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Congestion Management Process

2020 Documentation and Methodology Update

DRAFT – 6/18/2020

METROPOLITAN PLANNING ORGANIZATION

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Table of Contents

Introduction

Traffic congestion is one of the many transportation issues impacting the economic vitality and quality of life of the Rockingham Planning Commission region. Congestion also exacerbates environmental impacts contributing to air quality and other ecological concerns. The Congestion Management Process (CMP) is a systematic planning and project programming tool that aids in the effective management of the transportation system through development and implementation of multimodal 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 discussion of the context, goals and objectives, the geographic area and transportation network elements included, how congestion is defined and identified, the performance measures utilized, how performance will be monitored, and a "toolbox" of strategies that can aid in addressing congestion issues.

The Need for a CMP

The inherently high cost of capacity expansion and limited financial resources require that a variety of strategies be utilized to ensure that the transportation system efficiently and effectively moves people and goods and it is important to document these strategies in a structured process to get maximum benefit from investments. The CMP is the tool for detailing this process and connecting the planning goals of the region to short range project implementation. The benefits of a CMP include:

- Data and analysis that can better focus limited federal transportation funds where they can do the most to help the region meet mobility and system efficiency goals.

- Enhancements to each mode of transportation, improved connections among modes, and between transportation, land use, economic development, and environmental planning.
- Participation and coordination between a range of stakeholders to improve data collection and track progress and obtain priority for projects in the TIP and Plan.
- 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 (23 CFR § 450.322) requires that metropolitan regions with more than 200,000 people (known as Transportation Management Areas or TMAs) maintain a CMP and use it to improve transportation planning and decision making. The current surface transportation law, the Fixing America's Surface Transportation Act ("FAST Act"), enacted in 2015 maintains the CMP as an integrated process that augments the overall metropolitan planning process and central directive to maintain and operate a safe and effective transportation system. The goal of the CMP is implementation of 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 mitigating congestion and its impacts. The intention is that agencies look beyond capacity expansion and utilize strategies that manage demand, reduce single occupancy vehicle travel, and improve transportation system management and operations. The CMP 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 single occupancy vehicle capacity expansion projects because the region is a part of the larger Boston MA-NH-RI Urbanized Area.

According to the provisions in MAP-21, this process should encompass:

1. Methods to monitor and evaluate the performance of the multimodal transportation system, identify the underlying 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;
2. Regionally specific and cooperatively established 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;
3. A coordinated program for data collection and system performance monitoring to define the extent and duration of congestion, to contribute in determining the causes of congestion, and evaluate the efficiency and effectiveness of implemented actions;
4. Identification and evaluation of the expected performance and benefits of appropriate congestion management strategies based on the established performance measures;
5. An implementation schedule, implementation responsibilities, and possible funding sources for each strategy (or combination of strategies) proposed for implementation; and
6. Implementation of a process for periodic assessment of the effectiveness of implemented strategies, in terms of the area's established performance measures.

Framework, Goals, and Objectives

The overarching goal of the RPC Congestion Management Process is to better understand current and expected transportation system congestion and to utilize that information to aid decision-making regarding project priorities for the region. This is in support of the [MPO Long Range Transportation Plan] which utilizes the analysis, metrics, and strategies of the Congestion Management Process to identify and prioritize project needs. Based on this, the CMP is intended to address the following goals:

- Plan for a sustainable transportation system that efficiently accommodates existing and anticipated demand for movement of people and goods.
- Plan for a convenient and reliable transportation system that ensures accessibility for all, ensures ease of use, and results in acceptable travel times and reasonable cost.
- Provide timely information on system performance and potential strategies for addressing congestion and system inefficiencies.

Framework

Since 1990, Vehicle Miles of Travel (VMT) in New Hampshire has grown by 40% (Figure 1), outpacing 22% population growth and a 9% increase in lane-miles (one measure of capacity). Over that same timeframe, capital outlays for transportation improvements have grown by 200% and maintenance expenditures by 65% (Figure 2). In the RPC region, the trend has shown generally increasing delay from year to year with an average annual increase of over 7% per year (Figure 3) and a total of nearly 25% over the last four years. This is much greater than the .7% per year average annual growth rate of the population and total change of 2.2%.

