



***2006 Update of the Congestion Management
Process Procedures***

Adopted: November 16, 2006.

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1. Introduction

The New York Metropolitan Transportation Council (NYMTC) is a regional council of governments which serves as the Metropolitan Planning Organization (MPO) designated by the Governor of the State of New York and certified by the Federal government for New York City, Long Island, and Lower Hudson Valley (Figure 1). NYMTC's jurisdiction includes an area of approximately 2,440 square miles with a population approaching 13 million people. The region has one of the most extensive transportation networks in the world, with 477 miles of commuter rail, 225 miles of rail rapid transit, 22,806 centerline miles of roadways, as well as several commercial airports and maritime facilities for passengers and goods.

Figure 1 – NYMTC Region



The roadway network in the NYMTC region is vital to the movement of people and goods, and the functioning of the region's economy. Roughly seventy percent of the New York metropolitan region's 4.9 million daily commuters travel on modes that rely on the roadway network: 53% in cars, trucks, vans, or taxis; 8% on buses; and 8% on foot.ⁱ Further, nearly all freight east of the Hudson River is moved by trucks on the roadway network. However, despite its extensive multi-modal transportation system, recent studies by the Texas Institute of Transportation indicate that the New York metropolitan area experiences nearly 400 million total person-hours of delay, second in the country only to the Los Angeles metropolitan area in total delay.ⁱⁱ

With a population that far exceeds the minimum threshold of 200,000 that is specified in federal planning regulations, the NYMTC region is a federally-designated Transportation Management Area (TMA). As a TMA, NYMTC is required by federal regulations (23 CFR 500.109) to develop and implement a regional Congestion Management Process (CMP) as an integral part of its ongoing regional planning process.

In addition, other federal regulations (23 CFR 450.320) link air quality planning with the CMP; stating: “In TMAs designated as non-attainment for ozone or carbon monoxide, federal funds may not be programmed for any project that will result in a significant increase in carrying capacity for single occupancy vehicles...unless the project results from a Congestion Management Process.”

Although Federal transportation legislation has mandated the assessment and management of available roadway capacity through a CMP in TMAs before new roadway capacity can be added to the network, MPOs are given a good deal of flexibility in establishing their CMP procedures. Hence each MPO has customized their approach to their CMP. This document explains the procedures that NYMTC utilizes in implementing its CMP. The procedures explained here are intended to integrate the CMP into NYMTC’s existing planning activities. This document also describes additional data needs and performance measures that might be considered for inclusion in the CMP in the future. The NYMTC’s CMP provides the means to measure current and forecasted roadway congestion conditions and provides the tools to identify and evaluate strategies to address regional congestion problems.

2. What is a CMP?

The Federal Highway Administration (FHWA) defines roadway congestion in the following manner:

Congestion is the level at which transportation system performance is no longer acceptable due to traffic interference. The level of system performance deemed acceptable by State and local officials may vary by type of transportation facility, geographic location (metropolitan area or subarea, rural area) and/or time of day.”ⁱⁱⁱ

The CMP is a systematic planning process for measuring, reporting and managing roadway congestion on a region-wide basis. As defined in federal regulation, “an effective CMP is a systematic process for managing congestion that provides information on system performance and on alternative strategies for alleviating congestion and enhancing the mobility of persons and goods to levels that meet State and local need.”⁴ A region which is a TMA must establish a viable CMP before Federal funds can be used to increase the Single Occupancy Vehicle (SOV) capacity of the roadway system.

A CMP is one component of a larger regional planning process, and it is important to describe its role within the overall system. A well-defined CMP is not a replacement for existing planning procedures, and congestion is not the only factor under consideration when planning the priority of transportation improvements. The proper role of the CMP is as a specific element that adds

value to the planning process by providing agencies, the public and decision-makers with a tool by which congestion can be examined in greater detail and more effectively addressed.

Since NYMTC's region is a TMA which does not currently attain specific air quality standards, additional federal requirements apply to the CMP, including:

- All reasonable, multi-modal Transportation Demand Management (TDM)/Operations and Supply Management (OSM) strategies must be analyzed in corridors where roadway capacity increase is proposed.
- If the analysis demonstrates that the TDM/OSM strategies cannot offset the need for additional capacity, the CMP shall identify all reasonable strategies for managing the SOV facility effectively.
- All TDM/OSM strategies identified in the CMP shall be incorporated into SOV projects or committed to by the State and the MPO.
- Federal funds may not be programmed in a non-attainment TMA for any roadway or SOV project unless based on an approved CMP.

The FHWA recommends the following seven key components for an effective CMP:

- 1) *Area of Application* – the CMP must cover a well-defined area
- 2) *System Definition* – the CMP must define the transportation network that will be analyzed
- 3) *Performance Measures* – the CMP must define the metrics by which it will measure congestion (for example, vehicle hours of delay or average speed)
- 4) *Performance Monitoring Plan* – there must be a regularly scheduled plan for examining the transportation network and evaluating the status of congestion
- 5) *Identification and Evaluation of Strategies* – there must be a systematic program, or toolbox, for selecting congestion mitigation strategies and evaluating potential benefits
- 6) *Monitoring Strategy Effectiveness* – the strategies must be monitored to assure positive benefits
- 7) *Implementation and Management* – there must be a plan for implementing the CMP as part of the regional transportation planning process

As shown both in this document and in the NYMTC's 2005 CMS Status Report, NYMTC's CMP includes all of these critical elements.

3. Goals and Components of the CMP

NYMTC's CMP is a systematic process for planning to address regional congestion by exploring the basic questions of where, when, and to what extent congestion occurs. The CMP also identifies and evaluates strategies that can be considered by NYMTC's members for reducing and managing congestion.

The overall goal of the CMP is to reduce growth of future SOV trips, particularly during peak travel periods. Consistent with the goals of NYMTC's 2005-2030 Regional Transportation Plan, the CMP is intended to:

- Improve the mobility of people and goods by reducing vehicle hours of delay and person hours of delay;
- Improve the reliability and convenience of the transportation system, ensuring ease of use, acceptable travel times and reasonable costs;
- Manage the transportation system efficiently to accommodate existing and anticipated demand for movement of people and goods; and,
- Provide information on system performance and alternative strategies for alleviating congestion.

In order to accomplish these goals, NYMTC's CMP has been designed to provide:

- Performance measures for measuring regional levels of delay and congestion;
- A database for measuring changes in the regional traffic conditions;
- Computerized highway and transit networks that can be used for simulating regional travel patterns, for estimating regional congestion, and for displaying the results on Geographic Information System (GIS) maps;
- A status report on congestion in the region that is provided as part of the update of NYMTC's Regional Transportation Plan;
- Forecasts of future congestion levels based upon the latest regional population and employment forecasts;
- Procedures for evaluating, at a regional level, strategies for reducing and managing congestion; and,
- Procedures for assessing the most effective strategies through NYMTC's Unified Planning Work Program and advancing them to implementation via the Transportation Improvement Program.

As explained in the following sections, the CMP has been designed to make use of the Best Practice Model (BPM), NYMTC's transportation simulation model, for traffic and delay simulations, and to integrate the findings of the CMP into NYMTC's metropolitan transportation planning process.

4. Relationship of CMP to the Planning Process

The CMP procedures closely integrate the CMP with the metropolitan transportation planning process, as illustrated in Figure 2. The CMP is integrated into the planning process as part of the development of the following regional planning and programming documents:

- The Regional Transportation Plan (Plan)– which defines the region’s transportation needs and lays out a long range planning framework for improving the transportation system over a minimum of a twenty-year period
- The Transportation Improvement Program (TIP) – which is a five-year program of all proposed federally funded transportation projects in the NYMTC region, and
- The Unified Planning Work Program (Work Program)– which defines NYMTC’s short term (1-2 years) planning priorities

As shown in Figure 2, the CMP involves the direct participation of NYMTC’s member agencies. At the regional level, the BPM is used as the principal tool for estimating the extent of existing congestion, forecasting the level of future congestion, and evaluating mitigation strategies within the CMP. At the project level, other appropriate planning tools are also utilized to meet CMP requirements. The CMP utilizes a series of analytical tools, consisting of the BPM, the Post Processor for Air Quality (PPAQ), the Post Processor for Congestion Management Processes (PPCMP), and the Performance Queries for Surface Transportation (PEQUEST) to forecast and analyze travel in the NYMTC region. Those projects or programs that cannot be evaluated using the BPM are assessed with other techniques to estimate their effect on congestion; these are known as “off-model” analyses and are used for projects such as programs to increase telecommuting. The modeling process applied to the CMP is described in more detail in Section 6.

