2010

Congestion Management Process

ROCKINGHAM
PLANNING
COMMISSION

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Introduction

Traffic congestion is one of the many issues affecting the economic vitality and quality of life of the Rockingham Planning Commission region. It also has environmental impacts as congestion contributes to air quality and other ecological concerns. The Congestion Management Process (CMP) is a planning and project programming tool that aids in the effective management of the transportation system through development and implementation of operational and travel demand management strategies. It also provides system performance information to decision-makers to assess the effectiveness of implemented strategies as well as identify system investment priorities. This Rockingham Planning Commission (RPC) CMP includes the following:

1. Identified Congestion Management Objectives for the region
2. The established geographic area for which the CMP applies
3. A defined transportation system
4. An established set of performance measures to evaluate the existing system and the outcomes of future improvements.
5. A Performance Monitoring Plan
6. A set of potential strategies to utilize in the region to mitigate congestion

The Need for a CMP

As the region continues to grow, managing congestion will remain an important goal for the Long Range Plan, especially given limited financial resources and the inherent difficulties in expanding the roadway network. As demand and operational management strategies are implemented to address congestion problems, it becomes increasingly important to documenting these strategies in a structured process to get maximum benefit from investments in the transportation system. The CMP is the tool for documenting this process and connecting the Long Range planning goals of the region to short range project implementation. The benefits of an ongoing CMP include:

- More focused use of limited federal transportation funds where they can do the most to help the region meet congestion and system efficiency goals.
- Enhancements to each mode of transportation for what it does well, improved connections among modes, and between transportation, land use, economic development, and environmental planning
- Encouraging participation and coordination between a wider range of stakeholders which can improve data collection and progress tracking provide guidance on helping projects conform to the CMP, and obtain priority for conforming projects in the TIP and LRP.
- Regular monitoring and evaluation of system performance
- Analysis of the effectiveness of strategies to address congestion in the region.

Congestion Management Process Background and Requirements

Federal law requires that metropolitan regions with more than 200,000 people (known as Transportation Management Areas (TMAs)) maintain a Congestion Management Process (CMP) and use it to improve transportation planning and decision making. The current surface transportation law; the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), enacted in August 2005 intends the CMP as an integrated process that augments the overall metropolitan planning process. The goal is a systematic, transparent way for transportation planning agencies to identify and manage congestion, and utilize performance measures to direct funding toward projects and strategies that are most effective for addressing congestion.

Congestion Management Systems (CMS) were first mandated in 1991 as part of the Intermodal Surface Transportation Efficiency Act (ISTEA). ISTEA required state departments of transportation and Metropolitan Planning Organizations to implement a CMS with five other management systems (intermodal, public transportation, safety, pavement, and bridge). In 1995, the National Highway System Designation Act made all of the management systems optional at the state level. However, the metropolitan planning provisions of ISTEA continued to require that all Transportation Management Areas (TMAs) with a population in excess of 200,000 maintain a CMS as part of their planning process. This stipulation continued in the subsequent Transportation Equity Act for the 21st Century (TEA-21) adopted in 1998, and aside from the change in name from a "System" to a "Process", the requirements have not changed substantially under SAFETEA-LU.

Following the metropolitan planning process, Transportation Management Areas (TMA) need to address congestion management through providing for:

> "(a) The transportation planning process in a TMA shall address congestion management through a process that provides for safe and effective integrated management and operation of the multimodal transportation system, based on a cooperatively developed and implemented metropolitan-wide strategy, of new and existing transportation facilities eligible for funding under title 23 U.S.C. and title 49 U.S.C. Chapter 53 through the use of travel demand reduction and operational management strategies."[23 CFR § 450.320]

Consideration needs to be given to strategies that manage demand, reduce single occupancy vehicle travel, and improve transportation system management and operations. The Congestion Management Process should result in multimodal system performance measure and strategies that can be utilized in the development of the metropolitan transportation plan and reflected in the transportation improvement program (TIP). The RPC Long Range Transportation Plan (Plan) must consider the results of the congestion management process including the identification of SOV projects because the region is a part of the larger Boston MA-NH-RI Urbanized Area as well as part of a nonattainment area for ozone.

According to the provisions in SAFETEA-LU, this process should encompass:

- Methods to monitor and evaluate the performance of the multimodal transportation system, identify the causes of recurring and non-recurring congestion, identify and evaluate alternative strategies, provide information supporting the implementation of actions, and evaluate the effectiveness of implemented actions.
- Definition of congestion management objectives and appropriate performance measures to assess the extent of congestion and support the evaluation of the effectiveness of congestion reduction and mobility enhancement strategies for the movement of people and goods.

Performance measures should be established cooperatively by State, MPO and local officials - in consultation with operators of major modes of transportation.

- Establishment of a coordinated program for data collection and system performance monitoring to define the extent and duration of congestion. This data collection program should be coordinated with existing data sources like a Transportation Management Center (TMC).
- Identification and evaluation of the anticipated performance and expected benefits.
- Development of implementation schedule, along with information on implementation responsibility and possible funding source for each strategy.
- Implementation of a process for periodic assessment of the effectiveness of implemented strategies. The results of this assessment should be provided to decision makers and the public to provide guidance for future strategy selection.

Goals and Objectives of the CMP

The overarching goal of the RPC Congestion Management Process is to measure and identify current and expected transportation system congestion through data collection, travel demand modeling, and capacity analysis and to utilize that information to aid decision-making regarding project priorities for the region. This follows from Goal Three of the Long Range Transportation Plan which has direct application to the content and intent of the Congestion Management Process:

> **"Goal 3: TRANSPORTATION SYSTEM ATTRIBUTES:** *Develop a transportation system that moves goods and provides universal access for all residents and visitors to employment centers, housing areas, shopping areas, professional services, entertainment and sports venues, and recreation areas in a manner that is efficient and safe."*

Similarly, many of the MPO Policies listed under Goal 3 of the Long Range Plan are applicable to the Congestion Management Process, and provide guidance in the development of the objectives, performance measures, and strategies that form a link between the two documents:

Policy 3.2: *Ensure that all components of the region's transportation system are well-integrated, efficient and user-friendly.*

Policy 3.4: *Identify and implement operational and management strategies to improve the performance of the existing transportation facilities, relieve vehicular congestion, and maximize the safety and mobility of people and goods.*

Policy 3.6: *Encourage communities to work cooperatively in planning and prioritizing transportation projects, in developing and implementing consistent access management standards, and in developing zoning that is compatible across community lines.*

Policy 3.7: *Promote energy conservation in the movement of people and goods, including support for the development and implementation of alternative fuels (and alternative methods of using those fuels) that have a positive environmental impact.*

Policy 3.8: *Utilize new technologies to reduce congestion, improve traffic flow, and enhance public transportation.*

