# Congestion Management System

# Description and Procedures

NYMTC
NEW YORK METROPOLITAN TRANSPORTATION COUNCIL

# 1. Introduction

What is congestion? Congestion is defined in the Interim Final Rule on Management and Monitoring Systems in the Intermodal Surface Transportation Act (ISTEA) of 1991 by the Federal Highway Administration (FHWA) to be:

> *"The level at which the transportation system performance is no longer acceptable due to traffic interference. The level of acceptable system performance may vary by type of transportation facility, geographic location and/or time of day."*

Over the past decade federal transportation legislation has mandated the assessment and management of available roadway capacity through a Congestion Management System (CMS) before new roadway capacity can be added to a regional plan or improvement program. As the region's Metropolitan Planning Organization (MPO), the New York Metropolitan Transportation Council (NYMTC) is required to develop and implement a regional CMS as an integral part of its ongoing regional planning process.

New York is ranked the thirteen highest in the nation–out of the 68 urban areas included in the Texas Transportation Institute's Travel Rate Index (TRI)– for levels of congestion. The TRI weighted index indicates how much longer a trip takes than if it had occurred in free flow conditions. Drivers in the New York and northeastern New Jersey region realize an average of approximately 38 hours of delay each year. The most congested city, Los Angeles, is Number 1 on the TRI with approximately 82 hours of delay per year for the average Los Angeles driver (Schrank and Lomax, 1999). Although total congestion may be greater in 12 other metropolitan areas across the country, the cost of congestion in the New York region is estimated at $8.3 billion per year (Drapeau, 2000). Reducing congestion saves time and money.

There are 341 MPOs in the country, and as many variations on Congestion Management Systems. These variations are due to the good deal of flexibility given to the MPOs by the federal government in establishing CMS procedures. The NYMTC CMS provides the opportunity to measure current and forecasted congestion, measures the effectiveness of the Regional Transportation Plan's impact on congestion, and provides the first step in developing effective solutions.

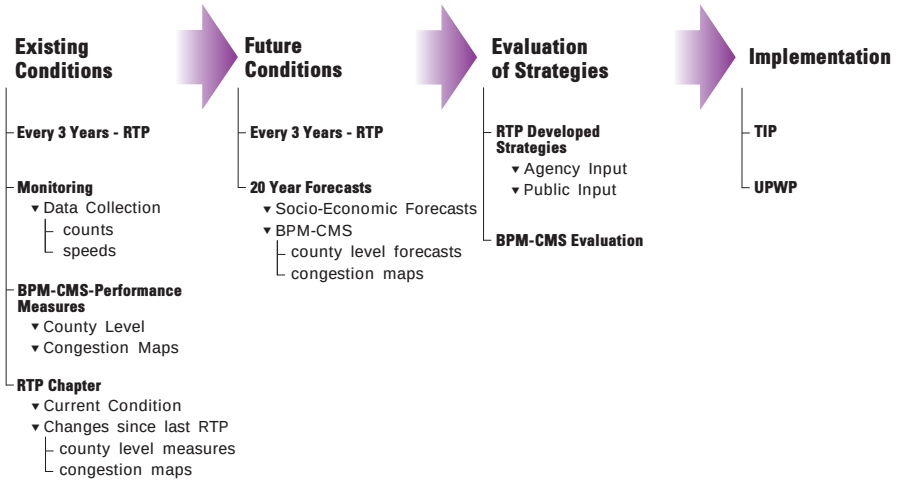
This report describes the procedures that NYMTC uses to evaluate the impact of the Regional Transportation Plan (RTP) on congestion at the regional level and the steps that are taken to develop strategies for managing congestion that are eventually included in the Transportation Improvement Program (TIP) and the annual Unified Planning Work Program (UPWP).

The RTP is one of NYMTC's federally required planning products. The RTP lays out the region's transportation needs and desires over a twenty year period. The current Plan was adopted by NYMTC in 1994 and first updated in 1999. Federal regulations require that the plan be updated every three years.

The TIP is a multimodal program of bridge, bikeway, pedestrian, transit, highway, safety and demand management projects. NYMTC's TIP is updated every two years and amended as needed and includes federally and nonfederally funded projects.

The UPWP is a list of actions that the NYMTC staff and the NYMTC members will take to accomplish the objectives of the RTP. The UPWP is updated each year.