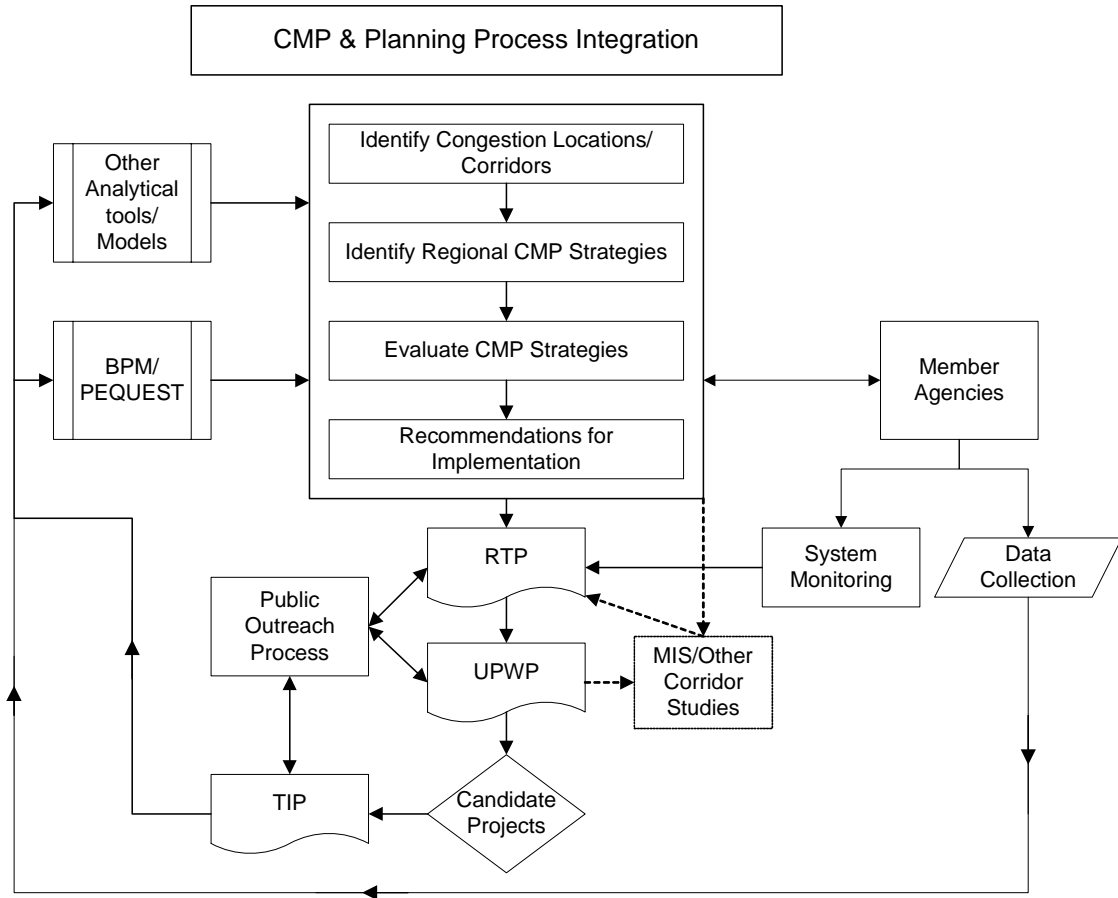
For selected congestion locations, the CMP provides a toolbox of strategies to address congestion for consideration by the member agencies. The member agencies propose mitigation projects utilizing the feasible strategies identified through the CMP. This process is repeated every planning cycle, or as needed by the members. Thus, it is both an interactive and iterative process.

System monitoring and data collection are also critical elements of the integration of CMP into NYMTC’s overall planning process. Monitoring and data collection efforts provide feedback on the effectiveness of strategies at various levels, which ultimately influences regional policy, planning, and programming of projects for addressing congestion.

The CMP can also influence the development of major project analyses and corridor or areawide studies in two ways. First, it provides system performance information which may be used to identify corridors or segments for detailed analysis. Second, the CMP toolbox identifies alternative congestion management strategies for consideration in studies of this type, which ultimately define transportation improvements. When traffic congestion is referenced in the Purpose and Need statement of a study, the study should consider congestion management strategies included in the CMP as a starting point for the development of alternative strategies.

This does not preclude the study from considering other strategies that may not be in the CMP, nor does it require that the study select a strategy from the CMP as the preferred alternative.

Figure 2



5. Performance Measures

Performance measures are the foundation stones of a CMP. They are established to quantify levels of congestion and to provide analytical framework by which congestion trends can be determined. Transportation system performance is a subjective as well as objective concept, so it is essential that it is measured and presented in a way that the public can readily understand.

The basic criteria for CMP performance measures were outlined in FHWA's 1990 National Urban Congestion Management Report (Pisarski, 1990). The report suggests that congestion measures should be:

- Credible, and intuitively accepted as a reasonable expression of the problem,
- Easily defined; to permit uniform interpretation,
- Feasible to collect, within the reasonable range of activities of the participating agencies, and
- Cost and labor sensitive, reflecting the realities of the skills and resources available to the MPO and participating agencies.

Table 1 illustrates typical performance measures used in CMP evaluation along with a brief description of the data required.

Selected Performance Measures

The following eight performance measures are utilized by NYMTC in its CMP. These performance measures can be calculated from available data already calculated in the planning process, therefore eliminating the expense of collecting new data. These measures will provide a wide assessment of the key components of congestion:

Primary Performance Measures:

I. Demand-to-Capacity (D/C) Ratio is a measure that reflects the level of mobility and the quality of travel of a roadway facility or a section of a roadway facility. It compares the roadway capacity with the number of vehicles that desire to travel past a point during a specified period. The capacity of a roadway segment is defined as the theoretical maximum volume that can be processed by that segment during a specified time period. Capacity is a function of several factors including number of lanes and lane width, signalization, parking characteristics, geometric characteristics, terrain, etc.

TABLE 1**PERFORMANCE MEASURES & DATA SPECIFICATIONS**

Performance Measures	Data Specifications
Demand / Capacity Ratio	Estimated Trip demand based on Travel Demand Model, Socio-economic data, Roadway Capacity,
Volume / Capacity Ratio	AADT, Roadway Geometry, Peak Hour Volume, Roadway Capacity
Level of Service	Peak Hour Volume, Length of Roadway,
Vehicle Hours-Delay	Length of Roadway, Peak Hour Average Speed
Person Hours-Delay	Vehicle Occupancy, Peak Hour Average Speed, Length of Roadway
Travel Time Index/Rate	Free flow Travel Time, Peak Period Travel Time, Roadway Length, Free Flow Speed, Congested Speed
Vehicle Density/Lane Miles of Congestion	Roadway Capacity, Roadway Volume, Roadway Length
Highway Mobility Index	Roadway Length, Free Flow Travel Speed, Peak Hour Travel Speed, Vehicle Delay
% Travel Time in Congestion/Atypical Congestion	Free Flow Travel Time, Actual Travel Time
Accessibility Index	Percentage of population within x minutes of y percent of employment sites
Travel Speed	Free Flow Travel Speed, Peak Hour Travel Speed, Roadway Length
PMT by Speed	Peak Hour Volume, Length of Roadway, Vehicle Occupancy, Free Flow Travel Speed, Peak Hour Travel Speed
Vehicle Miles Traveled	Peak Hour Volume, Length of Roadways
Vehicle Hours Traveled	Peak Hour Volume, Length of Roadways, Average Peak Hour Speed
Person Miles Traveled	Vehicle Occupancy, Length of Roadways, Peak Hour Volume
Person Hours Traveled	Vehicle Occupancy, Peak Hour Volume, Length of Roadways, Average Peak Hour Speed
Transit Mobility Index / Transit System Measures	Transit System Breakdown, Transit Utilization Rate, Transit Capacity
Walk / Bike Mobility Index	Inventory of Bicycle and Pedestrian Facility,
Average Vehicle Occupancy	Vehicle Occupancy, Roadway Length, Peak Hour Volume
Intermodality Index / Mode Shares	Park & Ride Capacity, Transit Lots Capacity,
Freight Delay (Truck & Rail)	Freight System Breakdown, Freight System Capacity, Freight System Roadway Length, Free Flow Travel Speed, Peak Hour Travel Speed
Incident Measures	Roadway Congestion due to Incidents, Incidents types,
Environmental Measures	Emission Density, Length of Roadway
Excess Fuel Consumption	Free Flow Vehicle Fuel Usage, Peak Hour Vehicle Fuel Usage
Safety / Accidents (Property Damage / Injuries / Fatalities)	Peak Hour Recorded Number of Accidents, Length of Roadway, Type of Accident
Economic Development	Jobs Created, New Housing Starts, Economic Cost of Lost Travel Time

It should be noted that the D/C ratio is different from the Volume-to-Capacity (V/C) ratio which is typically used in a CMP. The volume on a roadway is the total number of vehicles, including passenger vehicles, trucks, and buses, using that facility during a particular time period. Existing volumes can be determined by conducting manual and automated traffic counts. However, under saturated flow conditions (i.e., severe congestion and stop-and-go traffic), when volumes are at or exceeding the theoretical capacity of the roadway, field counts do not reflect the actual trip demand and do not provide reliable information about the intensity of congestion. Because actual demand could be higher than the traffic volume being processed under these conditions, the D/C ratio is the better statistic to be used to define congestion, since it allows estimation of congestion based on travel demand.