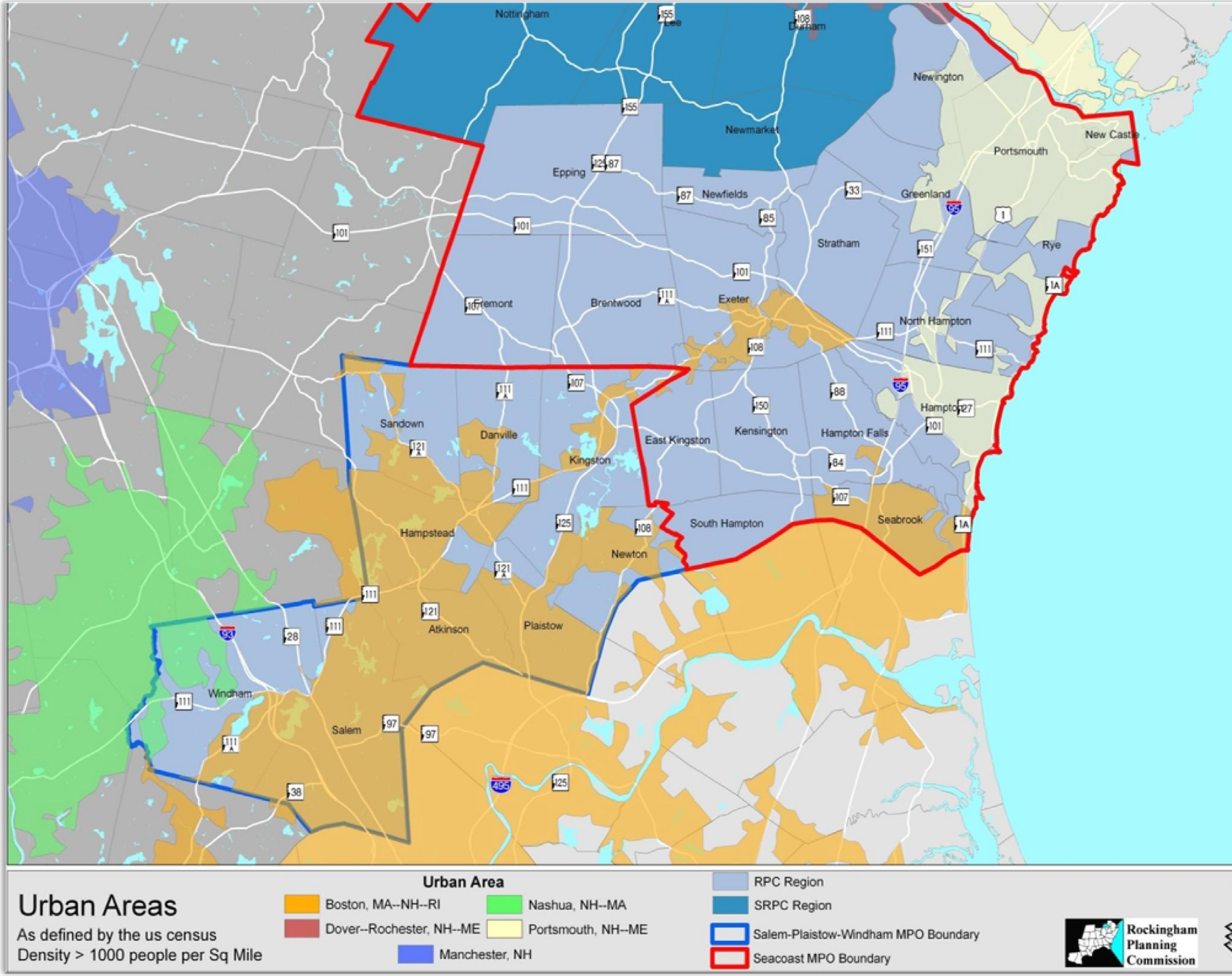
Policy 3.9: *Minimize the impacts of through traffic on neighborhoods, commercial areas, and local roads by maximizing the use of primary transportation corridors and employing techniques such as traffic calming.*

For the purposes of the CMP, the policies in the Long Range Plan must be modified to be more specific and detailed to track progress toward meeting them over different timeframes (daily, annual), different scales (regional, corridor), by various modes (highway, freight, transit), as well as from both the facility perspective (volume to capacity ratio and level of service) and the user experience perspective (travel time, delay, and reliability). As this is the first work on a CMP for the RPC region (and in New Hampshire), the current set of objectives is primarily focused on the establishment of the data collection and monitoring program and coordination with other MPO and statewide processes. The objectives of the CMP are the following:

- ***Objective 1:*** Develop travel time data for each of the corridors included in the Congestion Management Process for at least one peak period. One half of the corridors will be updated each year after the initial data collection.
- ***Objective 2:*** Establish permanent automatic traffic monitoring stations along all CMP corridors by 2015.
- ***Objective 3:*** Integrate CMP data collection efforts with the efforts of NH DOT and the other NH MPOs by 2015.
- ***Objective 4:*** Produce a biennial CMP report that details data collection and analysis efforts as well as the current state of included corridors and the details of any projects implemented.
- ***Objective 5:*** For the 2011 annual CMP report, produce detailed profiles for each corridor and/or transit service included in the CMP.
- ***Objective 6:*** Integrate the CMP into the project development and prioritization process of the MPO for the 2012 TIP and Long Range Plan updates.

Geographic Coverage Area

Technically, the RPC Congestion Management Process could include just the Rockingham Planning Commission communities within the Boston, MA-NH-RI urbanized area. This includes 12 of the 27 RPC communities; Atkinson, Danville, Exeter, Hampstead, Hampton Falls, Kingston, Newton, Plaistow, Salem, Sandown, Seabrook, and Windham. It is expected that the results of the 2010 Census will expand the Boston, MA-NH-RI urbanized area to include additional RPC communities and potentially merging with the Portsmouth, NH-ME urbanized area. For that reason, and to completely include specific transportation corridors within the CMP, all 27 communities within the Rockingham Planning Commission MPO planning area will be included in the analysis and process.


Urban Areas
As defined by the us census
Density > 1000 people per Sq Mile
Urban Area
Boston, MA--NH--RI
Dover--Rochester, NH--ME
Manchester, NH
Nashua, NH--MA
Portsmouth, NH--ME
RPC Region
SRPC Region
Salem-Plaistow-Windham MPO Boundary
Seacoast MPO Boundary
Rockingham Planning Commission
Nottingham
Lee
Durham
Newington
Newmarket
New Castle
Portsmouth
Epping
Newfields
Greenland
Rye
Stratham
Fremont
Brentwood
Exeter
North Hampton
Sandown
Danville
Kingston
East Kingston
Kensington
Hampton Falls
Hampton
Hampstead
South Hampton
Seabrook
Newton
Atkinson
Plaistow
Windham
Salem
155
108
87
125
101
33
85
151
1
1A
111
107
111A
88
95
150
27
121A
84
121
28
93
97
38
495

System Definition

There is a backbone of transportation routes that carry the majority of long distance travel within the region as well as to and from adjacent regions. These routes carry the highest volumes of people and goods between the communities and the regional employment and other activity centers. These routes tend to be on the National Highway System (NHS) and are made up of Interstate Highways, Expressways, and other Principal Arterials. These roadways in the RPC are:

- ***Interstate 95 (I-95)*** is an eight lane, toll facility that crosses the southeastern portion of the RPC between Massachusetts and Maine. The route serves as a major commuter transport corridor in the region, as well as handling year round tourist traffic between southern and northern coastal New England and the Maritime Provinces of Canada. Because of the tourist traffic, volumes on the roadway vary significantly by time of year from an average of 69,000 (2008) vehicles per day in the winter, to 129,000 (2007) vehicles on an average weekend day at the peak of summer traffic in August.

- ***Interstate 93 (I-93)***, a grade-separated freeway, is located in the western part of the region and runs north/south from Massachusetts through Salem and Windham and north to Manchester, Concord, and northern New Hampshire. The Average Daily Traffic (ADT) ranged from approximately 108,000 at the NH-MA state line to approximately 72,000 at the Derry- Windham town line in 2008. Interstate 93 is currently scheduled to undergo a widening to 4 lanes in each direction from exit 1 north through Exit 3. Interchanges and bridges will also be reconfiguration and reconstructed and Park and Rides constructed at Exits 2, 3, 4, and 5, transit service along the corridor, and technical assistance to communities (CTAP) impacted by growth due to the project. Plans also extend the widening north to Manchester (3 lanes in each direction), however limited funding has put this portion of the project on hold at this time.

- ***NH 101*** is the region's major east-west highway and in the past was a high traffic and high accident corridor. A major upgrade was completed in 2001, completing the current grade separated, four-lane facility connecting Interstate 93 in Manchester with Interstate 95 in Hampton. East of the interchange with Interstate 95, NH 101 reduces to two lanes until its end at Route 1A in Hampton. The transformation of this roadway has reduced the number and severity of some types of accidents (head-on collisions for instance), but has also seen a significant increase in traffic. According to the permanent counter located in eastern Exeter, the adjusted average daily traffic was 33,500 at the completion of construction (2001). By 2007 this had grown to 41,000 showing a 5% per year average growth rate.

