth management and congestion pricing;*
- (ii) Traffic operational improvements;*
- (iii) Public transportation improvements;*
- (iv) ITS technologies as related to the regional ITS architecture; and*
- (v) Where, necessary, additional system capacity.”⁶*

To address this point, strategy lists have been developed as a way of categorizing congestion management strategies and characterizing the current impact, or potential impact, these strategies have throughout our region.

These lists are modeled after the longstanding Transportation Emission Reduction Measure (TERM) process for air quality in the region. The TERM list was formed as a way of developing additional plan and program elements which could be utilized to mitigate emission increases.

Similarly, lists have been developed for strategies under consideration for Congestion Management. At this time the effort is proposed to be qualitative, as the congestion information is not tied to one specific location. In addition, some strategies are regional while others are local, and a qualitative effort better characterizes the impact they have on the region as a whole.

The following section contains background and summary information of how the Strategy Lists were developed.

4.2.2 DESCRIPTIONS OF STRATEGIES

The general characteristics of strategies are provided in Table 4-2 and Table 4-3; one for operational management strategies (those strategies contributing to a more effective use of existing systems) and one for demand management strategies (those that influence travel behavior). The qualitative criteria across the top of the lists, and the methodology used to categorize each strategy as “some impact (x)”, “significant impact (xx)”, and “high impact (xxx)” are the same for both tables. The separate tables are simply for the purpose of distinguishing the two types of strategies. A more detailed review of the strategies is provided in Appendix G.

⁶ §450.322(d), Metropolitan Transportation Planning, Final Rule, Federal Register, May 27, 2016 – emphasis added.

Table 4-2: Congestion Management Process (CMP) Demand Management Strategies Criteria

		QUALITATIVE CRITERIA									
		Impacts on Congestion									
		Reduces Overall Congestion	Reduces Incident-related Congestion	Supports/Promotes Multi-modal Transportation	Regional Applicability	Local Applicability	Existing Level of Deployment	Ease of Implementation	Cost	Cost Effectiveness	Enhance Existing Programs
STRATEGY											
C.5.0 Alternative Commute Programs											
C.5.1	Carpooling	xxx	x	x	xxx	xxx	xxx	xx	x	xxx	xxx
C.5.2	Ridematching Services	xxx	x	x	xxx	xxx	xxx	xx	x	xxx	xxx
C.5.3	Vanpooling	xxx	x	x	xxx	xx	xx	xx	x	xxx	xxx
C.5.4	Telecommuting	xx	x	x	xxx	xx	xx	xxx	x	xx	xxx
C.5.5	Promote Alternate Modes	xx	x	xxx	xxx	xxx	xxx	xxx	x	xx	xxx
C.5.6	Compressed/flexible work weeks	xx	x	x	xxx	xxx	xxx	xxx	x	x	xx
C.5.7	Employer outreach/mass marketing	xx	x	xxx	xxx	xxx	xx	xx	xx	xx	xxx
C.5.8	Parking cash-out	xx	x	xxx	x	xxx	x	x	xx	xx	x
C.5.9	Alternative Commute Subsidy Program	xx	x	xxx	xxx	xx	xx	x	x	xxx	xxx
C.6.0 Managed Facilities											
C.6.1	HOV	xx	x	xxx	xxx	xx	xx	xx	xxx	xxx	xxx
C.6.2	Variably Priced Lanes (VPL)	xxx	x	xx	xxx	xx	x	x	xxx	xxx	xx
C.6.3	Cordon Pricing	xxx	x	xxx	xxx	x	x	x	xx	xxx	xx
C.6.4	Bridge Tolling	xxx	x	x	xx	xx	x	x	xxx	xx	x
C.7.0 Public Transportation Improvements											
C.7.1	Electronic Payment Systems	xx	x	xxx	xx	xx	xxx	xx	xx	xxx	xx
C.7.2	Improvements/added capacity to regional rail and bus transit	xx	xx	xxx	xx	xxx	xx	x	xxx	xxx	xx
C.7.3	Improving accessibility to multi-modal options	xx	x	xxx	xx	xxx	xx	xx	xx	xx	xxx
C.7.4	Park-and-ride lot improvements	xx	x	xx	xx	xx	xx	xx	xx	xx	xx
C.7.5	Carsharing Programs	xx	x	xxx	xxx	xxx	xx	xxx	xx	xx	xxx
C.8.0 Pedestrian, bicycle, and multi-modal improvements											
C.8.1	Improve pedestrian facilities	xx	x	xxx	xx	xxx	xx	xx	xx	xx	xxx
C.8.2	Creation of new bicycle and pedestrian lanes and facilities	xx	x	xxx	xxx	xxx	xx	xx	xx	xx	xxx
C.8.3	Addition of bicycle racks at public transit stations/stops	x	x	xx	xxx	xxx	xx	xxx	x	x	xxx
C.8.4	Bike sharing programs	xx	x	xxx	xxx	xxx	xx	xxx	xx	xx	xxx
C.9.0 Growth Management											
C.9.1	Coordination of Regional Activity Centers	xx	x	xxx	xxx	xxx	xx	x	xxx	xxx	xx
C.9.2	Implementation of TLC program (i.e. coordination of transportation and land use with local gov'ts)	xx	x	xxx	xxx	xxx	xx	xxx	x	xxx	xxx
C.9.3	"Live Near Your Work" program	xx	x	xx	xxx	xx	x	xx	x	x	xx