By definition, a roadway where the demand is at or near capacity is considered to be congested. Typically, a D/C ratio of 0.8 (i.e., 80% of the roadway's capacity) can be considered the start of moderate congestion. As the D/C ratio approaches 1.0, the segment will experience severe congestion conditions resulting in significant delays.

PEQUEST calculates D/C ratios and speeds by first determining the vehicle-moving capacity of a roadway link using *Highway Capacity Manual* standards, based on facility type, area type and number of lanes. The forecasted demand from the BPM, adjusted to reflect time of day variation, is loaded onto the link, and an initial D/C ratio is calculated. If control devices such as traffic signals are present, supplemental analysis is performed using the signalized and unsignalized intersection procedures from the *Highway Capacity Manual*. If the D/C ratio is greater than approximately 1.2 for a specified hour, PEQUEST also employs an algorithm to distribute trips to "shoulder hours" before or after the peak travel hour. Speeds are then calculated using the D/C ratios and other link attributes.

PEQUEST utilizes a complex technique to calculate the average D/C ratios for roadway links over a four-hour 6 am – 10 am weekday peak period. This process is controlled by four factors: the link D/C threshold, the intersection D/C threshold, the peak period width, and the disposition of over-capacity demand.

Performance Measure: D/C ratio for the 6am – 10 am weekday period

Data Required:

- Peak period traffic counts
- Length of Roadway
- Location of roadway segment (to and from)
- Number of lanes in each direction
- Lane capacity for vehicles and total capacity for vehicles per hour

Performance Standard:

<u>D/C Ratio</u>	<u>Congestion Level</u>
< 0.8	Uncongested
0.8 – 1.0	Congested
> 1.0	Severely Congested

II. Vehicle Hours of Delay (VHD) is a common measure of congestion on roadways. VHD is the sum total of delay experienced by all vehicles on the network. Delay can be thought of as the difference between estimated actual travel speed and free flow travel speed (i.e., travel speed in the absence of congestion), and is therefore a measure that is readily understood by the traveling public.

Performance Measures: Total VHD for the 6am – 10 am weekday period

Data Required:

- Length of roadways
- Free flow speed on roadways
- Average speed on each of the roadways during the peak period
- Posted speed limits on roadways

Performance Standard:

VHD is calculated on a county-wide or borough-wide basis, summed for all roadway links of each facility type

III. Person Hours of Delay (PHD) is calculated by multiplying VHD by the average vehicle occupancy rate (rates of 1.48 was used for New York City, 1.75 For Nassau and Suffolk counties; and 1.44 for Westchester, Rockland, and Putnam counties) in order to estimate the delay experienced by individual people.

Performance Measure: Total PHD for the 6am – 10 am weekday period

Data Required:

- Length of roadways
- Free flow speed on roadways
- Average speed on each of the roadways during the peak hour
- Average auto occupancy by roadway by county

Performance Standard:

PHD is calculated on a county-wide or borough-wide basis, summed for all links of each facility type for the 6am -10am weekday period. PHD is currently calculated by using county-level occupancy factors developed from the vehicle occupancy survey conducted by National Household Travel Survey conducted by U.S. Department of Energy in 2001. These factors are an average for the entire day; in future reports this will be replaced by specific peak-period factors once this data becomes available.

Secondary Performance Measures:

I. Vehicle Miles Traveled (VMT) is the sum of distances traveled by all motor vehicles in a specified region. The BPM is used to generate estimates of the average trip lengths for vehicles in the region. The average trip length measure can then be used in estimating vehicle miles of travel, which in turn is used in estimating gasoline usage or mobile source emissions of air pollutants.

II. Average Travel Speed is the calculation of a weighted average of speed. The average speed for each element of the road system is multiplied by the amount of travel on that system. Using the amount of travel as a weighting factor provides a way to get an average “system experience” of travelers for each portion of the road system. This fundamental concept is used in the Urban Mobility Study methodology. The average speed is calculated by the following formula:

$$\text{Average Speed (mph)} = \frac{\text{Average Freeway Speed} \left(\frac{\text{Freeway}}{\text{VMT}} \right) \div \text{Average Arterial Speed} \left(\frac{\text{Arterial}}{\text{VMT}} \right)}{\text{Freeway VMT} + \text{Arterial VMT}}$$

III. Lane-Miles of Congestion is a measure that reflects the level of mobility provided by a roadway or a section of a roadway. It indicates the road space that functions at less than free-flow speeds during the peak. It compares actual roadway volume with maximum acceptable volume for that roadway. A roadway is defined as congested if the annual average daily traffic (AADT) volume is equal to or greater than 85 percent of the maximum acceptable volume for that roadway.

IV. Travel Time Index (TTI) is the ratio of peak period to free-flow travel times, considering only recurring delays. For example, a TTI of 1.5 for a specific route indicates that if the free-flow time on that route is 30 minutes, the travel time during peak congestion is 45 minutes.

6. Measuring and Forecasting Congestion

NYMTC’s modeling tools used to measure current and future congestion in the region include a regional network-based simulation model, the BPM, and three post processors for congestion analysis; PPAQ, PPCMP, and PEQUEST. The application of these models in the CMP is described below.

- ***The Best Practice Model (BPM)***

The BPM is a network-based transportation simulation model. It covers 28 contiguous counties in the New York – New Jersey – Connecticut metropolitan area. It is comprised of a set of journey- based travel demand forecasting models. The BPM uses GIS-based highway and transit networks to simulate the transportation system. The highway network has 53,000 roadway links containing all minor arterial roadways and those of higher classifications. The transit network contains 2,756 route variations coded that encompass commuter rail, subway, express bus, local bus, and ferry routes. The region simulated in the BPM is divided into 3,586 transportation analyses zones.

A large amount of data was collected to develop the base year BPM, including:

- NYMTC Household Interview Survey, which is a 24-hour activity based survey for 11,000 thousand households in the region,

- Population, Household, and Employment data by the Transportation Analyses Zones,
- Traffic counts from over 2,200 locations,
- Transit ridership data on all transit services in the region, and
- Travel time data.

The BPM first generates total number of trips that are produced by and attracted to each transportation analysis zone based on the socio-economic characteristics of each household in the zone and employment opportunities in the zone. Then the trips are fed into the mode choice/destination models that produce trips for each origin/destination pair of transportation analysis zone by travel mode, trip purpose, and time of the day. The trips are then assigned to the highway network to produce estimates of traffic flow and roadway link-level delays.

- ***Post Processors***

The post processors (PPAQ, PPCMP and PEQUEST) are flexible software system used to further process trip information generated by the BPM and calculate congestion, emissions of various pollutants and system performance reporting capabilities for both general operational analysis and for emissions analysis. These systems provide an effective means of analyzing improvements to the transportation system and their impacts on congestion that can not be accurately represented in the BPM.

The Transportation Simulation Modeling Process

The modeling process begins by running highway assignments with the Best Practice Model to produce output that include initial speeds, volumes, and other data. These data serve as the primary input into the post processors, which adjusts the initial volumes and speeds calculated by the BPM to account for the impacts of traffic signals and other adjustments. They then use the congested speeds and delays to determine the amount of person travel for each roadway link and to estimate the amount of non-recurring congestion that occurs. Non-recurring congestion includes delays due to accidents or other incidents, and is a major contributor to delay, impacting congested speeds and air pollution. By including these delays in the speed calculations, the post processors allow for more accurate representation of the transportation system and provide the opportunity to analyze transportation improvement projects that might impact incident response times in the future. The final step in the process is to calculate Level of Service (LOS) and other performance measures and to generate reports summarizing the network performance measures.

The overall process for generating and evaluating CMP performance measures using the BPM and PEQUEST is shown in Figure 3.