- ***NH 16***, also known as the ***Spaulding Turnpike***, is a north-south, limited access toll roadway which carries commuter and tourist traffic, and serves as a gateway from the Seacoast to the Lakes Region. ADTs on NH 16 are approximately 70,000 vehicles per day (2007) at the Little Bay Bridges between Newington and Dover. This facility is scheduled to be improved between Exits 3 and 6 by widening the bridges and roadway to 4 lanes in each direction, and reconfiguring the interchanges. Additional work will occur on connecting roadways to improve traffic flow on and off of the highway.

- ***NH 125*** is primarily a 2 lane roadway that carries traffic from Massachusetts through Plaistow, Kingston, Brentwood and Epping where it exits the RPC region. The road connects I-495 to NH 111, NH 101, and further north to US Route 4, and Route 16 (Spaulding

Turnpike) and into Maine. Except for short four lane sections near the Massachusetts border and around NH 101, NH 125 is a two lane roadway with ADTs that range from 25,000 (2005) at the border, to approximately 15,000 (2006) in Kingston, and 24,000 vehicles per day north of NH 101 in Epping. NH 125 is being improved in Plaistow and Kingston by widening, adding traffic signals, and making other intersection improvements, and implementing access management policies. A study of the corridor from Epping to Rochester was recently completed with extensive recommendations for improvements in Epping that would widen the roadway to 5 lanes and reconfigure traffic signals along the route. A study of the Brentwood portion of the corridor will start in 2008.

- ***Interstate 495***, although outside of the RPC region, is an important facility which follows an east-west path through the center of the adjacent Merrimack Valley Region. The highway forms an "outer belt" around the Boston Metropolitan area and provides connections to NH highways in the area such as Routes 28 and 97 in Salem, and Route 125 in Plaistow, as well as providing an east-west connection between Interstates 93 and 95.

- ***US 1*** is a heavily developed two lane roadway for most of its length that provides local connections to communities along the seacoast, access to NH beaches for tourists, as well as high levels of commercial activity. Traffic volumes vary greatly depending on location and range from 13,000-26,000 (2006). Volumes stay above 20,000 vehicles per day through much of the area between Seabrook and Hampton, and drop off in North Hampton and Rye to the 15,000-18,000 range. Volumes grow again as you enter Portsmouth until the split for the US 1 Bypass which connects again to Interstate 95, the Spaulding Turnpike, as well as continuing to Maine via the Sarah Long Bridge. US 1 itself continues through Portsmouth, and crosses to Maine via the Memorial Bridge. Projects are underway to rehabilitate the Memorial Bridge as well as the bridges along the US 1 Bypass.

- ***US 1 Bypass:*** The US 1 Bypass connects US 1 from the south end of Portsmouth to I-95 and the Spaulding Turnpike (NH 16) and then continues across the Sarah Long Bridge to Kittery, ME. The bypass also provides connections to Portsmouth streets at Borthwick Avenue (to Portsmouth Hospital), and Woodbury and Maplewood Avenues connection to both the downtown and the retail centers along Woodbury Avenue. The roadway carries approximately 25,000 ADT on the section south of the Portsmouth traffic circle and approximately 16,000 on the north section. A plan has been developed for the corridor to make significant capacity and safety improvements as well as rehabilitate the many bridges over the bypass. Except for the bridge work, the improvements are on hold pending funding availability.

- ***NH 28*** provides a parallel route to Interstate 93 in Salem and Windham and on to Manchester. This is a heavily travelled roadway with significant retail and other commercial development, particularly in Salem. Volumes range from 23,000-25,000 Average Daily Traffic (ADT) in Salem, to around 18,000 vehicles at the Windham town line, and to 12,000 ADT at the Derry town line.

- ***NH 33*** provides a connection between Stratham where it intersects with NH 108 at the Stratham circle and I-95 in Portsmouth where it serves as a western route around the Great Bay. Improvements to the I-95 interchange and the opening of the southern entrance to the Pease International Tradeport in Portsmouth have boosted the traffic volumes on the roadway to around 25,000 ADT.

- ***NH 107:*** NH 107 connects US1 and Interstate 95 in Seabrook with NH 150, NH 108, and NH 125 to the west before turning northward and crossing NH 101 outside of the RPC region at Exit 5 in Raymond. The roadway is heavily travelled between US 1 and I-95 carrying approximately 24,000 ADT on this critical section. West of I-95 traffic drops off significantly to approximately 10,000 ADT and then 7,000 ADT at the Kensington town line and stays at that volume or lower except where the roadway is also designated as NH 125 in Kingston. For the purposes of the CMP, monitoring will be along the segment of the roadway in the vicinity of US 1 & I-95.

- ***NH 108*** is a two lane roadway with ADTs ranging from 5,000 vehicles per day at the Massachusetts border in Plaistow, to 23,000 per day in Exeter and Stratham, where it serves commuters, commercial traffic, and provides a connection to NH 101. NH 108 continues on to Newfields where it exits the region with volumes around 18,000 ADT. Focus will be confined to the Exeter/Stratham portion of the corridor where it connects with NH 101 and with NH 33.

- ***NH 111*** provides a second east-west route through the RPC region that connects the coast in North Hampton to Windham, and continues west to Nashua. This facility interconnects Route 1, NH 125, NH 28, and I-93. The roadway has two distinct regions of heavy activity located around I-93 in the west, and Exeter and NH 101 in the east. Volumes range from a low of 5,000 ADT in North Hampton, to 19,000 ADT through Exeter, to 23,000 near I-93 in Windham (2005).

- ***COAST*** , The Cooperative Alliance for Seacoast Transportation provides bus transit service in Exeter, Stratham, Greenland, Portsmouth and Newington, with connections northward to Dover, Somersworth, Rochester, Farmington, and South Berwick, Maine. The Portsmouth Trolley service, Route 7, and the southern portion of Route 2 will be monitored and included in the CMP.

- ***Intercity bus service*** is available in the I95, I93, and NH Route 125 corridors, with an emphasis on Boston-bound commuter travel as well as access to Logan Airport. C&J, formerly C&J Trailways, provides over 20 round trips daily between Boston and the Portsmouth Transportation Center, with northbound connections to Dover. The Coach Company provides three daily commute hour trips from Plaistow to Boston via Newburyport. In the I93 corridor The Boston Express currently operates extensive Boston-bound commuter bus service between Concord, Manchester, and Boston with 18 southbound and 19 northbound trips stopping at the Exit 2 park and ride in Salem. Service will be expanding to Exit 3 in Windham with the completion of the park and ride at that location as well.

- ***Amtrak's Downeaster*** service between Portland and Boston includes several station stops in Southern Maine, Northern Massachusetts, and three New Hampshire communities – Exeter, Durham, and Dover. The service expanded in 2007 to feature five daily round trips, plus a supplemental sixth commuter trip via bus. During FY2008 the Downeaster carried over 440,000 riders, with over 30% of passengers boarding or alighting at New Hampshire stations. MBTA commuter rail service is available from Newburyport and Haverhill in Northern Massachusetts and is potentially expanding into Plaistow.

- There are currently eight ***Park & Ride facilities*** in the region operated by the NH Department of Transportation (NHDOT). These include lots in Epping at the intersection of

Routes 101 and 125; in Hampstead at the intersection of Route 111 and 121; in Hampton at the intersection of Route 101 and 27; in Plaistow on Westville Road just east of Route 125; in Salem at Exit 2 on I-93; in Windham at Exit 3 on I-93; and in Portsmouth at Exit 3A on I-95, and on Route 33 just east of I-95. The Exeter rail station, operated by the Town of Exeter, also functions as a Park & Ride facility.