- 1. Some Impact (x)
- 2. Significant Impact (xx)
- 3. High Impact (xxx)

Table 4-3: Congestion Management Process (CMP) Operational Management Strategies Criteria

		QUALITATIVE CRITERIA									
		Impacts on Congestion									
		Reduces Overall Congestion	Reduces Incident-related Congestion	Supports/Promotes Multi-modal Transportation	Regional Applicability	Local Applicability	Existing Level of Deployment	Ease of Implementation	Cost	Cost Effectiveness	Enhance Existing Programs
STRATEGY											
C.1.0 Incident Mngt./Non-recurring											
C.1.1	Imaging/Video for surveillance and Detection	xx	xxx	xx	xxx	xxx	xx	xx	xx	xxx	xxx
C.1.2	Service patrols	xx	xxx	x	xxx	xxx	xx	xxx	xx	xxx	xxx
C.1.3	Emergency Mngt. Systems (EMS)	x	xx	x	xx	xxx	xxx	xx	xxx	xxx	xxx
C.1.4	Emergency Vehicle Preemption	x	xx	x	x	xxx	xx	xx	xx	x	xx
C.1.5	Road Weather Management	x	xxx	x	xxx	xxx	xx	xx	xx	xx	xx
C.1.6	Traffic Mngt. Centers (TMCs)	xx	xxx	xx	xxx	xx	xx	xx	xx	xxx	xxx
C.1.7	Curve Speed Warning System	xx	xx	x	x	xx	x	xx	xx	xx	x
C.1.8	Work Zone Management	xx	xxx	x	xx	xxx	xx	xx	xx	xx	xx
C.1.9	Automated truck rollover systems	x	xx	x	x	xx	xx	xx	xx	xx	xx
C.2.0 ITS Technologies											
C.2.1	Advanced Traffic Signal Systems	xxx	xx	xx	xxx	xxx	xx	xx	xxx	xxx	xxx
C.2.2	Electronic Payment Systems	xxx	x	xx	xxx	xx	xx	xx	xx	xxx	xx
C.2.3	Freeway Ramp Metering	xx	x	x	xx	xx	x	xx	xx	xx	xx
C.2.4	Bus Priority Systems	x	x	xxx	xxx	xxx	x	xx	xxx	xx	xx
C.2.5	Lane Management (e.g. Variable Speed Limits)	xx	xx	x	xx	xxx	x	xx	xx	xx	xx
C.2.6	Automated Enforcement (e.g. red light cameras)	x	x	x	x	xxx	xx	xx	xx	xx	xx
C.2.7	Traffic signal timing	xxx	x	xx	xxx	xxx	xx	xxx	x	xxx	xxx
C.2.8	Reversible Lanes	xx	x	x	xx	xxx	x	x	xx	xx	xx
C.2.9	Parking Management Systems	xx	x	xx	xx	xxx	x	x	xxx	xx	xx
C.2.10	Dynamic Routing/Scheduling	xx	x	xx	xxx	xxx	x	x	xxx	xx	xx
C.2.11	Service Coordination and Fleet Mngt. (e.g. buses and trains sharing real-time information)	xx	x	xxx	xxx	xxx	x	x	xx	xx	xx
C.2.12	Probe Traffic Monitoring	xx	xxx	x	xx	xx	x	xx	xx	xxx	xx
C.3.0 Advanced Traveler Information Systems											
C.3.1	511	xx	xxx	xx	xxx	x	xx	xx	xxx	xx	xxx
C.3.2	Variable Message Signs (VMS)	xx	xxx	xx	xx	xxx	xx	xx	xx	xxx	xxx
C.3.3	Highway Advisory Radio (HAR)	x	xx	x	xx	xxx	xx	xxx	xx	x	xx
C.3.4	Transit Information Systems	xx	xx	xxx	xx	xxx	xx	x	xx	xx	xxx
C.4.0 Traffic Engineering Improvements											
C.4.1	Safety Improvements	x	xxx	x	x	xxx	xx	xxx	x	xxx	xxx
C.4.2	Turn Lanes	xx	x	x	x	xxx	xx	xx	xx	xx	x
C.4.3	Roundabouts	x	xx	x	x	xxx	x	x	x	xx	xx