CMP Performance Measures and BPM

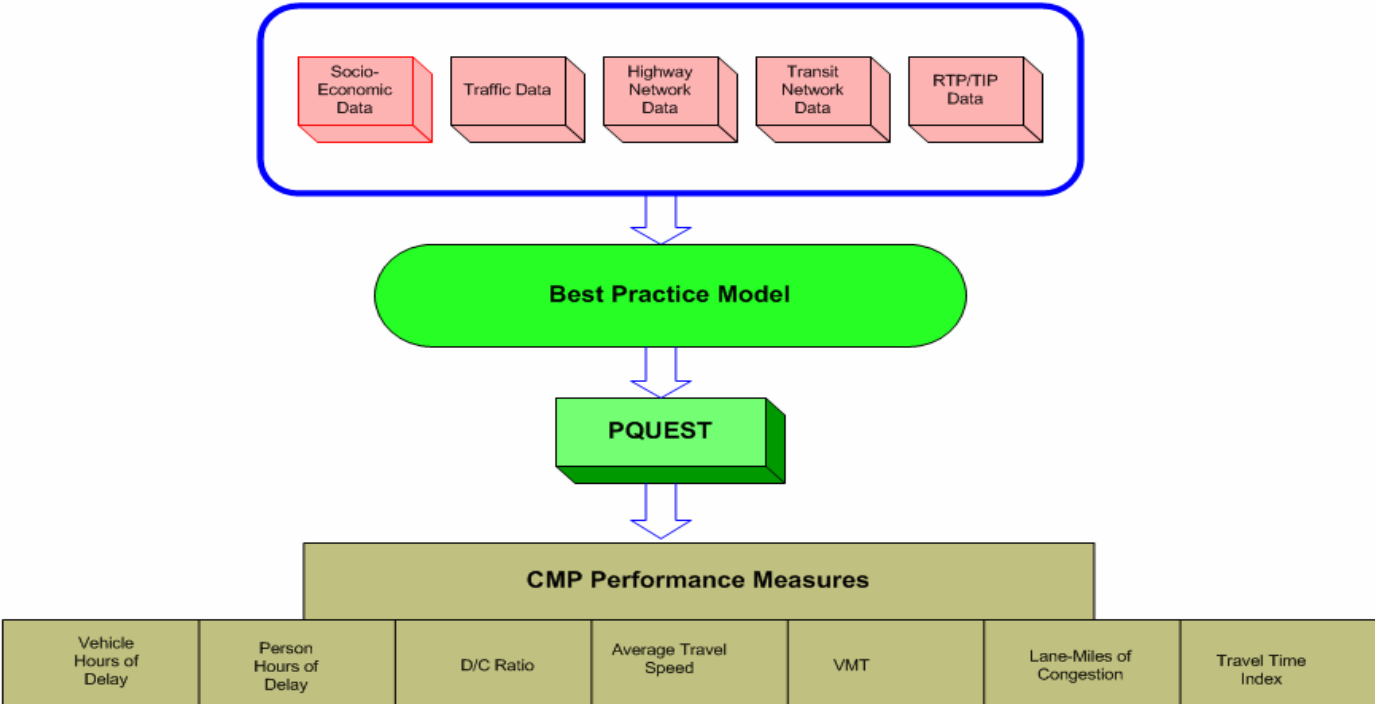


Figure 3: CMP Performance Measures and BPM

7. Required Data

NYMTC's CMP is built upon large databases that describe the region, its socioeconomic/demographic patterns, its travel patterns, and its transportation system, both currently and in the future

A. *Regional Travel Patterns*

Travel patterns in the NYMTC region are always changing. While this usually means that vehicular volumes are growing, growth rates can vary by location and time of day. To monitor these changing conditions, vehicular counts are collected for roadway links represented in the BPM on a three year cycle.

- **Traffic Counts** – Traffic counts are needed to monitor the changes in vehicular volume over time and to recalibrate the BPM traffic assignments. Counts are taken at over 2,200 locations around the NYMTC 10-county region. Traffic counts are compared to the modeled vehicular volumes for all links on that same border to determine if the modeled volumes are reasonable. The collection of traffic data is organized and standardized by NYMTC's measures. Counts are conducted for a minimum of 72 hours, to assure adequate statistical sampling.
- **Vehicle Occupancy Rates** – Vehicle Occupancy Rates are used to calculate Person Hours of Delay. This data will primarily be collected for major arterials and will include statistical sampling of vehicle occupancy rates during peak and off peak periods in addition to daily rates.
- **Vehicle Speed** – Actual vehicular speeds are sampled along the major corridors. This data is used to calibrate the BPM speed estimates. Sampling is conducted on 26 routes over 5 time periods (AM, Midday, PM, Evening, and Night). In the future, NYMTC will supplement these data using the TRANSMIT project on regular basis to calibrate and update the BPM every three years. NYMTC and its member agencies may also utilize speed data collected by Traffic Management Centers through ITS equipments/sensors and also collect speed data using GPS based equipments on arterial not covered by ITS system to supplement ITS data.
- **Transit Services** – Transit service data is needed to recalibrate the BPM making sure the model's multi-modal choice models are still adequate. This data is stored in GIS files attached to the BPM transit networks. A plan will be developed to collect the transit data from all private and public operators. Building. Examples of data items include:
 - Routes or line changes
 - Schedules
 - Station and stop boarding/alighting counts,
 - Line ridership reports, and
 - Estimates of dwell time at high volume stations or bus stops.

Any data available in regular reporting mechanisms (such as the FTA Section 15 Reports) will also be used to achieve proper ongoing data coverage for CMP analysis.

- **Commodity Flows**- Data will be describing the flow of freight in the region. While the focus of the CMP will primarily be truck movements, the overall freight database will also include commodity-flow data. The BPM also produces a truck and commercial vehicle trip table, which distributes trips from each origin to all the destinations in the 28 counties of New York, New Jersey, and Connecticut. As more data becomes available, the models will be enhanced so that truck delays can be estimated and forecasted in future.

B. Regional Transportation Network

The regions' highways and transit networks are represented in the BPM in the BPM and must also be maintained to accurately represent the current and future transportation system.

- **Highway Network** - the BPM highway network is GIS-based and includes all minor arterials and higher classifications of roadway facilities. There are about 53,000 links in the highway network and 3,600 transportation analysis zones (TAZs). The network links include attributes such as number of lanes, functional class, capacity, free flow speeds, high-occupancy vehicle lanes, tolls, signals per mile, and parking restrictions by time of the day. Truck routes are also coded in the network. The networks will be maintained to reflect the accuracy of the physical attributes of the actual network
- **Transit Network** – The BPM transit networks cover 28 counties in the tri-state region. The transit networks include all modes: commuter rail, subway, bus (local, limited and express) and ferry routes. There are 2,756 transit routes coded in the network, representing services provided by both the private and public operators. For each route, information on the number of stops or stations, service frequency, travel times, and access limitations are stored in the GIS database. The transit network also contains data on park-and-ride access to transit.

C. Regional Socio-Economic/Demographic Patterns

The BPM assigns trips to the highway and transit network based on 3,600 TAZs which simulate the generation and attraction of travel across the region. Socio-economic and geographical data are used to accurately calculate these TAZs

- **Current Conditions** – NYMTC collects and maintains a large amount of socio-economic data (SED) for thirty one counties in and around the NYMTC region. The SED is disaggregated by TAZs and is an important input to the BPM. The data collected includes:
 - Total population,
 - Population in group quarters,
 - K-12 enrollment,
 - Housing units by type (single family and multifamily),

- Households,
- Average household size,
- Employment by industry,
- Earnings (annual average wages) by industry,
- Floor space (residential and non residential),
- Primary employment by land use, and
- Household income.

NYMTC also produces SED forecasts by TAZ at five-year intervals up to the horizon year of the Regional Transportation Plan. Future development patterns are also estimated in the form of future employment and labor force forecasts. This data is used as an input to the BPM to forecast future travel patterns and to develop estimates for future congestion.

G. Estimating Current and Future Delay

NYMTC estimates current and future vehicle- and person-hours of delay as part of the periodic update of the Regional Transportation Plan.

Current Congestion and Delay

Current traffic conditions are estimated using collected data combined with modeling techniques. As mentioned in Section 4, traffic counts and speed data are collected at about 2,200 locations around the region. This data, which is updated every three years at each location, is used to calibrate the BPM traffic assignments. Region-wide traffic assignments are then generated with the BPM, reflecting actual changes in traffic since the preceding analysis. The assigned volumes are then post processed to estimate the measures of delay - both link-level and county-wide.

This data is used in several ways. Link-level delays, measured as D/C ratio, are shown in GIS maps and used in public workshops to generate public discussion about congestion in each of the ten counties in the NYMTC region. Also, area-wide congestion and delays are estimated and analyzed at the county level, using the performance measures described later in this document. The county-level analysis estimates the changes in delay and congestion since the last planning cycle. This information is an important consideration in the development of the Regional transportation Plan, especially in the development of projects and strategies that are included in the Plan's recommendations.

Future Congestion and Delay

Forecasts of future congestion and related delay are an important part of NYMTC's CMP. NYMTC's BPM will develop these forecasts, which will also be done every four years as part of the update of the Regional Transportation Plan. The forecasts of future congestion and delay will become part of the statement of future conditions to be addressed by the Plan.

The primary input into the forecasts will be NYMTC's adopted socio-economic forecasts, which include population, employment, and income. The BPM uses these inputs to forecast future trips. The BPM generates future trip tables, does a mode-split estimation, and then assigns trips to the

future network, creating link-level travel demand. These results are then post-processed to estimate delay on routes in the network and to identify congested roadways.

Other BPM outputs such as speeds and traffic volumes are used to calculate other performance measures. Taken together, these results give NYMTC's members the tools necessary to determine if the investments identified in the Plan can produce the desired future results. The BPM's GIS component displays the results of the assessment of current and future congestion on maps for public review and for analysis by the staff of NYMTC and its member agencies.