Identifying and Defining Traffic Congestion

The U.S. Department of Transportation defines congestion as "*the level at which transportation system performance is no longer acceptable due to traffic interference*" and The Transportation Research Board defines congestion as "*travel time or delay in excess of that normally incurred under light or free-flow travel conditions*." However determining exactly at what point delay becomes excessive or performance "no longer acceptable", is dependent upon geographic location, the type of transportation facility, and even time of day. On a basic level, congestion is easy to distinguish and define as you can observe stop and go traffic on the roadways, crowded sidewalks, and packed buses. For the purposes of the Congestion Management Process however, more explicit definitions are needed to delineate those locations with excessive congestion, track trends, and identify locations expected to become congested in the future. Previous experience and research has shown that congestion is the result of seven root causes[1], often interacting with one another:

- ***Physical Bottlenecks ("Capacity")*** – Capacity is the maximum amount of traffic capable of being handled by a given highway section. Capacity is determined by a number of factors: the number and width of lanes and shoulders; merge areas at interchanges; and roadway alignment (grades and curves).
- ***Traffic Incidents*** – Are events that disrupt the normal flow of traffic, usually by physical impedance in the travel lanes. Events such as vehicular crashes, breakdowns, and debris in travel lanes are the most common form of incidents.
- ***Work Zones*** – Are construction activities on the roadway that result in physical changes to the highway environment. These changes may include a reduction in the number or width of travel lanes, lane "shifts," lane diversions, reduction, or elimination of shoulders, and even temporary roadway closures.
- ***Weather*** – Environmental conditions can lead to changes in driver behavior that affect traffic flow, such as slower traveling speeds and greater spacing of vehicles.
- ***Traffic Control Devices*** – Intermittent disruption of traffic flow by control devices such as railroad grade crossings and poorly timed signals also contribute to congestion and travel time variability.
- ***Special Events*** – Are a special case of demand fluctuations whereby traffic flow in the vicinity of the event will be radically different from "typical" patterns. Special events occasionally cause "surges" in traffic demand that overwhelm the system.
- ***Fluctuations in Normal Traffic*** – Day-to-day variability in demand leads to some days with higher traffic volumes than others. Varying demand volumes superimposed on a system with fixed capacity also results in variable (i.e. unreliable) travel times.

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[1] From "White Paper: The Congestion Management Process for State and Metropolitan Transportation Planning", Erin Flanigan, P.E., AASHTO, November, 2008. http://www.statewideplanning.org/_resources/242_NCHRP-08-36-76b.pdf

Based on this information, a number of ways to define congestion related to automobile and transit travel in the region are offered. For the purposes of the Congestion Management Process these definitions are focused in three areas; Capacity Utilization, Recurring Congestion (daily peak period travel), and Non-Recurring Congestion (impacts of accidents and other unpredictable events).

Facility Type	Definition of Congestion
Roadway Segments	• Links with a Level of Service of E or F (Freeways) • Links with a Level of Service of E, or F (Non-freeways) • Segments with travel times 1.5 times (or greater) than the free-flow travel time • Segments with high crash frequencies during peak periods (Greater than the regional average of 0.09 accidents per day or 1 accident every 10.72 days)
Intersections	• Overall composite LOS of E, or F • Intersections with crash frequencies during peak periods that are greater than the regional average
Transit	• Transit Load factor: Trips with 80% or more bus capacity utilized • Route with < 90% On-time performance

Applicable Performance Measures

Performance measures are a qualitative or quantitative characteristic describing the quality of service provided by a transportation facility or service primarily from the user's point of view. Development of congestion or performance measures is a key issue in the CMP as there needs to be consistency between the evaluation criteria, and the associated data collection and analytical procedures that are selected to support them. In addition, for a measure to useful, supporting data must be readily available or easy to collect given limited resources. The CMP will be utilizing a limited set of performance measures that address how much capacity is being used, how much day-to-day congestion is experienced, and provide insight into the impacts of non-recurring congestion from traffic accidents and other incidents. The following measures of transportation system performance are typical of those that will be utilized in the CMP for the RPC Region:

Capacity Utilization Measures

- ***Vehicle Miles of Travel (VMT):*** This measure estimates what percentage of the capacity of a roadway is being utilized by traffic. It is calculated by multiplying the amount of vehicle travel on a designated roadway by the total mileage of that roadway.
- ***Volume Capacity Ratio and Level of Service:*** The volume/capacity (v/c) ratio is a number between zero and two and is derived from dividing the traffic volume on a road by the capacity of that roadway. In a standard engineering capacity analysis, a volume/capacity ratio of 1.00 represents a road where the volume matches the capacity. As the number surpasses 1.00 and approaches 2.00, more congestion is indicated. The Seacoast Regional Travel Demand Model has a slightly different scale where failure condition is indicated by a v/c ratio of 1.35 or greater as shown in the table below. Level of Service (LOS) applies an A to F "grade" to ranges of v/c ratios and equates them to vehicles move along the roadway. LOS A is the equivalent to free flowing traffic while F indicates a breakdown in flow.

- ***Transit Level Of Service:*** Transit level of service (LOS) is a performance measure, which identifies the congestion level based on the volume capacity ratio on a route during peak periods. LOS is represented by the letters "A" through "F," with "A" being the best and "F" being not desirable. Listed below is the determination of respective LOS based on the volume capacity ratio.

Measures of Congestion for each Level of Service

Level of Service	Signalized Intersection Stopped Delay per Vehicle (seconds)*	Unsignalized Intersection Stopped Delay per Vehicle (Seconds)	Equivalent Volume to Capacity Ratio (v/c)*	Equivalent Travel Demand Model v/c Ratio	Density Range (passenger cars per mile per lane)*	Transit volume to capacity Ratio (v/c) [Riders]
A	≤ 10.0	≤ 10.0	≤ 0.50	< 0.60	0 – 11	0 to .50
B	10.1 to 20.0	10.1 to 15.0	0.60 to 0.69	0.60 to 0.80	> 11 – 18	51 to .75
C	20.1 to 35.0	15.1 to 25.0	0.70 to 0.79	0.80 to 1.00	> 18 – 26	.76 to 1.0
D	35.1 to 55.0	25.1 to 35.0	0.80 to 0.89	1.00 to 1.20	> 26 – 35	1.01 to 1.25
E	55.1 to 80.0	35.1 to 50.0	0.90 to .99	1.20 to 1.35	> 35 – 45	1.26 to 1.50
F	> 80.0	> 50.0	≥ 1.00	> 1.35	> 45	> 1.5

* Source: 2000 Highway Capacity Manual, FHWA, Chapter 13.

Measures of Recurring Delay

- ***Congested Speed:*** is the estimated speed at which traffic would be moving based on modeled congestion. The congested speed is taken directly from the travel model on the segment of the road with the slowest congested speed.

- ***Delay:*** A measure of delay that indicates the number of hours the traffic stream is delayed, measured in vehicle-hours.

- ***Vehicle Delay***: is a measure of actual delay per vehicle (in seconds) on the road.

- ***Transit Travel Time***: Is a measure of how long a transit vehicle takes to travel a route or a corridor, including the time necessary to stop and disembark or take-on passengers.

- ***On-time Performance***: is a measure of how often a particular transit service arrives and departs destinations according to advertized schedules. Routes experiencing congested travel may reflect this in poor on-time performance.

- ***Travel Time Index:*** The Travel Time Index (TTI) is the ratio of peak period travel time to free flow travel time. The TTI expresses the average amount of extra time it takes to travel in the peak relative to free-flow travel. A TTI of 1.3, for example, indicates a 20-minute free-flow trip will take 26 minutes during the peak travel time periods, a 6-minute (30 percent) travel time penalty.

Level of Service	Posted Speed			
	45-55 MPH	35-40 MPH	30 MPH	25-30 MPH
	Model-generated Average Travel Speed (MPH)*			
A	> 42	> 35	> 30	> 25
B	34 – 42	28 – 35	24 – 30	19 – 25
C	27 – 34	22 – 28	18 – 24	13 – 19
D	21 – 27	17 – 22	14 – 18	9 – 13
E	16 – 21	13 – 17	10 – 14	7 – 9
F	≤ 16	≤ 13	≤ 10	≤ 7

* Source: 2000 Highway Capacity Manual, FHWA, Chapter 13.

Measures of Non-Recurring Delay

- ***Travel Time Reliability:*** Traffic accidents, special events, construction activities, weather, and other factors create variation in travel time that effect decisions that individuals make regarding routes and departure times. With appropriate information, a measure of reliability can be derived that from the differences in travel time when accounting for the frequency of non-recurring events.