## Components of NYMTC's Congestion Management System




## 2. Components of NYMTC's CMS

NYMTC's Congestion Management System is a complete process for managing regional congestion that addresses the basic questions of where, when, and to what extent congestion will occur. The CMS also identifies and evaluates strategies that can be considered by Council members for reducing and managing congestion. NYMTC's CMS includes and provides:

- Performance measures for determining levels of delay and congestion in the region,
- A database of traffic counts and speed data for measuring changes in the regional traffic conditions,
- Geocoded computerized highway and transit networks that can be used for simulating regional travel patterns, estimating regional congestion, and displaying the results on Geographic Information System (GIS) maps,
- An ongoing assessment of congestion in the region that is updated every three years with each 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 incorporating the most effective strategies into NYMTC's TIP and UPWP.

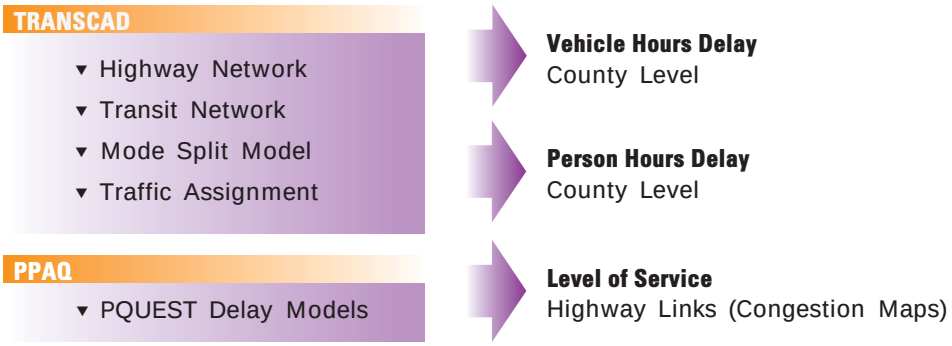
NYMTC's CMS has been carefully integrated with its regional planning process to minimize the need for additional resources to maintain the CMS and to incorporate its findings into the metropolitan planning process. The CMS relies upon NYMTC's Best Practice Model as the primary tool for estimating congestion, forecasting future congestion and evaluating solution strategies. The specifics for accomplishing these goals are detailed in this report.

## 3. Performance Measures

Performance measures are the basic building blocks of a CMS. They are established to quantify levels of congestion, and to provide the mechanism by which changing levels of congestion – either improving or deteriorating – can be determined. Performance is a relative concept so it is important that it be measured in a way that the traveling public can easily comprehend.

### NYMTC's CMS Performance Measures

#### BPM-CMS




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

- Credible; intuitively accepted as a reasonable expression of the problem,
- Easily defined; permitting 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.

In its early stages NYMTC's CMS will use measures of delay to measure congestion. In a region like NYMTC's it is highly unlikely that congestion will ever be eliminated. Nonetheless, monitoring changes in congestion is important.

The measures are known as area-wide measures because they estimate the impact that congestion has on an area rather than on specific facilities. Specifically, the performance measures are:

- Levels of Service, expressed in standard measures of A, B, C, D, and F.
- Vehicle Hours of Delay (VHD), expressed in terms of hours per thousand vehicle miles traveled as a measure of congestion on our highways. Delay can be thought of as the difference

between estimated actual travel speed and free flow travel speed, and is therefore a measure that is readily observed by the traveling public.

- Person Hours of Delay (PHD), which is calculated by multiplying the VHD by the average vehicle occupancy rate. This reflects the fact that vehicle occupancy differs from place to place, and that the number of people affected by one vehicle hour of delay may vary.

These performance measures will be reported for five time periods - the morning peak (6:00 AM – 10:00 AM), midday (11:00 AM – 2:00 PM), afternoon peak (4:00 – 7:00 PM), night-time (7:00 PM – 6:00 AM), and daily (24 hour) periods – thereby reflecting the duration of congestion in the region. To monitor the extent of congestion, these measures will be reported for each county and by type of facility (i.e. freeways) for each direction of travel in the region.