8. Identifying Locations for Analysis and Developing Approaches to Congestion Management

NYMTC's CMP identifies congested links in the highway network according to specified criteria based primarily on D/C ratio as calculated through the BPM. Congestion is currently categorized for the CMP on the basis of the following parameters using the average of a four-hour weekday morning peak period for current and future conditions:

- $D/C < 0.8$ is considered *uncongested*
- $D/C > 0.8$ and < 1.0 is considered *congested*
- $D/C > 1.0$ is considered *severely congested*

For identification of the congested locations, an average D/C ratio for a four hour peak period is used, as opposed to an absolute peak hour. This approach takes into account both intensity and duration of congestion to identify congested links, as required by Federal regulation. Prioritizing congested locations for more detailed study can be accomplished through the use of additional performance measures such as vehicle hours of delay and/or person hours of delay, as well as other factors such as safety and operational issues related to the location.

Once areas of congestion have been selected for further analysis, CMP strategies should be evaluated for their feasibility for mitigating the congestion. In general, the strategies are prioritized according to the following hierarchy:

- Actions that decrease travel demand;
- Actions that alter travel demand by shifting automobile trips into transit, ridesharing or non-auto modes;
- Actions that improve the operation of the roadway system; and
- Actions that increase the capacity of the roadway system by increasing transit services or adding travel lanes.

The goal of the CMP is primarily to reduce future vehicle trips as a means of reducing congestion. Adding roadway capacity to accommodate demand for more vehicle trips can be considered only when congestion cannot be effectively managed through vehicle trip reduction.

A CMP "toolbox" which contains potential approaches to congestion mitigation is attached to this report as Appendix A. These approaches are divided into the eight categories shown below. For each of the eight categories, three to six options are provided, along with their potential benefits, estimated cost and anticipated time frame. When confronted with a congestion issue,

each toolbox approach should be considered in turn and an initial evaluation made as to the appropriateness of the related option. The eight categories of approaches are:

- Roadway system improvements that reduce vehicular demand by increasing use of shared-ride modes (including premium treatments such as adding special use lanes for high-occupancy vehicles and transit);
- Transit service improvements and incentives (including transit fare incentive programs) where appropriate;
- Pedestrian and bicycle system improvements;
- Transportation Demand Management strategies to increase and facilitate various forms of ridesharing and trip reduction;
- Intelligent Transportation System and Transportation Supply Management strategies (including traveler information and signal coordination);
- Access management strategies (including driveway consolidation frontage roads);
- Land development strategies (including transit-oriented and pedestrian-oriented development); and
- Parking management strategies (including premium or free parking at the trip destination for those who rideshare and parking pricing).

9. Defining and Evaluating Conceptual Congestion Management Approaches

The final aspect of NYMTC's CMP is the evaluation of potential approaches to congestion management. Many of these strategies will be defined conceptually during preparation of the Regional Transportation Plan while others will emerge during detailed feasibility, subarea, or congestion management studies which focus on congestion identified in the Plan.

As stated above, the BPM output illustrates locations where congestion thresholds are exceeded on roadway facilities throughout the region. NYMTC's member agencies, with input from the public, will consider and propose conceptual approaches where feasible to manage congestion in problem areas identified through this analysis. Potential conceptual approaches will then be further defined and evaluated through specific planning studies or analyses.

The NYMTC member agencies will take the lead in evaluating the impacts of conceptual approaches to congestion. NYMTC's BPM is the primary tool for analyzing the regional effectiveness of the approaches. Other analysis packages may be employed to evaluate more localized congestion impacts, but they will all use the underlying assumptions and inputs of the BPM as a platform.

10. Implementation and Monitoring of Congestion Management Approaches

Through the regular update of the Regional Transportation Plan and follow on planning studies, the CMP will identify feasible congestion management improvements and then the other components of NYMTC's planning process will be employed to move selected improvements to implementation.

For example, once specific improvements have been defined, they can be considered for inclusion in the Transportation Improvement Program, or TIP. NYMTC's TIP is updated every two years and amended as needed. The TIP enables improvement projects of all types to receive federal funds for implementation. As CMP-related improvements are implemented, their impacts on congestion will be accounted for in congestion forecasts undertaken in the on-going planning process. On a region-wide basis, the effectiveness of implemented strategies will be incorporated into the subsequent update through the monitoring and reporting of the performance measures. Section 5 of this document describes the types of performance measures that are typically assessed to monitor the effectiveness of CMP strategies. In conjunction with updates of the Plan, overall system performance will also be reported periodically in the CMP Status Report.

11. Corridor or Subarea Congestion Management Studies

Corridor or subarea Congestion Management (CM) studies will be conducted by the agency with jurisdiction over the roadway segments in question. The studies will define the scope of CMP-related improvements that may be needed, in roadway capacity in response to current or future congestion problems identified in the Regional Transportation Plan. The agency with jurisdiction over the roadway segment(s) under study will be the lead agency in the CM study and responsible for study management and financing.

- ***Congestion Management Studies as Part of the Regional Planning Process*** – when the RTP and/or CMP Status Report identifies specific congestion problems, the NYMTC member with jurisdiction over the roadway segment(s) in question may choose to undertake a CM study to identify the most effective improvements for mitigating the congestion. The CM study will evaluate a full range of options, including additions to roadway capacity; operational improvements to more effectively manage the existing capacity; new or improved transit services, and demand management strategies. The selected improvement could then be added to NYMTC's TIP for implementation.
- ***Congestion Management Studies in Response to Added SOV Highway Capacity*** – in a transportation management area, Federal regulations require a CM study whenever the addition of new SOV (Single Occupant Vehicle) roadway capacity is considered. In this situation, the CM study must be completed by the agency which has jurisdiction over the roadway segment(s) in question before the project is included in the TIP. The CM study must: 1) demonstrate that travel demand reduction and operational management strategies cannot fully satisfy the need for additional capacity in the project corridor and that

additional SOV capacity is warranted; 2) must identify all reasonable strategies to manage the SOV facility effectively (or to facilitate its management in the future) that will maintain the functional integrity of the lane or lanes; and, 3) include other highway-based travel demand reduction and operational management strategies appropriate for the corridor, but not appropriate for incorporation into the SOV facility itself. In accordance with federal requirements, all travel demand reduction and operational management strategies that have been identified and deemed feasible will be incorporated into the SOV capacity expansion project or committed to by the State and NYMTC for implementation.

CM studies are a subset of the federal CMP requirements. They must identify and evaluate the anticipated performance and expected benefits of appropriate congestion management strategies. The goal of these strategies is to contribute to the more efficient use of existing and future transportation systems based on the NYMTC region established CMP performance measures. CM studies may be included within other studies, including subarea or corridor planning studies, major project analyses and environmental impact analyses.

In the NYMTC region, CM studies will be conducted in response to congestion problems identified in the Regional Transportation Plan and subsequent planning process. Any highway project included in the regional planning process which meets the criteria described above, whether or not federal funding is utilized, could include a CM study-type analysis. However, a CM study is not required for pure state-of-good-repair or maintenance projects. It is also not required for a project considering additions to linear roadway capacity if less than one mile in length. Although a CM study can be performed at any stage of the planning process but prior to inclusion of the project in the TIP, it is recommended that it be performed as early as possible in order to support the project planning process.

CM studies should include the following elements:

- 1) A statement of the ultimate objectives of the CM study and a description of the study area.
- 2) A description of extent of congestion in the study area utilizing performance measures identified earlier in the document.
- 3) A description of the causes of congestion in the study area.
- 4) An evaluation of the strategies for the study area that meet each of the following types in order:
 - Actions that decrease demand for trip making, especially during peak periods;
 - Actions that place trips into transit or other non-auto modes;
 - Other actions that reduce future SOV trips;
 - Actions that optimize system operation for vehicles; and,
 - Actions that increase the capacity of the roadway system by adding general purpose lanes.

The proposed actions should come from a CMP “toolbox” which would include such options as increased bus transit service, better access management, or increased signal optimization.

- 5) Utilization of the NYMTC BPM, in conjunction with other software packages as needed (or other suitable analytic tools), to estimate reduction in traffic congestion resulting from proposed actions. Congestion reduction must be estimated in all counties within the scope of the corridor study. The parameters must include at a minimum reduction in Vehicle Hours of Delay (VHD) and Person Hours of Delay (PHD) during the AM and PM peak periods.
- 6) A summary table of the overall effect of the proposed actions on congestion during peak travel period(s).
- 7) An implementation schedule, implementation and monitoring responsibilities and possible funding sources for each CMP strategy (or combination of strategies) proposed for implementation.

Although subject to FHWA review, ultimate review and certification of the adequacy of the CM study is the responsibility of the implementing agency.

12. Cost of Congestion

Estimates for the cost per hour of delay vary according to different sources, but are generally based on the estimated average wage in the region, slightly adjusted by the cost to trucks of delayed delivery of goods. A summary of the cost of congestion utilized by different U.S. MPOs is provided in Table 1. As listed in this table, the estimates for the cost of an hour of delay range from a low value of \$6.12 in Washington State to a high value of \$15.59 for a nation-wide average in 1995 dollars.