- ***Crash Rate:*** The crash rate for a corridor is the number of accidents per million miles of travel. Combined with other measures, this can provide insight into the causes of congestion on some corridors as accidents can have dramatic impacts on the capacity of the roadway for short periods of time.
- ***Crash Frequency:*** The frequency at which accidents occur on a roadway, especially during peak periods of travel, plays an important factor in the travel time reliability expectations that users have of a particular roadway. While a corridor may have a relatively low accident rate overall, even a few accidents can create lasting disruptions if timed during peak travel times. Examining the frequency at which accidents are happening on CMP corridors can provide insight into the amount of disruption that travelers face on roadways and the resulting variability in travel times.
- ***Work Zone and Special Event Identification:*** The identification of work zones and special events that impact traffic along CMP corridors can aid in the understanding of non-recurring congestion in the region. NH DOT is utilizing "Smart Work Zones" for several major construction projects in the state, and speed sensors provide information on delay related to those projects, and can help to estimate the delays caused by future projects. In addition, understanding what special events or construction is occurring during other data collection activities such as travel time studies provide important context to changes in travel time or travel speeds over time.

The intent of this initial CMP is to establish a limited set of performance measures that enhance the analytical capability of the staff and transportation decision-makers. It is expected that these will evolve and change over time as new needs arise, different data becomes available, or as resources permit.

Equations Utilized to Calculate Mobility Measures

Individual Measures	
Delay per Traveler	$\text{Delay per Traveler (annual hours)} = \dfrac{\left[\text{Actual Travel Time (minutes)} - \text{FFS or PSL Travel Time (minutes)}\right] \times \text{Vehicle Volume (vehicles)} \times \text{Vehicle Occupancy (persons/vehicles)} \times \dfrac{\text{250 weekdays}}{\text{year}} \times \dfrac{\text{hour}}{\text{60 minutes}}}{\text{Vehicle Volume (vehicles)} \times \text{Vehicle Occupancy (persons/vehicles)}}$
Travel Time	$\text{Travel Time (person – minutes)} = \text{Actual Travel Rate (minutes per mile)} \times \text{Length (miles)} \times \text{Vehicle Volume (vehicles)} \times \text{Vehicle Occupancy (persons/vehicles)}$
Travel Time Index or Travel Rate Index	$\text{Travel Time Index or Travel Rate Index} = \dfrac{\text{Actual Travel Rate (minutes per mile)}}{\text{FFS or PSL Travel Rate (minutes per mile)}}$
Buffer Index	$\text{Buffer Index (\%)} = \left[\dfrac{\text{95th Percentile Travel Time (minutes)} - \text{Average Travel Time (minutes)}}{\text{Average Travel Time (minutes)}}\right] \times 100\%$
Planning Time Index	$\text{Planning Time Index (no units)} = \dfrac{\text{95th Percentile Travel Time (minutes)}}{\text{FFS or PSL Travel Time (minutes)}}$
Area Mobility Measures	
Total Delay	$\text{Total Segment Delay (person - minutes)} = \left[\text{Actual Travel Time (minutes)} - \text{FFS or PSL Travel Time (minutes)}\right] \times \text{Vehicle Volume (vehicles)} \times \text{Vehicle Occupancy (persons/vehicles)}$
Congested Travel	$\text{Congested Travel (vehicle - miles)} = \sum \left[\text{Congested Segment Length (miles)} \times \text{Vehicle Volume (vehicles)}\right]$
Percent of Congested Travel	$\text{Percent of Congested Travel} = \left[\dfrac{\sum_{i=1}^{n}\left[\left[\text{Actual Travel Time}_i\text{ (minutes)} - \text{FFS or PSL Travel Time}_i\text{ (minutes)}\right] \times \left[\text{Vehicle Volume}_i\text{ (vehicles)} \times \text{Vehicle Occupancy}_i\text{ (persons/vehicles)}\right]\right]_{\text{Each congested segment}}}{\sum_{j=1}^{m}\left[\text{Actual Travel Rate}_j\text{ (minutes per mile)} \times \text{Length}_j\text{ (miles)} \times \text{Vehicle Volume}_j\text{ (vehicles)} \times \text{Vehicle Occupancy}_j\text{ (persons/vehicles)}\right]_{\text{All segments}}}\right] \times 100$
Congested Roadway	$\text{Congested Roadway (miles)} = \sum \text{Congested Segment Length (miles)}$
Accessibility	$\text{Accessibility (opportunities)} = \sum \text{Objective Fulfillment Opportunities (e.g., jobs) Where Travel Time} \le \text{Target Travel Time}$
Equations from Texas Transportation Institute “Guidebook for Mobility Monitoring In Small to Medium-Sized Communities”	

Performance Monitoring Plan

Currently, the primary traffic data collection effort of the MPO is a three component annual program of traffic counting in the region. The first component consists of permanent counters embedded in the roadways that capture data 24 hours a day, every day of the year. The second component consists of seventy-two hour automatic directional traffic volume counts conducted with the exact number and location of counts determined by NHDOT, and coordinated with community requests and project needs where possible. Through this, the RPC conducts up to 160 ADT counts and 12 Manual Classification counts each season. The final component consists of manual turning movement counts conducted at up to 10 intersections during the peak-hour (unless otherwise specified) at locations coordinated with the NHDOT. For a fully functioning Congestion Management Process, data collection efforts will need to be modified and expanded in several ways.

Annual Volume and Classification Counts

The number of classification counts will need to be increased to better track truck volumes on the CMP corridors in the region. It also may be necessary to perform more counts than currently completed, or shift some current count locations to places more advantageous for the monitoring of congestion on the CMP corridors. In some cases, traffic volumes may require the use of equipment designed to capture volumes and vehicle classification on heavily travelled roadways such as radar based systems. Data collected from this aspect includes snapshots of traffic volumes, vehicle classification information, point travel speeds and direction of travel.

Permanent Traffic Counters

The number of permanent traffic volume counters will need to be expanded to ensure that there is at least one counter on each end of the National Highway System (NHS) roadways in the region (I-93, I-95, NH 16, NH 101), as well as at least one on the other CMP corridors. Data collected from the permanent counters includes directional traffic volumes for each day of the year (barring technical issues). In some cases vehicle classification or other data may be available as well.

Permanent Counter Locations in the RPC Region

Route	Location
US 1	Hampton South of NH 101
US 1	North Hampton North of B&M Bridge
NH 1A	Hampton at Seabrook Town Line
NH 28	Windham at Derry Town Line
NH 101	Exeter East of NH 88
I-95	Seabrook at NH/MA State Line
I-95	Hampton Exit 2 Tolls
US4/NH16	Newington at Exit 4/5
I-93	Salem @ NH/MA State Line
I-93	Windham at Derry Town Line
NH 125	None
NH 111	None
NH 33/108	None

Travel Time Studies

GPS-based travel time runs will be conducted to measure a variety of quantitative data that is important to identify and evaluate congested locations. Such data will accommodate performance measures that account for travel time, delay, speeds, and stops during one or more peak travel periods. The busiest peak travel periods in the RPC region typically occur during weekday morning (approximately 7:00-9:00 AM) and afternoon (approximately 4:00-6:00 PM) commuter and school travel periods. There are also significant weekend peak periods related to regional recreation and tourism opportunities during the summer months and regional retail centers all year. Travel time data collection efforts will expand upon the peak periods to include adjacent non-peak times (7:00-10:00 AM and 3:00-7:00 PM for example) to provide off-peak travel times for comparison purposes. Primary measures for comparing or prioritizing multiple corridors will include total delay and delay rate, measured travel time and delay, delay ratio, average speed, number of stops, and stop rate. Travel time data may also be supplemented with commercially available data depending on availability and cost.

Transit Use and Travel Data

A variety of data is currently collected by the transit agencies and companies in the region. The RPC CMP will be leveraging that data availability and supplementing it where possible with additional data collection activities. Currently COAST collects periodic boarding and disembarkation data, as well as conducts biennial surveys that gauge rider needs and attitudes. In addition, next year COAST will be conducting an update to their data on average trip lengths for riders. RPC will also be working with Boston Express, C&J Trailways, and the Downeaster to get travel time data, ridership, boarding information, and on-time performance statistics.