- 1. Some Impact (x)
- 2. Significant Impact (xx)
- 3. High Impact (xxx)

4.3 Examples of Strategies Studies

4.3.1 ANALYSIS OF TRANSPORTATION EMISSIONS REDUCTION MEASURES (TERMs)

4.3.1.1 Overview

Transportation Emission Reduction Measures (TERMs) are strategies or actions employed to offset increases in nitrogen oxide (NO_x) and volatile organic compound (VOC) emissions from mobile sources. The TPB has been adopting TERMs since FY 1995.

The Clean Air Act Amendments of 1990 (CAAA) and SAFETEA-LU requires metropolitan planning organizations and DOTs to perform air quality analyses, to ensure that the transportation plan and program conform to mobile emission budget established in the State Implementation Plans (SIP). Consequently MPOs and DOTs are required to identify TERMs that would provide emission-reduction benefits and other measures intended to modify motor vehicle use.

Selection of the TERMs requires quantitative as well as qualitative assessment. The quantitative assessment includes specific information on the benefits, costs, and expected air-quality benefits. Qualitative criteria includes ranking based on the subjective criteria's such as ease of implementation, how to implement, and synergy with other measures.

The effects of TERMs on GHG reduction in the Washington region were analyzed in the "What Would It Take" Scenario Study (see Section 4.3.3).

4.3.1.2 Findings and Applications to Congestion Management

Most TERMs are intended to reduce either the number of vehicle trips (VT), vehicle miles traveled (VMT), or both. These strategies may include ridesharing and telecommuting programs, improved transit and bicycling facilities, clean fuel vehicle programs or other possible actions. These TERMs are not only important to offsetting increases in NO_x and VOC, but many are important in congestion management by reducing trips and miles of travel.

The Washington region has adopted and implemented several TERMs with the sole aim of reducing emissions, such as the addition of clean diesel bus service, taxicabs with Compressed Natural Gas (CNG) cabs, and CNG buses. However, many TERMs also have an impact on congestion management. Examples of some of these congestion-mitigating TERMs that have been implemented included upgrading traffic signal systems, telecommuting programs, park-and-ride lots, and pedestrian facilities.

4.3.2 SCENARIO PLANNING

4.3.2.1 "CLRP Aspirations" Scenario

Presented in 2013, the "CLRP Aspirations" scenario was an integrated future land use and transportation scenario for building on the key results of previous TPB scenario studies. It included concentrated land use growth in Regional Activity Centers, a regional network of variably priced lanes, and a high quality bus rapid transit network operating on the VPL network for the current planning horizon year 2040. Relative to the 2012 CLRP baseline for 2040, the full CLRP Aspirations Scenario showed increases in trips of all modes (auto person trips, transit trips, and non-motorized trips) due to the increase in population, both auto and transit capacity, and shifts in land use that

enable more non-motorized trips. The Scenario showed a slight decrease in VMT, a decrease in VMT per capita, and a significant decrease in regional vehicle-hours of delay. ⁷

4.3.2.2 “What Would It Take?” Scenario

Completed in May 2010, the "What Would It Take?" scenario started with the adopted COG non-sector specific goals for reducing mobile source greenhouse gas emissions for 2030 and beyond. It assesses how such goals might be achieved in the transportation sector through different combinations of interventions that include increasing fuel efficiency, reducing the carbon-intensity of fuel, and improving travel efficiency. The study found that:

- Strategies analyzed to date do not achieve regional goals of reducing greenhouse gas emissions, and additional strategies can and should be analyzed.
- Goals are difficult to meet and will require emission reductions in all three categories: Vehicle efficiency (CAFE improvement), alternative fuel (cellulosic ethanol), and travel efficiency (strategies aimed at reducing VMT, congestion, and delays).
- While major reductions can come from federal energy policies, local governments can make significant reductions quickly.
- Some strategies may not have major greenhouse gas (GHG) reduction potential, but have multiple benefits worth exploring through benefit-cost analysis (e.g. the MATOC program).

The study also recommended nine potential local actions that can be implemented quickly to reduce GHG.

4.3.2.3. Multi-Sector Working Group

This group comprised senior staff from transportation, planning, and environment sectors of COG member agencies including state departments of transportation. A consultant studied effective strategies to reduce greenhouse gases from the transportation, land use and built environment sectors. Many of the strategies studied had the added benefit of reducing vehicle trips and vehicle miles of travel affecting congestion positively. This was a study under the direction of the COG Board of Directors and the January 2016 Technical Report on Multi-Sector Approach to Reducing Greenhouse Gas Emissions in the Metropolitan Washington Region was published.⁸

4.3.2.4. Long-Range Plan Task Force

In 2016 and 2017, TPB formed this task force to identify a limited set of regionally significant projects, programs, and policies above and beyond what is in the region's current long-range transportation plan. The Task Force and supporting consultants identified and analyzed a number of long-range planning strategies, many of which could address congestion. Following the Task Force's work, Seven Endorsed Initiatives were included in Visualize 2045 planning.⁹

⁷Kirby, R. *Briefing on Update to the CLRP Aspirations Scenario*. Presentation to the National Capital Region Transportation Planning Board, April 17, 2013.

<https://www.mwcog.org/file.aspx?A=BYqX%2FYRjw4QJXyVrhayXQ0lqev7TBuWvru6hN30lc9Y%3D>

⁸ <https://www.mwcog.org/documents/2016/08/01/multi-sector-approach-to-reducing-greenhouse-gas-emissions-in-the-metropolitan-washington-region-final-technical-report/>

⁹ <http://mwcog.maps.arcgis.com/apps/Cascade/index.html?appid=debc2550777b4cc2bae2364c7712a151>

4.3.3 MATOC BENEFIT-COST ANALYSIS

The Metropolitan Area Transportation Operations Coordination (MATOC) Program is a joint program of VDOT, MDOT, DDOT, WMATA and TPB. It aims to provide real-time situational awareness of transportation operations in the National Capital Region (NCR), especially during emergencies and other incidents with significant impacts on travelers and on the transportation systems of the region.

A benefit-cost study has been carried out to quantify the effectiveness of this program which shows a \$ 10 benefit for every \$ 1 spent on the program.

4.3.4 MOITS STRATEGIC PLAN

The Management, Operations, and Intelligent Transportation Systems program (MOITS – since renamed Systems Performance, Operations, and Technology [SPOTS] program) of the TPB developed a strategic plan for the program dated June 16, 2010 and the plan is available on MWCOC website.¹⁰ The Strategic Plan defined and promoted potential regional projects or activities for the management, operations, and application of advanced technology for the region’s transportation systems, as well as to advise member agencies on management, operations, and transportation technology deployments for meeting common regional goals and objectives.

The MOITS Strategic Plan built upon the TPB Vision by identifying four key tactical actions toward achieving and building upon the goals, objectives, and strategies of the Vision. It identifies nine emphasis areas derived from the National ITS Architecture, seven proposed projects out of which three have been implemented, and two are in the planning stage three strategic efforts out of which two are being considered for implementation, and a number of “best practices” for consideration by the member agencies and jurisdictions. The Plan also recommended use of a few key performance measures, including travel time index, buffer time index and planning time index, which are already used in this CMP Technical Report. The Strategic Plan concluded with seven key recommendations for the MOITS Technical Subcommittee and Program.

¹⁰ <http://www1.mwcog.org/transportation/activities/operations/plan/MOITS-Strategic-Plan-Executive-Summary-2010-06-16.pdf>