Cost of Congestion Throughout United States				
Source	Cost of Delay	Units	Year	Region
2001 Baltimore Regional Transportation Plan <i>Baltimore Regional Transportation Board</i>	\$12.96	Dollars/vehicle-hour	1996	Baltimore Area
2003-08 TIP Capital District Transportation Committee (Albany, NY)	\$8.18	Dollars/vehicle-hour	1991	Albany Area
Texas Transportation Institute <i>Urban Mobility Report (2004)</i>	\$13.45	Dollars/person-hour	2002	Average US Urban Area
RAND California	\$12.85	Dollars/person-hour	N/A	California
United States Department of Transportation	\$12.70	Dollars/person-hour	1998	Nationwide
HERS Model	\$15.59	Dollars/vehicle-hour	1995	Nationwide
IDAS Model	\$9.63	Dollars/person-hour	1995	Nationwide
Caltrans	\$8.16	Dollars/person-hour	2000	California
Washington State Department of Transportation	\$6.12	Dollars/person-hour	2000	Washington State

Limited sources of data are available to estimate travel time by vehicle type. FHWA's HERS (Highway Economic Requirements System) tool, based on slightly different parameters than those assumed in the table above (such as inclusion of the cost of depreciation), and provides the following values by vehicle type in 1995 dollars. These rates were then inflated to 2005 dollars based on an inflation rate of three percent per year.

Value of Travel Time by Vehicle Type

Vehicle Type	1995 Dollars/veh. Hour	2005 Dollars/veh. Hour
Small Auto	\$15.71	\$21.11
Medium Auto	\$15.75	\$21.17
4-Tire Truck	\$17.84	\$23.98
6-Tire Truck	\$19.98	\$26.85
3-4 Axle Truck	\$23.66	\$31.80
4-Axle Combination Truck	\$25.49	\$34.26
5-Axle Combination Truck	\$25.24	\$33.92

The United States Department of Transportation (USDOT) estimated a national average cost per vehicle-hour of delay for passenger cars (exclusive of trucks) of \$12.70 as of 1998. If inflated by three percent per year, this results in a national rate of \$15.62 by 2005. However, it would be expected that this value would be higher in the New York City area, in which wages tend to be higher than the national average. In 2001, the New York State Department of Transportation (NYSDOT) established a 2001 value of \$20.46 per vehicle-hour of delay for all vehicles based on the application of the Cost Calculator model (COCA).^{iv} COCA was developed by the NYSDOT as a spreadsheet tool to calculate the hourly cost of delay. The COCA model takes into account variables such as average vehicle occupancy for automobiles and trucks, percent auto and truck traffic, average salary rates of New York State residents and truck drivers, the value of freight per hour of delay time, and the value of wasted fuel per hour of delay. COCA also assumes an overall truck percentage of 6 percent. The model does not differentiate the value of time by different truck classifications but assumes an average truck driver hourly wage of \$21 per hour and a value to delay freight one hour in a truck of \$39. If an inflation rate of three percent per year is applied to the 2001 estimation of cost of delay, the hourly delay costs in 2005 are \$23.00 for all vehicles and \$43.89 for trucks.

13. NYMTC's Responsiveness to Federal Highway Administration (FHWA) Guidelines for an Effective CMP

The Federal Highway Administration recommends seven key attributes for an effective. As indicated in the following list, the NYMTC's CMP provides for each of these attributes. Reference to the specific section of the Procedures Manual which discusses the specific attribute is indicated parenthetically.

1. Area of Application – the CMP must cover a well-defined area.

The NYMTC CMP applies to the entire NYMTC planning area (See Section 1 of the Procedures Manual).

2. System Definition – the CMP must define the transportation network that will be analyzed.

The transportation network analyzed for the NYMTC CMP is included in the Regional Transportation Plan.

3. Performance Measures – the CMP must define the metrics by which it will measure congestion (i.e., vehicle hours of delay, average speed).

Performance measures currently utilized by the NYMTC CMP include level of service, demand to capacity ratio (D/C), vehicle hours of delay, and person hours of delay. Additional performance measures are proposed for future incorporation into the CMP (See Section 7).

4. Performance Monitoring Plan – there must be a regularly scheduled plan for examining the transportation network and evaluation the status of congestion.

The NYMTC's CMP is integrated into the overall NYMTC planning process and involves ongoing examination of the transportation network and the status of congestion (See Section 4 for an overview of the process)

5. Identification and Evaluation of Strategies – there must be a systematic program, or toolbox, for selecting congestion mitigation strategies and evaluating potential benefits.

The NYMTC's CMP has established a systematic program for determining congestion "hot spot" locations, identifying appropriate mitigation strategies, and evaluating their potential benefits utilizing the NYMTC BPM and related post processors. (See Sections 8 and 9)

6. Monitoring Strategy Effectiveness – the strategies must be monitored to assure positive benefits.

At the local level, monitoring the effectiveness of individual CMP projects is primarily the responsibility of the implementing agency. At the regional level, the effectiveness of CMP strategies is incorporated into subsequent updates to the CMP and through the monitoring of performance measures (See Section 10)

7. Implementation and Management – there must be a plan for implementing the CMP as part of the regional transportation planning process.

Implementation and management of the NYMTC's CMP are fully integrated into the overall NYMTC transportation planning process. (See Sections 4 and 10)

Based on the documentation of the NYMTC's CMP as presented in the Procedures Manual, the NYMTC's CMP addresses all seven key CMP attributes as specified by FHWA.

Appendix A: CMP Toolbox

Table TLBX-1 - Potential Highway Strategies

Strategies/Projects	Congestion and Mobility Benefits	Implementation Costs and other Impacts	Implementation Timeframe
<p>1a. Increasing Number of Lanes without Highway Widening</p> <p>This takes advantage of “excess” width in the highway cross section used for break-down lanes or median.</p>	<ul style="list-style-type: none"> • Increase capacity 	<ul style="list-style-type: none"> • Construction and engineering • Maintenance 	<ul style="list-style-type: none"> • Short-term: 1 to 5 years (includes planning, engineering, and implementation)
<p>1b. Geometric Design Improvements</p> <p>This includes widening to provide shoulders, additional turn lanes at intersections, improved sight lines, auxiliary lanes to improve merging and diverging.</p>	<ul style="list-style-type: none"> • Increase mobility • Reduce congestion by improving bottlenecks • Increase traffic flow and improve safety 	<ul style="list-style-type: none"> • Costs vary by type of design 	<ul style="list-style-type: none"> • Short-term: 1 to 5 years
<p>1c. HOV Lanes</p> <p>This increases corridor capacity while at the same time provides an incentive for single-occupant drivers to shift to ridesharing. These lanes are most effective as part of a comprehensive effort to encourage HOVs, including publicity, outreach, park-and-ride lots, and rideshare matching services.</p>	<ul style="list-style-type: none"> • Reduce Congestion by reducing VMT • Reduce regional trips • Increase vehicle occupancy • Improve travel times • Increase transit use and improve bus travel times 	<ul style="list-style-type: none"> • HOV, separate ROW costs • HOV, barrier separated costs • HOV, contra flow costs • Annual operations and enforcement • Can create environmental and community impacts 	<ul style="list-style-type: none"> • Medium-term: 5 to 10 years (includes planning, engineering, and construction)
<p>1d. Super Street Arterials</p> <p>This involves converting existing major arterials with signalized intersections into “super streets” that feature grade-separated intersections.</p>	<ul style="list-style-type: none"> • Increase capacity • Improve mobility 	<ul style="list-style-type: none"> • Construction and engineering substantial for grade separation • Maintenance variable based on area 	<ul style="list-style-type: none"> • Medium-term: 5 to 10 years (includes planning, engineering, and implementation)
<p>1e. Highway Widening by Adding Lanes</p> <p>This is the traditional way to deal with congestion.</p>	<ul style="list-style-type: none"> • Increase capacity, reducing congestion in the short term • Long-term effects on congestion depend on local conditions 	<ul style="list-style-type: none"> • Costs vary by type of highway constructed; in dense urban areas can be very expensive • Can create environmental and community impacts 	<ul style="list-style-type: none"> • Long-term: 10 or more years (includes planning, engineering, and construction)

Source: Adapted from ITE, *A Toolbox for Alleviating Traffic Congestion* by Cambridge Systematics, Inc.