Park and Ride Utilization

Gather current data on use of regional park and ride facilities, including the Portsmouth Transportation Center (PTC), as well as park and ride lots in Salem, Windham, Hampton, Hampstead, and Plaistow. Of particular interest is assessing multi-day use vs. daily use by commuters and the impacts of that use on daily capacity.

Real-time Traffic Data

RPC will work with the NH DOT Traffic Management Center to utilize real-time traffic data where it is available. The Traffic Management Center also utilizes sensors in a limited number of "Smart Work Zones" to monitor and manage traffic through areas of construction. The TMC utilizes the data generated to generate a number of reports regarding the impacts of the construction sites on travel including variables such as incidents weather, and other factors. Much of this information can be accessed in real time via the NH DOT 511 website (http://www.nh.gov/dot/511/index.htm) however access to archival data may be possible and will be useful in determining travel time reliability.

Implementation and Monitoring Plan

The initial development of the CMP requires a certain amount of data collection and analysis to identify the appropriate corridors to include, the relevant performance measures, and the potential data collection efforts required. In that sense, the RPC has already began implementing the CMP through efforts to establish baseline information on the corridors expected to be included, and will continue to do so with the initiation of travel time studies in summer, 2010. Tracking congestion will require annual efforts by RPC staff and the establishment of scheduled data collection, analysis, and summarization through the following steps:

1. ***CMP Corridor Definition:*** The limits of the corridor for the purposes of the CMP must be established, and evaluated over time for changes such as new congested areas outside of areas currently considered. Once defined, a corridor must be separated into logical segments and nodes to provide a finer level of detail, as well as to facilitate data collection and reporting. Node locations should include all signalized intersections and major route junctions, as well as political boundaries.
2. ***Corridor Data Collection:*** Basic information regarding each corridor should be collected through available data sources and through a field review of each roadway. Information

collected should include classification information, special uses or considerations, issues and concerns, adjacent land uses, multimodal uses, photos of the corridor, traffic volume and classification data, and accident statistics. This is supplemented by annual data collection efforts over time to gather travel time and delay information along with vehicle volumes and classification.

3. ***Corridor Performance Summary:*** A summary report will be produced for each corridor in the CMP to compile all data collected in the steps above. The report will consist of a map of the corridor and relevant traffic information as well as a summary narrative identifying changes on the corridor, as well as any apparent trends. The report will be updated on an annual basis and will also identify and evaluate Congestion Management Toolbox strategies that fit the circumstances of each segment or intersection proposed to be addressed with mitigation efforts.
4. ***CMP Performance Summary:*** The individual corridor reports and data collected will be compiled into a regional summary on an annual basis. In addition to including the individual corridor summaries, this report will identify regional trends and impacts from changes. This document will assist decision-makers in project considerations for funding, as well as provide background project development information for proposals from NH DOT and the communities.

Update Process

The Congestion Management Process is an ongoing effort that will require consistent management and updating as new information is collected over time. The RPC will maintain responsibility for updating and revising the Congestion Management Process, conducting data collection efforts, preparing and distributing reports, as well as coordination with regional partners in these efforts. The update schedule for the CMP is the following:

- Annually collect data and update Corridor Performance Summaries
- Annually produce a CMP Performance Summary
- Biennially review and update the CMP data collection efforts, and modify as necessary. At this time new areas to be considered for addition to the CMP should be monitored and listed for consideration to be added at the next update.
- Every 4 years review and update all aspects of the CMP as necessary. This should include a review and assessment of the utility of the annual reports as well as an evaluation of the effectiveness of any congestion management strategies that have been implemented.

Integration into the Planning Process

The final step in implementing and maintaining the CMP is fully integrating the process into the other planning efforts of the MPO. The data made available to the decision-makers in the region through the corridor summaries and regional report

- Use the CMP as further basis for the establishment of corridor monitoring committees which has been a goal of the MPO for a number of years.
- Use the CMP information to develop project selection criteria for use by the MPO and other agencies
- Use the CMP data to identify congestion management strategies for all monitored corridors.

- Use the potential strategies identified and other CMP data to aid in the project prioritization process for including projects in the MPO Long Range Plan, State Ten Year Plan, and the TIP.
- Use the CMP to convey information to the general public through the annual corridor summaries as well as through the regional summary.
- Utilize reviews of the CMP to assess the effectiveness of any implemented strategies in the region

Next Steps

As the Congestion Management Process is both iterative and ongoing, work has already begun on the data collection efforts discussed in this document. Once the Congestion Management Process has been approved and adopted by the RPC, it becomes a formal component of the Metropolitan Planning process and work will begin on the development of the corridor summary reports and the annual regional summary based on information collected during the summer traffic count data collection efforts as well as planned travel time studies. Work will also continue on the coordination of data collection efforts with other agencies and on expanding data collection capabilities.

CONGESTION MANAGEMENT PROCESS

STRATEGIES TOOLBOX

Congestion Management Process Toolbox

One of the components of the Congestion Management Process for the region is a toolbox of potential congestion reduction and mobility strategies. The idea behind this toolbox is to identify and encourage ways to deal with congestion and mobility problems beyond traditional roadway widening projects. As the CMP is implemented, the toolbox will be utilized as the starting point for evaluating alternative solutions and will act as as a checklist to consider each potential solution and determine whether it had a reasonable potential for providing benefit to the congested area. If a particular strategy could potentially work it would then be evaluated in detail, while those not likely to be successful would include a brief explanation of why it is not appropriate. The strategies included in this toolbox essentially fit into the categories of supply management, demand management, and land use management.

For each of the strategies described in the toolbox, the potential for congestion reduction, implementation cost and schedule, and analysis method have been estimated. The congestion reduction impacts are defined by indicators such as the potential reduction of single occupant vehicles (SOV), improved travel times, and reduced delay.

The implementation costs and schedules consider design and maintenance costs, inter-jurisdictional agreements, and implementation timing over short-term (one to five years), medium-term (five to 10 years), and long-term (over 10 years). The implementation costs and schedules presented in each section are based on information prepared by the Institute of Transportation Engineers (ITE) and Cambridge Systematics for other projects, and therefore will vary for specific implementation in the region. The strategies are presented using the following categories:

Highway Projects

Table 1 presents the potential highway infrastructure projects that may be applicable for the region. The regional travel model and Highway Capacity Manual based intersection/segment analysis will be the primary tools to assess the transportation impacts. The TDM Evaluation Model and IDAS can also be applied to evaluate HOV lanes.

Transit Projects

Transit services and infrastructure projects have traditionally been implemented in regions to provide an alternative to automobile travel potentially reducing peak-period congestion and improving mobility and accessibility for commuters. Table 2 presents the transit projects that may be applicable for the region. These projects tend to reduce systemwide VMT in relatively small increments but do improve corridor and systemwide accessibility, improve roadway travel times, and decrease congestion on the roadway system.

Bicycle and Pedestrian Projects

Non-motorized modes of transportation, such as biking and walking, are often overlooked by transportation professionals. Investments in these modes can increase safety and mobility in a cost-efficient manner, while providing a zero-emission alternative to motorized modes. The strategies listed in Table 3 can be implemented in the area with relatively little cost, but tend to have local rather than system wide impacts. The effectiveness of an investment in non-motorized travel depends heavily on coordination with local land use policies and connections with other modes, such as transit, for longer- distance travel. Safety and aesthetics should also be emphasized in the design of bicycle and pedestrian facilities in order to increase their attractiveness.

TDM Strategies

Transportation demand management (TDM) strategies are used to reduce travel during the peak, commute period. They are also used to help agencies meet air quality conformity standards, and are intended to provide ways to provide congestion relief/mobility improvements without high cost infrastructure projects. Table 4 presents the TDM strategies that may be applicable for the region.