In the future, NYMTC will look to enhance the performance measures used in the CMS to include more data and additional travel modes. These enhancements could include:

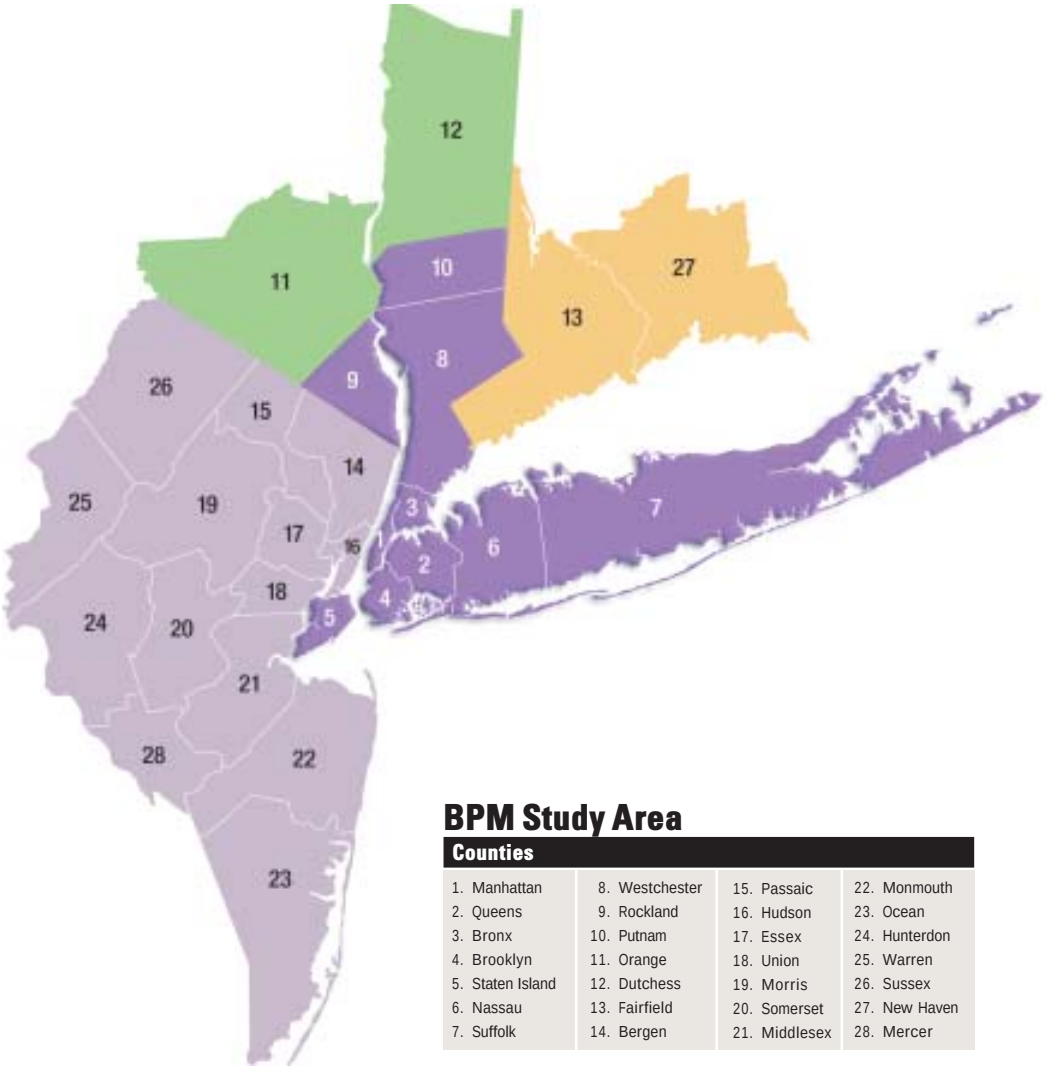
- Performance measures added to address the effects of congestion of freight,
- A hybrid measure based upon the frequency of non-recurring delay used as an estimate of travel time risk, because travel time risk has been shown to be a major concern of the traveling public.
- Intelligent Transportation Systems (ITS) to improve the region's ability to collect count and speed data. Data generated by regional traffic control centers such as INFORM and automatic fare collection processes such as EZ-PASS create a robust data source for travel times. NYMTC staff members are currently investigating potential use of this data, which may lead to the development of a method for incorporating the data into the CMS.
- Analysis of weekend congestion.
- Speed/Density information.

## 4. NYMTC's BPM-CMS

To estimate and report the performance measures described in previous section, a software system known as the BPM-CMS will be used. This tool has been specifically developed to serve as a technical resource for the region's CMS.