Table TLBX-2 - Potential Transit Strategies

Strategies/Projects	Congestion Impacts	Implementation Costs	Implementation Timeframe
<p>2a. Reducing Transit Fares This encourages additional transit use, to the extent that high fares are a real barrier to transit.</p>	<ul style="list-style-type: none"> • Reduce daily VMT • Reduce congestion • Increase ridership 	<ul style="list-style-type: none"> • Lost in revenue per rider • Capital costs per passenger trip • Operating costs per passenger trip • Operating subsidies needed to replace lost fare revenue • Alternative financial arrangements need to be negotiated with donor agencies 	<ul style="list-style-type: none"> • Short-term: Less than one year
<p>2b. Increasing Bus Route Coverage or frequencies This provides better accessibility to transit to a greater share of the population. Increasing frequency makes transit more attractive to use.</p>	<ul style="list-style-type: none"> • Increase transit ridership • Decrease travel time • Reduce daily VMT 	<ul style="list-style-type: none"> • Capital costs per passenger trip • Operating costs per trip • New bus purchases likely 	<ul style="list-style-type: none"> • Short-term: 1 to 5 years (includes planning, engineering, and construction)
<p>2c. Implementing Park-and-Ride Lots These can be used in conjunction with HOV lanes and/or express bus services. They are particularly helpful for encouraging HOV use for longer distance commute trips.</p>	<ul style="list-style-type: none"> • Reduce congestion by increasing Vehicle occupancy rate • Increase mobility and transit efficiency 	<ul style="list-style-type: none"> • Structure costs for transit stations 	<ul style="list-style-type: none"> • Medium-term: 5 to 10 years (includes planning, engineering, and construction)
<p>2d. Implementing Rail Transit This best serves dense urban centers where travelers can walk to their destinations. Rail transit from suburban areas can sometimes be enhanced by providing park-and-ride lots.</p>	<ul style="list-style-type: none"> • Reduce daily VMT 	<ul style="list-style-type: none"> • Capital costs per passenger • New systems require large up-front capital outlays and ongoing sources of operating subsidies, in addition to funds that may be obtained from federal sources, under increasingly tight competition. 	<ul style="list-style-type: none"> • Long-term: 10 or more years (includes planning, engineering, and construction)

Source: Adapted from ITE, *A Toolbox for Alleviating Traffic Congestion* by Cambridge Systematics, Inc.

Table TLBX-3 - Potential Bicycle and Pedestrian Strategies

Strategies/Projects	Congestion Impacts	Implementation Costs	Implementation Timeframe
<p>3a. New Sidewalks and Designated Bicycle Lanes on Local Streets.</p> <p>Enhancing the visibility of bicycle and pedestrian facilities increases the perception of safety. In many cases, bike lanes can be added to existing roadways through restriping.</p>	<ul style="list-style-type: none"> • Increase mobility and access • Increase non-motorized mode shares • Separate slow-moving bicycles from motorized vehicles • Reduce incidents 	<ul style="list-style-type: none"> • Design and construction costs for paving, striping, signals, and signing • ROW costs if widening necessary • Bicycle lanes may require improvements to roadway shoulders to ensure acceptable pavement quality 	<ul style="list-style-type: none"> • Short-term: 1 to 5 years (includes planning, engineering, and construction)
<p>3b. Improved Bicycle Facilities at Transit Stations and Other Trip Destinations.</p> <p>Bicycle racks and bike lockers at transit stations and other trip destinations increase security. Additional amenities such as locker rooms with showers at workplaces provide further incentives for using bicycles.</p>	<ul style="list-style-type: none"> • Increase bicycle mode share • Reduce motorized vehicle congestion on access routes 	<ul style="list-style-type: none"> • Capital and maintenance costs for bicycle racks and lockers, locker rooms 	<ul style="list-style-type: none"> • Short-term: 1 to 5 years (includes planning, engineering, and construction)
<p>3c. Design Guidelines for Pedestrian-Oriented Development.</p> <p>Maximum block lengths, building setback restrictions, and streetscape enhancements are examples of design guidelines that can be codified in zoning ordinances to encourage pedestrian activity.</p>	<ul style="list-style-type: none"> • Increase pedestrian mode share • Discourage motor vehicle use for short trips • Reduce VMT, emissions 	<ul style="list-style-type: none"> • Capital costs largely borne by private sector; developer incentives may be necessary • Public sector may be responsible for some capital and/or maintenance costs associated with right-of-way improvements • Ordinance development and enforcement costs 	<ul style="list-style-type: none"> • Short-term: 1 to 5 years
<p>3d. Improved Safety of Existing Bicycle and Pedestrian Facilities.</p> <p>Maintaining lighting, signage, striping, traffic control devices, and pavement quality, and installing curb cuts, curb extensions, median refuges, and raised crosswalks can increase bicycle and pedestrian safety.</p>	<ul style="list-style-type: none"> • Increase non-motorized mode share • Reduce incidents 	<ul style="list-style-type: none"> • Increased monitoring and maintenance costs • Capital costs of sidewalk improvements and additional traffic control devices 	<ul style="list-style-type: none"> • Short-term: 1 to 5 years

Table TLBX-3 - Potential Bicycle and Pedestrian (Continued)

Strategies/Projects	Congestion Impacts	Implementation Costs	Implementation Timeframe
<p><i>3e. Exclusive Non-Motorized Rights-of-Way.</i> Abandoned rail rights-of-way and existing parkland can be used for medium- to long-distance bike trails, improving safety and reducing travel times.</p>	<ul style="list-style-type: none"> • Increase mobility • Increase non-motorized mode shares • Reduce congestion on nearby roads • Separate slow-moving bicycles from motorized vehicles • Reduce incidents 	<ul style="list-style-type: none"> • ROW Costs • Construction and Engineering Costs • Maintenance Costs 	<ul style="list-style-type: none"> • Medium-term: 5 to 10 years (includes planning, engineering, and construction)

Source: Adapted from ITE, *A Toolbox for Alleviating Traffic Congestion* by Cambridge Systematics, Inc.

Table TLBX-4 - Potential TDM Strategies

Strategies/Projects	Congestion Impacts	Implementation Costs	Implementation Timeframe
<p>4a. Alternative Work Hours This allows workers to arrive and leave work outside of the traditional commute period. It can be on a scheduled basis or a true flex-time arrangement.</p>	<ul style="list-style-type: none"> • Reduce peak-period VMT • Improve travel time among participants 	<ul style="list-style-type: none"> • No capital costs • Agency costs for outreach and publicity • Employer costs associated with accommodating alternative work schedules 	<ul style="list-style-type: none"> • Employer-based • Short-term: 1 to 5 years
<p>4b. Telecommuting This involves employees to work at home or regional telecommute center instead of going into the office. They might do this all the time, or only one or more days per week.</p>	<ul style="list-style-type: none"> • Reduce VMT • Reduce SOV trips 	<ul style="list-style-type: none"> • First-year implementation costs for private-sector (per employee for equipment) • Second-year costs tend to decline 	<ul style="list-style-type: none"> • Employer-based • Short-term: 1 to 5 years
<p>4c. Pricing This involves pricing facilities to encourage off-peak or HOV travel, and includes time-variable road, and cordon (area) tolls, high-occupancy/toll (HOT) lanes and vehicle-use fees.</p>	<ul style="list-style-type: none"> • Reduce peak period VMT • Reduce SOV trips 	<ul style="list-style-type: none"> • First-year implementation costs for public -sector 	<ul style="list-style-type: none"> • Short-term: 1 to 5 years
<p>4d. Ridesharing This is typically arranged/ encouraged through employers or transportation management agencies (TMA), which provides ride-matching services.</p>	<ul style="list-style-type: none"> • Reduce work VMT • Reduce SOV trips 	<ul style="list-style-type: none"> • Savings per carpool and vanpool riders • Costs per year per free parking space provided • Administrative costs 	<ul style="list-style-type: none"> • Employer-based • Short-term: 1 to 5 years

Source: Adapted from ITE, *A Toolbox for Alleviating Traffic Congestion* by Cambridge Systematics, Inc.

Table TLBX-5 - Potential ITS and TSM Strategies

Strategies/Projects	Congestion Impacts	Implementation Costs	Implementation Timeframe
<p>5a. Traffic Signal Coordination This improves traffic flow and reduces emissions by minimizing stops on arterial streets.</p>	<ul style="list-style-type: none"> • Improve travel time • Reduce the number of stops • Reduce VMT, VHD and PHT by vehicle miles per day, depending on program 	<ul style="list-style-type: none"> • O&M costs per signal • Signalized intersections per mile costs variable 	<ul style="list-style-type: none"> • Short-term: 1 to 5 years
<p>5b. Reversible Traffic Lanes These are appropriate where traffic flow is highly directional.</p>	<ul style="list-style-type: none"> • Increase peak direction capacity • Reduce peak travel times • Improve mobility 	<ul style="list-style-type: none"> • Barrier separated costs per mile • Operation costs per mile • Maintenance costs variable 	<ul style="list-style-type: none"> • Short-term: 1 to 5 years
<p>5c. Freeway Incident Detection and Management Systems This is an effective way to alleviate non-recurring congestion. Systems typically include video monitoring, dispatch systems, and sometimes roving service patrol vehicles.</p>	<ul style="list-style-type: none"> • Reduce accident delay • Reduce travel time • Reduce VHT and PHT 	<ul style="list-style-type: none"> • Capital costs variable and substantial • Annual operating and maintenance costs 	<ul style="list-style-type: none"> • Medium- to Long-term: likely 10 years or more
<p>5d. Ramp Metering This allows freeways to operate at their optimal flow rates, thereby speeding travel and reducing collisions.</p>	<ul style="list-style-type: none"> • Decrease travel time • Decrease accidents • Improve traffic flow on major facilities 	<ul style="list-style-type: none"> • O&M costs • Significant costs associated with enhancements to centralized control system • Capital costs 	<ul style="list-style-type: none"> • Medium-term: 5 to 10 years
<p>5e. Highway Information Systems These systems provide travelers with real-time information that can be used to make trip and route choice decisions.</p>	<ul style="list-style-type: none"> • Reduce travel times and delay • Some peak-period travel shift 	<ul style="list-style-type: none"> • Design and implementation costs variable • Operating and maintenance costs variable 	<ul style="list-style-type: none"> • Medium-term: 5 to 10 years
<p>5f. Advanced Traveler Information Systems This provides an extensive amount of data to travelers, such as real time speed estimates on the web or over wireless devices, and transit vehicle schedule progress.</p>	<ul style="list-style-type: none"> • Reduce travel times and delay • Some peak-period travel and mode shift 	<ul style="list-style-type: none"> • Design and implementation costs variable • Operating and maintenance costs variable 	<ul style="list-style-type: none"> • Medium-term: 5 to 10 years

Source: Adapted from ITE, *A Toolbox for Alleviating Traffic Congestion* by Cambridge Systematics, Inc.