ITS and TSM Strategies

Intelligent transportation system (ITS) and transportation system management (TSM) strategies have traditionally focused on improving the operation of the transportation system without major capital investment and cost. While ITS strategies may be costly compared to more traditional TSM strategies, their relative congestion-reduction impacts can be significant. Table 5 presents the ITS and TSM strategies that may be applicable for the region. The strategies identified in Table 5 build upon the Regional and State ITS Architectures.

Access Management Strategies

Access management is a broad concept that can include everything from curb cut restrictions on local arterials to minimum interchange spacing on freeways. Restricting turning movements on local arterials can reduce accidents and prevent turning vehicles from impeding traffic flow. Similarly, eliminating merge points and weaving sections at freeway interchanges increases the capacity of the facility. The access management strategies listed in Table 6 are applicable to the region, and can be used in either the modification or original design of a facility.

Land Development Strategies

Land development strategies have been used in some areas to manage transportation demand on the system, and to help agencies meet air quality conformity standards. Land development strategies can include limits on the amount and location of development until certain service standards are met, or policies that encourage development patterns better served by public transportation and non-motorized modes. Table 7 presents the land development strategies that may be applicable for the region.

Parking Management Strategies

Parking management is most often used to decrease automobile trips for both work and non-work purposes, although in the context of enforcement it may also be used to improve traffic flow. Often, policies implemented by local governments and directed towards the private sector must be accompanied by incentives in order to ensure their effectiveness. Several strategies applicable to the region are presented in Table 8.

Table 1. Potential Highway Strategies for the CMP Toolbox

Strategies/Projects	Congestion and Mobility Benefits	Implementation Costs and Other Impacts	Implementation Timeframe	Analysis Method
1a. Increasing Number of Lanes without Highway Widening This takes advantage of "excess" width in the highway cross section used for break- down lanes or median.	• Increase capacity	• Construction and engineering • Maintenance	• Short-term: 1 to 5 years (includes planning, engineering, and implementation)	• Regional Travel Model • Highway Capacity Manual (HCM)
1b. Geometric Design Improvements This includes widening to provide shoulders, additional turn lanes at intersections, improved sight lines, auxiliary lanes to improve merging and diverging.	• Increase mobility • Reduce congestion by improving bottlenecks • Increase traffic flow and improve safety	• Costs vary by type of design	• Short-term: 1 to 5 years	• Regional Travel Model • Highway Capacity Manual (HCM)
1c. HOV Lanes 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.	• Reduce Regional VMT • Reduce regional trips • Increase vehicle occupancy • Improve travel times • Increase transit use and improve bus travel times	• HOV, separate ROW costs • HOV, barrier separated costs • HOV, contra-flow costs • Annual operations and enforcement • Can create environmental and community impacts. • Right-of-way	• Medium-term: 5 to 10 years (includes planning, engineering, and construction)	• Regional Travel Model • TDM Evaluation Model • Intelligent Transportation System Deployment Analysis System (IDAS)
1d. Super Street Arterials This involves converting existing major arterials with signalized intersections into "super streets" that feature grade-separated intersections.	• Increase capacity • Improve mobility	• Construction and engineering substantial for grade separation • Maintenance variable based on area • Environmental & community impacts	• Long-term: 10 or more years (includes planning, engineering, and construction)	• Regional Travel Model
1e. Highway Widening by Adding Lanes This is the traditional way to deal with congestion.	• Increase capacity, reducing congestion in the short term • Long-term effects on congestion depend on local conditions	• Costs vary by type of highway constructed; in dense urban areas can be very expensive • Can create environmental and community impacts	• Medium to Long-term: 5 to 10 or more years (includes planning, engineering, and construction) depending on scale of project & location	• Regional Travel Model • Micro-scale modeling • HCM

Source: Cambridge Systematics, Inc. and ITE, A Toolbox for Alleviating Traffic Congestion.

Table 2. Potential Transit Strategies for the CMP Toolbox

Strategies/Projects	Congestion Impacts	Implementation Costs	Implementation Timeframe	Analysis Method
2a. Reducing Transit Fares This encourages additional transit use, to the extent that high fares are a real barrier to transit.	• Reduce daily VMT • Reduce congestion • Increase ridership	• 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	• Short-term: Less than one year	• Regional Travel Model • Transportation Demand Management (TDM) Evaluation Model
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.	• Increase transit ridership • Decrease travel time • Reduce daily VMT	• Capital costs per passenger trip • Operating costs per trip • New bus purchases likely	• Short-term: 1 to 5 years (includes planning, engineering, and construction)	• TDM Evaluation Model • Regional Travel Model
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.	• Reduce regional VMT (up to 0.1 percent) • Increase mobility and transit efficiency	• Structure costs for transit stations	• Medium-term: 5 to 10 years (includes planning, engineering, and construction)	• TDM Evaluation Model • Regional Travel Model
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.	• Reduce daily VMT • Increased access and mobility	• 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.	• Long-term: 10 or more years (includes planning, engineering, and construction)	• Regional Travel Model
2e. Constructing bus pull-outs On many routes, buses remain in the roadway to load and unload passengers because	• Reduces delay and congestion	• Construction cost • Potential right-of-way needs • Can be minimized if incorporated into other highway projects or development impacts	• Short-term: 1 to 5 years (includes planning, engineering, and construction)	• Travel time studies

Source: Cambridge Systematics, Inc. and ITE, A Toolbox for Alleviating Traffic Congestion.

Table 3. Potential Bicycle and Pedestrian Strategies for the CMP Toolbox

Strategies/Projects	Congestion Impacts	Implementation Costs	Implementation Timeframe	Analysis Method
3a. New Sidewalks and Designated Bicycle Lanes on Local Streets. 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.	• Increase mobility and access • Increase non-motorized mode shares • Separate slow-moving bicycles from motorized vehicles • Reduce incidents	• 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	• Short-term: 1 to 5 years (includes planning, engineering, and construction)	• TDM Evaluation Model
3b. Improved Bicycle Facilities at Transit Stations and Other Trip Destinations. Bicycle racks and bike lockers at transit stations and other trip destinations increase security. Additional amenities such as locker rooms with showers at workplaces pro- vide further incentives for using bicycles.	• Increase bicycle mode share • Reduce motorized vehicle congestion on access routes	• Capital and maintenance costs for bicycle racks and lockers, locker rooms	• Short-term: 1 to 5 years (includes planning, engineering, and construction)	• TDM Evaluation Model
3c. Design Guidelines for Pedestrian-Oriented Development. Maximum block lengths, building setback restrictions, and streetscape enhancements are examples of design guide- lines that can be codified in zoning ordinances to encourage pedestrian activity.	• Increase pedestrian mode share • Discourage motor vehicle use for short trips • Reduce VMT, emissions	• 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	• Short-term: 1 to 5 years	• TDM Evaluation Model • Regional Travel Model
3d. Improved Safety of Existing Bicycle and Pedestrian Facilities. 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	• Increase non-motorized mode share • Reduce incidents	• Increased monitoring and maintenance costs • Capital costs of sidewalk improvements and additional traffic control devices	• Short-term: 1 to 5 years	• TDM Evaluation Model • Regional Travel Model
3e. Exclusive Non-Motorized Rights-of-Way. Abandoned rail rights-of-way and existing parkland can be used for medium- to long- distance bike trails, improving safety and reducing travel times.	• Increase mobility • Increase non-motorized mode shares • Reduce congestion on nearby roads • Separate slow-moving bicycles from motorized vehicles • Reduce incidents	• ROW Costs • Construction and • Engineering Costs • Maintenance Costs	• Medium-term: 5 to 10 years (includes planning, engineering, and construction)	• TDM Evaluation Model • Regional Travel Model

Source: Cambridge Systematics, Inc. and ITE, A Toolbox for Alleviating Traffic Congestion.