The BPM-CMS uses a set of programs, consisting of the Best Practice Model (BPM), the Post Processor for Air Quality (PPAQ), Post Processor for Congestion Management Systems (PPCMS), and the Performance Queries for Surface Transportation (PEQUEST), to analyze travel in the NYMTC region.

**The Best Practice Model** - The Best Practice Model is a TransCAD network-based simulation model. It covers 28 contiguous counties in the NY-NJ-CT area. It is a set of journey-based travel demand-forecasting models. The models use GIS based highway and transit networks. The highway network has 53,000 roadway links containing all minor arterial and above facilities. The transit network contains 2,756 routes that encompass commuter rail, subway, express bus, local bus, and ferry routes. The study area is divided into 3,585 Transportation Analyses Zones (TAZ). The base year for the BPM is currently being updated to 2002.




## BPM Study Area

**Counties**

| | | | |
|---|---|---|---|
| 1. Manhattan | 8. Westchester | 15. Passaic | 22. Monmouth |
| 2. Queens | 9. Rockland | 16. Hudson | 23. Ocean |
| 3. Bronx | 10. Putnam | 17. Essex | 24. Hunterdon |
| 4. Brooklyn | 11. Orange | 18. Union | 25. Warren |
| 5. Staten Island | 12. Dutchess | 19. Morris | 26. Sussex |
| 6. Nassau | 13. Fairfield | 20. Somerset | 27. New Haven |
| 7. Suffolk | 14. Bergen | 21. Middlesex | 28. Mercer |

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

- NYMTC Household Interview Survey data–the Household Interview Survey is a 24-hour activity-based survey for 11,000 thousand households in the region,
- Population, Household, and Employment data by TAZ,
- Traffic counts from over 2200 locations,
- Transit ridership data on all transit services in the region, and
- Travel time data.

The models will initially generate a total number of journeys that begin and end in each zone based on the socioeconomic characteristics of each household and employment opportunity in the zone. The journeys will then be fed into the mode choice/destination sub-programs to identify the following for each origin-destination pair: travel mode, trip purpose, and time of the day. The model will then assign these trips to the highway network. When the predicted traffic flows are compared to capacity, the model will calculate link-level delays. These delays are then used to adjust the travel times to reflect congested links.

**PPAQ** - The Post Processor for Air Quality (PPAQ) is a flexible computer software system used to process the links in the Best Practice Model (BPM) highway network and to calculate emissions using the Mobile model. This system provides an effective means of analyzing projects that can not be accurately represented in the BPM, including signal coordination projects. It will be used to monitor the level of congestion in the NYMTC region for the sample years 2005, 2007, 2015, and 2025.

**PPCMS** - The Post Processor for Congestion Management Systems (PPCMS) is the non-recurring congestion module in the PPAQ software system. PPCMS is a methodology for measurement and reporting of Incidents and the prediction of incident impacts on freeways. PPCMS uses the estimation of delay as a result of freeway incidents developed along with analysis of incident data obtained from eight US metropolitan areas as the basis for its calculations. PPCMS is only concerned with accounting for the non-recurring delay.

**PEQUEST** - The Performance Queries for Surface Transportation (PEQUEST) provides system performance reporting capabilities for both general operations analysis and for emissions analysis. PEQUEST can produce supplemental link operations databases in .DBF format which support performance analyses. The user can select from nearly 60 different performance reports, including both operations and emissions reports.

## 5. CMS Data Needs

NYMTC's CMS is built upon a large database that includes information describing regional travel patterns, the regional transportation network, and regional socioeconomic/demographic patterns.

### Data describing Regional Travel Patterns

Travel patterns in the NYMTC region are always changing. This usually means that traffic is growing, although it occasionally declines, and growth rates vary by location and time of day. To monitor these changing conditions data is collected over a three year cycle. This data will be used to calibrate the BPM and to measure changes in regional traffic, delays, and congestion using the performance measures identified in Section 3 of this report. The data collected and used are:

**Traffic Counts** – Traffic counts are needed for two reasons: one, to monitor the changes in traffic volume over time, and two, to calibrate the BPM traffic assignments on a cyclical basis for the Regional Transportation Plan. These counts are taken at over 2,255 locations around the NYMTC 10-county region by NYMTC staff and member agencies. These locations lie on regional screenlines that are used to calibrate the BPM assignment process. For the purposes of this analysis the screenlines are county borders. Traffic counts are taken at each major roadway crossing the border. These are then compared to the modeled assignments for all links on that same border to determine if the modeled assignments are reasonable. The counts at each screenline location will be updated every three years, with one-third of the locations counted in each year.