Table TLBX-6 - Potential Access Management Strategies

Strategies/Projects	Congestion Impacts	Implementation Costs	Implementation Timeframe
<p>6a. Left Turn Restrictions; Curb Cut and Driveway Restrictions Turning vehicles can impede traffic flow and are more likely to be involved in crashes.</p>	<ul style="list-style-type: none"> • Increased capacity, efficiency on arterials • Improved mobility on facility • Improved travel times and reduced delay for through traffic • Fewer incidents 	<ul style="list-style-type: none"> • Implementation and maintenance costs vary; range from new signage and striping to more costly permanent median barriers and curbs. 	<ul style="list-style-type: none"> • Short-term: 1 to 5 years (includes planning, engineering, and implementation)
<p>6b. Turn lanes and New or Relocated Driveways and Exit Ramps In some situations, increasing or modifying access to a property can be more beneficial than reducing access.</p>	<ul style="list-style-type: none"> • Increased capacity, efficiency • Improved mobility and safety on facility • Improved travel times and reduced delay for all traffic 	<ul style="list-style-type: none"> • Additional right-of-way costs • Design, construction, and maintenance costs 	<ul style="list-style-type: none"> • Short-term: 1 to 5 years (includes planning, engineering, and implementation)
<p>6c. Interchange Modifications Conversion of a full cloverleaf interchange to a partial cloverleaf, for example, reduces weaving sections on a freeway.</p>	<ul style="list-style-type: none"> • Increased capacity, efficiency • Improved mobility on facility • Improved travel times and reduced delay for through traffic • Fewer incidents due to fewer conflict points 	<ul style="list-style-type: none"> • Design and construction costs 	<ul style="list-style-type: none"> • Short-term: 1 to 5 years (includes planning, engineering, and implementation)
<p>6d. Minimum Intersection/ Interchange Spacing. Reduces number of conflict points and merging areas, which in turn reduces incidents and delays.</p>	<ul style="list-style-type: none"> • Increased capacity, efficiency • Improved mobility on facility • Improved travel times and reduced delay for through traffic • Fewer incidents 	<ul style="list-style-type: none"> • Part of design costs for new facilities and reconstruction projects. 	<ul style="list-style-type: none"> • Medium-term: 5 to 10 years (includes planning, engineering, and implementation)
<p>6e. Frontage Roads and Collector-Distributor Roads Frontage roads can be used to direct local traffic to major intersections on both super arterials and freeways. Collector-distributor roads are used to separate exiting, merging, and weaving traffic from through traffic at closely-spaced interchanges.</p>	<ul style="list-style-type: none"> • Increased capacity, efficiency • Improved mobility on facility • Improved travel times and reduced delay for through traffic • Fewer incidents due to fewer conflict points 	<ul style="list-style-type: none"> • Additional right-of-way costs • Design, construction, and maintenance costs 	<ul style="list-style-type: none"> • Medium-term: 5 to 10 years (includes planning, engineering, and implementation)

Source: Adapted from ITE, *A Toolbox for Alleviating Traffic Congestion* by Cambridge Systematics, Inc.

Table TLBX-7 - Potential Land Use Strategies

Strategies/Projects	Congestion Impacts	Implementation Costs	Implementation Timeframe
<p>7a. Mixed-Use Development This allows many trips to be made without automobiles. People can walk to restaurants and services rather than use their vehicles.</p>	<ul style="list-style-type: none"> • Increase walk trips • Decrease SOV trips • Decrease in VMT • Decrease vehicle hours of travel 	<ul style="list-style-type: none"> • Public costs to set up and monitor appropriate ordinances • Economic incentives used to encourage developer buy-in 	<ul style="list-style-type: none"> • Long-term: 10 or more years
<p>7b. Infill and Densification This takes advantage of infrastructure that already exists, rather than building new infrastructure on the fringes of the urban area.</p>	<ul style="list-style-type: none"> • Decrease SOV • Increase transit, walk, and bicycle • Doubling density decreases VMT per household • Medium/high vehicle trip reductions 	<ul style="list-style-type: none"> • Public costs to set up and monitor appropriate ordinances • Economic incentives used to encourage developer buy-in 	<ul style="list-style-type: none"> • Long-term: 10 or more years
<p>7c. Transit-Oriented Development This clusters housing units and/or businesses near transit stations in walkable communities.</p>	<ul style="list-style-type: none"> • Decrease SOV share • Shift carpool to transit • Increase transit trips • Decrease VMT • Decrease in vehicle trips 	<ul style="list-style-type: none"> • Public costs to set up and monitor appropriate ordinances • Economic incentives used to encourage developer buy-in 	<ul style="list-style-type: none"> • Long-term: 10 or more years

Source: Adapted from ITE, *A Toolbox for Alleviating Traffic Congestion* by Cambridge Systematics, Inc.

Table TLBX-8 - Potential Parking Management Strategies

Strategies/Projects	Congestion Impacts	Implementation Costs	Implementation Timeframe
<p>8a. On-Street Parking and Standing Restrictions</p> <p>Enforcement of existing regulations can substantially improve traffic flow in urban areas. Peak-period parking prohibitions can free up extra general purpose travel lanes or special bus or HOV “diamond” lanes.</p>	<ul style="list-style-type: none"> • Increase peak-period capacity • Reduce travel time and congestion on arterials • Increase HOV and bus mode shares 	<ul style="list-style-type: none"> • Design, construction, and maintenance costs for signage and striping. • Rigid enforcement of parking restrictions. 	<ul style="list-style-type: none"> • Short-term: 1 to 5 years (includes planning, engineering, and implementation)
<p>8b. Employer/Landlord Parking Agreements</p> <p>Employers can negotiate leases so that they pay only for the number of spaces used by employees. In turn, employers can pass along parking savings by purchasing transit passes or reimbursing non-driving employees with the cash equivalent of a parking space.</p>	<ul style="list-style-type: none"> • Reduce work VMT • Increase non-auto mode shares 	<ul style="list-style-type: none"> • Economic incentives used to encourage employer and landlord buy-in 	<ul style="list-style-type: none"> • Metropolitan and Employer-based • Short-term: 1 to 5 years
<p>8c. Preferential or Free Parking for HOVs</p> <p>This provides an incentive for workers to carpool.</p>	<ul style="list-style-type: none"> • Reduce work VMT • Increase vehicle occupancy 	<ul style="list-style-type: none"> • Relatively low costs, primarily borne by the private sector, include signing, striping, and administrative costs 	<ul style="list-style-type: none"> • Metropolitan and Employer-based • Short-term: 1 to 5 years
<p>8d. Location-Specific Parking Ordinances</p> <p>Parking requirements can be adjusted for factors such as availability of transit, a mix of land uses, or pedestrian-oriented development that may reduce the need for on-site parking. This encourages transit-oriented and mixed-use development.</p>	<ul style="list-style-type: none"> • Reduce VMT • Increase transit and non-motorized mode shares 	<ul style="list-style-type: none"> • Economic incentives used to encourage developer buy-in 	<ul style="list-style-type: none"> • Long-term: 10 or more years

Source: Adapted from ITE, *A Toolbox for Alleviating Traffic Congestion* by Cambridge Systematic, Inc.

ⁱ The 70% figure includes 0.4% who bicycle to work. The 30% who use off-street modalities include 25% who take the subway, 4% who ride commuter rail, and 0.2% who take ferries (numbers do not add up due to rounding). U.S. Census Bureau, Census 2000 Summary File 3

ⁱⁱ. Federal Regulation. CMS section 500:109

ⁱⁱⁱ. Federal Regulation. CMS section 500.109

^{iv} Mobility Management Section of Planning and Strategy Group, NYSDOT, “An Explanation of the Cost Calculator (COCA),” February 5, 2001.

^v If inflated at an annual rate of three percent to 2005, this would result in an hourly wage of \$24.34. For 2005, the Bureau of Labor Statistics reports a median hourly wage rate of \$18.53 for truck drivers in the New York-Northern New Jersey-Long Island NY-NJ-CT-PA SMSA. The hourly wage rate for the 75th percentile is \$21.71 and \$26.54 for the 90th percentile.