Table 4. Potential TDM Strategies for the CMP Toolbox

Strategies/Projects	Congestion Impacts	Implementation Costs	Implementation Timeframe	Analysis Method
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	• Reduce peak-period VMT • Improve travel time among participants	• No capital costs • Agency costs for outreach and publicity • Employer costs associated with accommodating alternative work schedules	• Employer-based • Short-term: 1 to 5 years	• TDM Evaluation Model • Regional Travel Model
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.	• Reduce VMT • Reduce SOV trips	• First-year implementation costs for private-sector (per employee for equipment) • Second-year costs tend to decline	• Employer-based • Short-term: 1 to 5 years	• TDM Evaluation Model • Regional Travel Model
4c. Ridesharing This is typically arranged/ encouraged through employers or transportation management agencies (TMA), which pro- vides ride-matching services.	• Reduce work VMT • Reduce SOV trips	• Savings per carpool and vanpool riders • Costs per year per free parking space provided • Administrative costs	• Employer-based • Short-term: 1 to 5 years	• TDM Evaluation Model • Regional Travel Model

Source: Cambridge Systematics, Inc. and ITE, A Toolbox for Alleviating Traffic Congestion.

Table 5. Potential ITS and TSM Strategies for the CMP Toolbox

Strategies/Projects	Congestion Impacts	Implementation Costs	Implementation Timeframe	Analysis Method
5a. Traffic Signal Coordination This improves traffic flow and reduces emissions by minimizing stops on arterial streets.	• Improve travel time • Reduce the number of stops • Reduce VMT by vehicle miles per day, depending on program	• O&M costs per signal • Signalized intersections per mile costs variable	• Short-term: 1 to 5 years	• IDAS • Regional Travel Model • Micro-scale modeling
5b. Reversible Traffic Lanes These are appropriate where traffic flow is highly directional.	• Increase peak direction capacity • Reduce peak travel times • Improve mobility	• Barrier separated costs per mile • Operation costs per mile • Maintenance costs variable	• Short-term: 1 to 5 years	• IDAS • Regional Travel Model
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.	• Reduce accident delay • Reduce travel time	• Capital costs variable and substantial • Annual operating and maintenance costs	• Medium- to Long-term: likely 10 years or more	• IDAS • Regional Travel Model
5d. Ramp Metering This allows freeways to operate at their optimal flow rates, thereby speeding travel and reducing collisions.	• Decrease travel time • Decrease accidents • Improve traffic flow on major facilities	• O&M costs • Significant costs associated with enhancements to centralized control system • Capital costs	• Medium-term: 5 to 10 years	• IDAS • Regional Travel Model
5e. Highway Information Systems These systems provide travelers with real-time information that can be used to make trip and route choice decisions.	• Reduce travel times and delay • Some peak-period travel shift	• Design and implementation costs variable • Operating and maintenance costs variable	• Medium-term: 5 to 10 years	• IDAS • Regional Travel Model
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.	• Reduce travel times and delay • Some peak-period travel and mode shift	• Design and implementation costs variable • Operating and maintenance costs variable	• Medium-term: 5 to 10 years	• IDAS • Regional Travel Model

Source: Cambridge Systematics, Inc. and ITE, A Toolbox for Alleviating Traffic Congestion.

Table 6. Potential Access Management Strategies for the CMP Toolbox

Strategies/Projects	Congestion Impacts	Implementation Costs	Implementation Timeframe	Analysis Method
6a. Left Turn Restrictions; Curb Cut and Driveway Restrictions Turning vehicles can impede traffic flow and are more likely to be involved in crashes.	• Increased capacity, efficiency on arterials • Improved mobility on facility • Improved travel times and reduced delay for through traffic • Fewer incidents	• Implementation and maintenance costs vary; range from new signage and striping to more costly permanent median barriers and curbs.	• Short-term:1 to 5 years (includes planning, engineering, and implementation)	• Localized Analysis • HCM • Micro-scale modeling
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.	• Increased capacity, efficiency • Improved mobility and safety on facility • Improved travel times and reduced delay for all traffic	• Additional right-of- way costs • Design, construction, and maintenance costs	• Short-term: 1 to 5 years (includes planning, engineering, and implementation)	• Localized Analysis • HCM • Micro-scale modeling
6c. Interchange Modifications Conversion of a full cloverleaf interchange to a partial cloverleaf, for example, reduces weaving sections on a freeway	• Increased capacity, efficiency • Improved mobility on facility • Improved travel times and reduced delay for through traffic • Fewer incidents due to fewer conflict points	• Design and construction costs	• Short-term:1 to 5 years (includes planning, engineering, and implementation)	• IDAS • Regional Travel Model
6d. Minimum Intersection/ Interchange Spacing. Reduces number of conflict points and merging areas, which in turn reduces incidents and delays.	• Increased capacity, efficiency • Improved mobility on facility • Improved travel times and reduced delay for through traffic • Fewer incidents	• Part of design costs for new facilities and reconstruction projects	• Medium-term: 5 to 10 years (includes planning, engineering, and implementation)	• Localized analysis • Micro-scale modeling
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.	• Increased capacity, efficiency • Improved mobility on facility • Improved travel times and reduced delay for through traffic •	• Additional right-of- way costs • Design, construction, and maintenance costs	• Medium-term: 5 to 10 years (includes planning, engineering, and implementation)	• IDAS • Regional Travel Model depending on scale • Micro-scale modeling

Source: Cambridge Systematics, Inc. and ITE, A Toolbox for Alleviating Traffic Congestion.

Table 7. Potential Land Use Strategies for the CMP Toolbox

Strategies/Projects	Congestion Impacts	Implementation Costs	Implementation Timeframe	Analysis Method
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.	• Increase walk trips • Decrease SOV trips • Decrease in VMT • Decrease vehicle hours of travel	• Public costs to set up and monitor appropriate ordinances • Economic incentives used to encourage developer buy-in	• Long Term: 10 or more years	• Regional Travel Model • TDM Evaluation Model
7b. Infill and Densification This takes advantage of infrastructure that already exists, rather than building new infrastructure on the fringes of the urban area.	• Decrease SOV • Increase transit, walk, and bicycle • Doubling density decreases VMT per household • Medium/high vehicle trip reductions	• Public costs to set up and monitor appropriate ordinances • Economic incentives used to encourage developer buy-in	• Long Term: 10 or more years	• Regional Travel Model • TDM Evaluation Model
7c. Transit-Oriented Development This clusters housing units and/or businesses near transit stations in walkable communities.	• Decrease SOV share • Shift carpool to transit • Increase transit trips • Decrease VMT • Decrease in vehicle trips	• Public costs to set up and monitor appropriate ordinances • Economic incentives used to encourage developer buy-in	• Long Term: 10 or more years	• Regional Travel Model • TDM Evaluation Model

Source: Cambridge Systematics, Inc. and ITE, A Toolbox for Alleviating Traffic Congestion.

Table 8. Potential Parking Management Strategies for the CMP Toolbox

Strategies/Projects	Congestion Impacts	Implementation Costs	Implementation Timeframe	Analysis Method
8a. On-Street Parking and Standing Restrictions 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.	• Increase peak- period capacity • Reduce travel time and congestion on arterials • Increase HOV and bus mode shares	• Design, construction, and maintenance costs for signage and striping. • Rigid enforcement of parking restrictions. •	• Short-term: 1 to 5 years (includes planning, engineering, and implementation) •	• IDAS • Micro-scale modeling
8b. Employer/Landlord Parking Agreements 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.	• Reduce work VMT • Increase non-auto mode shares	• Economic incentives used to encourage employer and landlord buy-in	• Metropolitan and Employer-based • Short-term: 1 to 5 years	• TDM Evaluation Model
8c. Preferential or Free Parking for HOVs This provides an incentive for workers to carpool. Can be utilized at Park and Ride lots as well as individual businesses.	• Reduce work VMT • Increase vehicle occupancy • Revenue from SOV parking helps offset infrastructure costs	• Relatively low costs, primarily borne by the private sector, include signing, striping, and administrative costs	• Metropolitan and Employer-based • Short-term: 1 to 5 years	• TDM Evaluation Model
8d. Location-Specific Parking Ordinances 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.	• Reduce work VMT • Increase transit and non-motorized mode share	• Economic incentives used to encourage developer buy-in	• Long-term: 10 or more years	• Regional Travel Model • TDM Evaluation Model

Source: Cambridge Systematics, Inc. and ITE, A Toolbox for Alleviating Traffic Congestion.