The collection, processing and maintenance of traffic data is organized and standardized by NYMTC's Traffic Counting Working Group. This group meets to discuss the latest traffic count needs and to make sure all counts are standardized using NYSDOT procedures. The regional and local agencies will collect data at locations coinciding with links crossing the screenlines in the BPM highway network. The counts will be conducted for a minimum of 72 hours, to assure an average daily traffic volume

covering 48 hours (two full days). Directional vehicle classification counts will also be collected for a minimum of AM and PM peak periods. Uniform seasonal, daily, and axle factors developed by NYSDOT will be used to estimate the Average Annual Daily Traffic (AADT).

**Speed Data** – Actual speeds are collected along the major corridors. This data is used to calibrate the BPM speed estimates. Speed runs are conducted on 26 routes over 5 time periods (AM, Midday, PM, Evening, and Night). In the future, NYMTC will add speed data to these locations collected from the TRANSMIT project on a regular basis to calibrate and update the BPM every three years.

**Transit Data** – Transit data is needed to calibrate the BPM every three years, ensuring the continuing adequacy of the model's multi-modal choice models. Transit congestion, however, will not be evaluated. This transit 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 upon the process used to collect data from all of the transit operators during the development stages of the BPM. Examples of data that will be collected include:

- Station boarding/alighting counts,
- Station turnstile on/off counts,
- Maximum load point estimates,
- Line ridership reports, and
- Estimates of dwell time at high volume stations or bus stops.

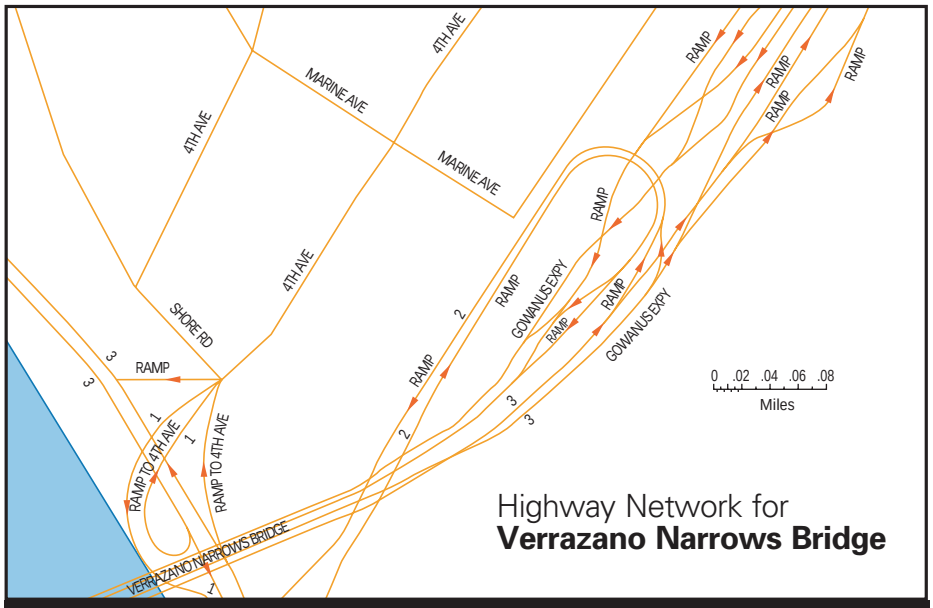
**Freight Data** - NYMTC staff is currently developing a procedure for collecting and maintaining data describing the flow of freight in the region. While the focus of the CMS will primarily be truck movements, the overall freight database will also include commodity-flow data. The BPM also produces 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 the future.

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 CMS analysis.

## Data describing the Regional Transportation Network

The BPM highway and transit networks are used by the CMS to describe the region's transportation system, providing the GIS capabilities needed to store and display the data and simulate traffic conditions. Using the BPM networks ensures that the CMS is compatible with other network-based analysis conducted by NYMTC, such as the analysis done on the Regional Transportation Plan and the Transportation Improvement Program, and NYMTC's conformity analysis.

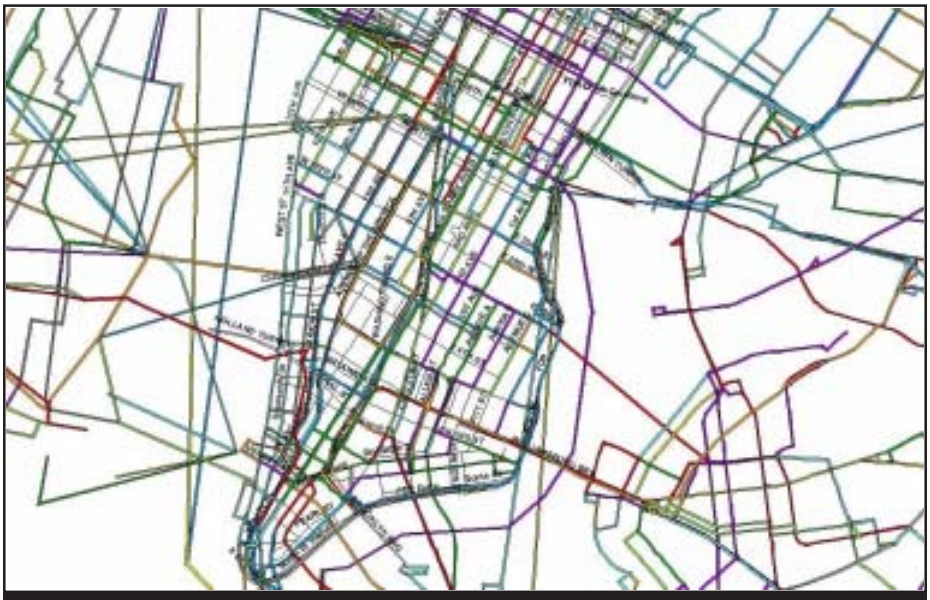
**The Highway Network** - The NYMTC highway network is GIS based and includes all minor arterials and above. The TransCAD GIS package has been used to build this network which covers 28 counties in the tri-state region. There are approximately 53,000 links in the highway network and 3,585 TAZs. All freeways and expressways in the highway networks are dualized with uni-directional ramps and interchanges. The network links include attributes such as number of lanes, functional class, capacity, free flow speeds, HOVs, tolls, signals per mile, and parking restrictions by time of the day. Truck routes are also coded in the network. The base year for the highway network is 2002. The networks will be maintained at NYMTC and updated with traffic counts, speed data, and other attributes, as information becomes available.




This map shows a portion of highway network with uni-directional ramp and expressway coding

**The Transit Network** - NYMTC transit networks are also developed in TransCAD software and cover 28 counties. The transit networks include all modes: commuter rail, subway, limited bus, express bus, local bus, and ferry routes. There are 2,756 routes coded in the network, run by both private and public operators.

For each route, information on the number of stations, service frequency, travel times, and access limitations are stored in the GIS database. All commuter and subway stations are coded as independent zones in the network. The transit network also contains data on Park and Ride access to transit. NYMTC staff will maintain this database with help from the Metropolitan Transportation Authority (MTA).



Transit Network for Lower Manhattan Color Coded by Routes

### Data describing Regional Socioeconomic/Demographic Patterns

NYMTC collects and maintains a large amount of socioeconomic data (SED) covering 31 counties in and around the NYMTC region, and summarized by TAZ. This data is an important input to the BPM. Some of the data collected are:

- Total population,
- Population in group quarters,
- K-12 enrollment,
- Housing units by structure size (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 forecasts of population, employment and labor force, from the year 2000 to 2025 at five-year intervals, for the same 31 counties, at the county level. Where possible, large regional development projects will be considered. This data is used as an input to the BPM to forecast future traffic patterns, and to develop estimates of future congestion during the development of the RTP. The Forecasting Working Group, constituting all of NYMTC's member agencies, worked very closely with NYMTC staff and NYMTC's consultant to reach a consensus on the population and employment forecasts.

## 6. Estimating Delays - Current and Future Conditions

### Current Conditions

Current traffic conditions are estimated using collected data combined with modeling techniques. As mentioned in Section 5, traffic counts and speed data are collected at approximately 2200 locations around the region to support NYMTC's CMS analysis. 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 last update of the RTP. The assigned volumes are then put into PPAQ to estimate the CMS measures of delay–both link-level and county-wide.

This data is used in several ways for the development of the RTP. Link-level delays, measured as level of service "F," 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 earlier in this report. The county-level analysis estimates the changes in delays and congestion since the last update of the RTP, three years earlier. This information is an important consideration in the development of the RTP, especially in the development of projects and strategies that should be included in the plan's recommendations. NYMTC's members make recommendations in the plan considering congestion, among other criteria.

## Future Conditions

An important part of NYMTC's CMS is the production of forecasts of future congestion. NYMTC's BPM-CMS will develop these forecasts every three years as part of updates of the Regional Transportation Plan. The analyses of future congestion become part of the statement of future conditions to be addressed by the plan.

The primary input into the congestion forecast will be NYMTC's socioeconomic forecasts. The BPM uses socioeconomic factors such as population, employment, and income to forecast future trips. Changes to any one or all of these factors will affect the BPM's forecasts. The BPM-CMS generates future trip tables, then makes a mode-split estimation, and finally assigns trips to the future network, creating link-level assignments. This information is then fed into PPAQ, which outputs the delay on routes in the network. This delay information is then used to identify congested routes.

The BPM forecast of speeds, volumes, and other network data allows for the development and monitoring of VHD and PHD, used by NYMTC as performance measures. This gives NYMTC members the tools necessary to determine if programmed investments in the Long-Range Plan generate the desired results.

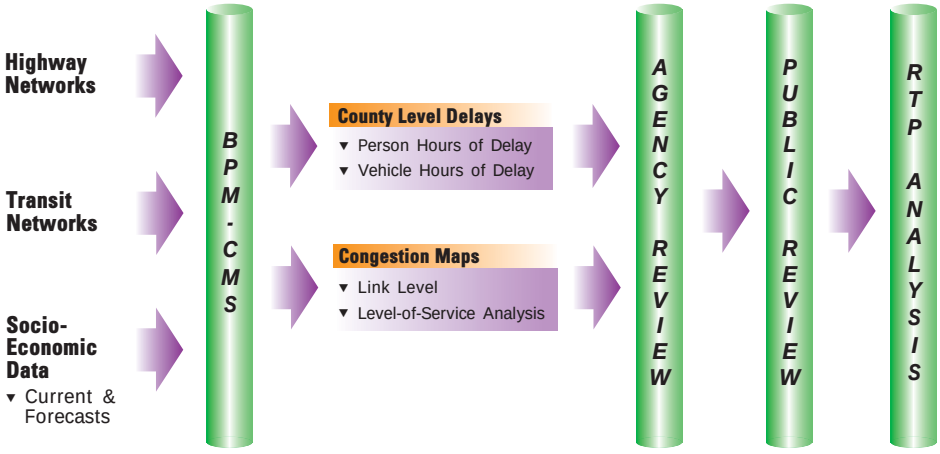
The BPM-CMS's GIS capabilities enable the results of the assessment of current and future congestion to be displayed on maps for public review and staff analysis by NYMTC and its member agencies.

## 7. Evaluation of Strategies

The final aspect of NYMTC's Congestion Management System is the evaluation of strategies to address congestion. These strategies will be generated and evaluated during preparation of the RTP.

The BPM-CMS initially generates output that illustrates "hot spots" on facilities throughout the region below the county level. In the roadway network, any facility at which capacity exceeds design volumes will be considered congested. A facility that *approaches* the capacity of its design volume (85% or higher) in the AM peak period will be considered congested, but not as severe or as critical as those that *exceed* capacity. These areas of congestion may warrant capacity improvements, Transportation System

### Procedures for Estimating Congestion



Management (TSM) or other systemic improvements. NYMTC's member agencies, with input from the public, will identify and propose solutions to the problem areas identified by the initial CMS output.

The primary analysis will be conducted at the county level, consistent with the structure of the Regional Transportation Plan, which also contains infrastructure and socioeconomic analysis at the county level. The NYMTC member agencies will propose projects, policies and strategies to address and alleviate congestion. Once the projects have been proposed, NYMTC staff will perform an analysis of the package of regional proposals and their impact on the regional network.

The proposed RTP strategies will then be prepared for evaluation: either as network-based improvements for strategies that can be located on the Best Practice Model highway and transit networks, or as PPAQ side files, for strategies that cannot be coded to the network. PPAQ can estimate PHD reductions for many types of strategies, such as Transportation Demand Management (TDM) strategies. TDM strategies cannot be coded to the geographic network because they are system-wide approaches, and do not have specific locations. This process estimates the overall effectiveness of the RTP strategies. The output is then organized and displayed by county so that the agencies with jurisdiction in that county can consider the effectiveness of the proposed plans.

Ideally, the plans will demonstrate a reduction in congestion levels, yet the process may require more than one iteration of CMS analysis, or model input and output. If the first set of proposed long range planning elements increases congestion on a regional level, the member agencies will revisit their proposed plans and modify them. The analysis will then be rerun until the output contains no negative effect on congestion. This is necessary due to legislation mandating a minimum demonstration of no increase in congestion on a regional level. The cumulative effect of this strategy is an estimate of the reduction of VHD on a regional basis, as well as a reduction of the total PHD on the network, based on the NYMTC member agency proposals.

NYMTC member agencies will take the lead in evaluating the impacts of individual projects on the local highway network and in implementing the strategies. NYMTC's BPM is the primary tool for analyzing the regional effectiveness of the strategies proposed in the RTP process, and is the regional rationale for the contents of the RTP.

## 8. Implementation of Strategies

Once the regional Congestion Management System process has identified and analyzed broad congestion management strategies, through the regular update of the Regional Transportation Plan, the other elements of NYMTC's planning process are employed to bring selected strategies to implementation.

Specifically, federal planning funds are employed as needed to plan the implementation of proposed strategies through Congestion Management (CM) Studies for specific roadways, corridors and/or areas of the region. CM Studies, which can be funded through NYMTC's UPWP or by Council members, are employed to judge the relative cost-effectiveness of congestion management strategies vis-a-vis capacity expansion projects, as required by the federal regulations governing CMS. CM Studies will result in specific transportation improvement concepts that address identified congestion.

Once improvement concepts have been defined, specific improvement projects can be considered for inclusion in the TIP. Thus, CM Studies will define improvement projects that can be included in the TIP, making them eligible receive to federal funds for implementation. Once a CMS project is implemented, an effort should be made by the implementation agency to measure the project's actual effectiveness. 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.

## 9. Corridor or Sub-area Congestion Management Studies

Corridor or Sub-area Congestion Management Studies can conducted for two reasons. One reason could be in response to current or future congestion problems identified in the Regional Transportation Plan. The second reason could be as part of the analysis of certain types of highway capacity enhancement projects.

**In Response To Congestion Problems Identified In The RTP** – When the RTP uncovers specific congestion problems, NYMTC's members may choose to undertake a study to identify the most effective strategies or projects for managing the congestion. The study could evaluate a full range of options including: highway expansion, new or improved transit services, ITS strategies, and TDM strategies. The selected strategy or project could then be evaluated further in NYMTC's UPWP or added to the TIP for implementation and/or construction.

**As Part Of The Analysis Of Highway Capacity Enhancement Projects** – Federal regulations require a CM Study whenever an agency proposes the addition of new Single Occupant Vehicle (SOV) highway capacity. In this situation the agency proposing the additional SOV capacity must conduct the CM Study 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. 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 identified reasonable travel demand reduction and operational management strategies will be incorporated into the SOV project or committed to by the State and NYMTC for implementation.

CM Studies are a microcosm of the federal CMS requirements in that they must identify and evaluate the anticipated performance and expected benefits of appropriate traditional and non-traditional congestion management strategies that will contribute to the more efficient use of existing and future transportation systems based on established NYMTC region CMS performance measures. CM studies need not be stand-alone studies and may be included as part of other studies, including Environmental Impact Statements.

In the NYMTC region, these studies are the responsibility of the member agencies, and would be conducted either in response to problems identified in the Regional Transportation Plan or as part of the project planning for any project to add at least one mile of SOV highway capacity. In either type of study, the NYMTC staff would be available to either support or lead the study by providing staff resources and/or analytical tools, such as the Best Practice Model.

## 10. Conclusion

NYMTC is currently in a pivotal developmental phase. The Council recently released its innovative new Best Practice Model and is updating its data collection efforts. This, and the complexity of the region, has thrust development of NYMTC's Congestion Management System to the forefront of its planning collaboration. NYMTC's CMS is an integral part of its ongoing regional planning process, and will continue to develop in order to address congestion problems in the New York Metropolitan area

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