This pattern is not unique to New Hampshire or the RPC region. The advocacy group Transportation for America indicated in a recent study that between 1993 and 2017 population increased 32% in the one hundred largest urbanized areas in the US. During that same timeframe freeway lane-miles increased by 42% and total annual hours of delay (congestion) increased by 144%.[1] Expansion of capacity to alleviate

Figure 1: Change in VMT, Population, and Roadway Lane-Miles (indexed) 1990-2018

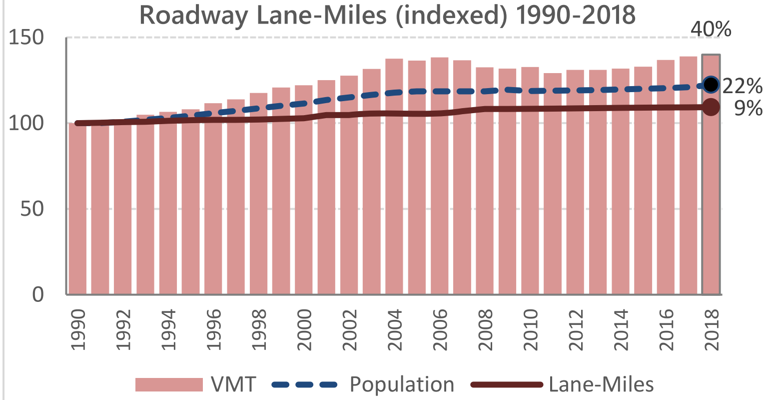
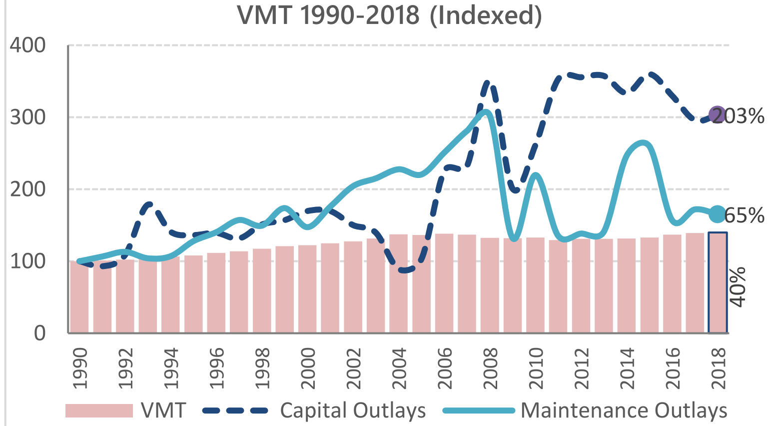


Figure 2: Change in Expenditures Compared to VMT 1990-2018 (Indexed)



[1] The Congestion Con, Transportation for America, March, 2020. https://t4america.org/wp-content/uploads/2020/03/Congestion-Report-2020-FINAL.pdf

Figure 3: RPC Region Total Annual Delay (Hours) from Congestion

	Est. Population	Est. Total Delay	Per Capita Delay
2016	*192,479*	*2,225,063*	*11.56*
2017	*194,043*	*2,335,637*	*12.04*
2018	*196,509*	*2,133,393*	*10.86*
2019	*196,748*	*2,769,691*	*14.08*
Total % Change	*2.2%*	*24.5%*	*21.8%*
Ave. Annual Growth Rate	*0.7%*	*7.6%*	*6.8%*

congestion does mitigate delays for a time, but the improved traffic flow draws more vehicles, and conditions eventually return to similar or worsened levels of delay. Combined with steady increases in the cost of construction this creates a system where expanding capacity generates diminishing returns on investment. Moving forward, a more strategic approach is necessary to address and mitigate the congestion experienced and plan for a resilient and sustainable transportation system.

For this reason, the RPC Congestion Management Process is focused around a framework that reflects the principles, vision, and goals of the RPC Regional Master Plan and the MPO Long Range Transportation Plan by prioritizing demand side strategies over expansion the roadway network and capacity. This is organized around the ***Avoid-Shift-Improve*** approach developed by the Sustainable Urban Transport Project[2] and incorporates a selective approach to roadway capacity expansion.

1. ***Avoid*** – Prioritize strategies to address congestion that reduce the need for travel, shorten trip lengths, and *promote system efficiency*.
2. ***Shift*** – Prioritize strategies that move trips to more efficient or environmentally friendly modes and promote trip efficiency.
3. ***Improve*** – Prioritize strategies that optimize the existing transportation infrastructure and promote vehicle and facility efficiency. Selectively pursue solutions that provide additional roadway capacity, primarily addressing existing bottlenecks and other smaller scale improvements.

Congestion Management Objectives

The Objectives of the CMP define more specifically what the MPO expects to accomplish in regard to addressing the issue of congested travel in the region and are derived from the Goals and Objectives of the MPO Long Range Transportation Plan as well as the overall purpose of the CMP. The goals must be modified to be more specific and detailed to track progress over different timeframes, at different scales, 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). The objectives of the CMP are included in Figure 4.

[2] Sustainable Urban Transport: Avoid-Shift-Improve (A-S-I), Sustainable Urban Transport Project, 2011. https://www.sutp.org/.

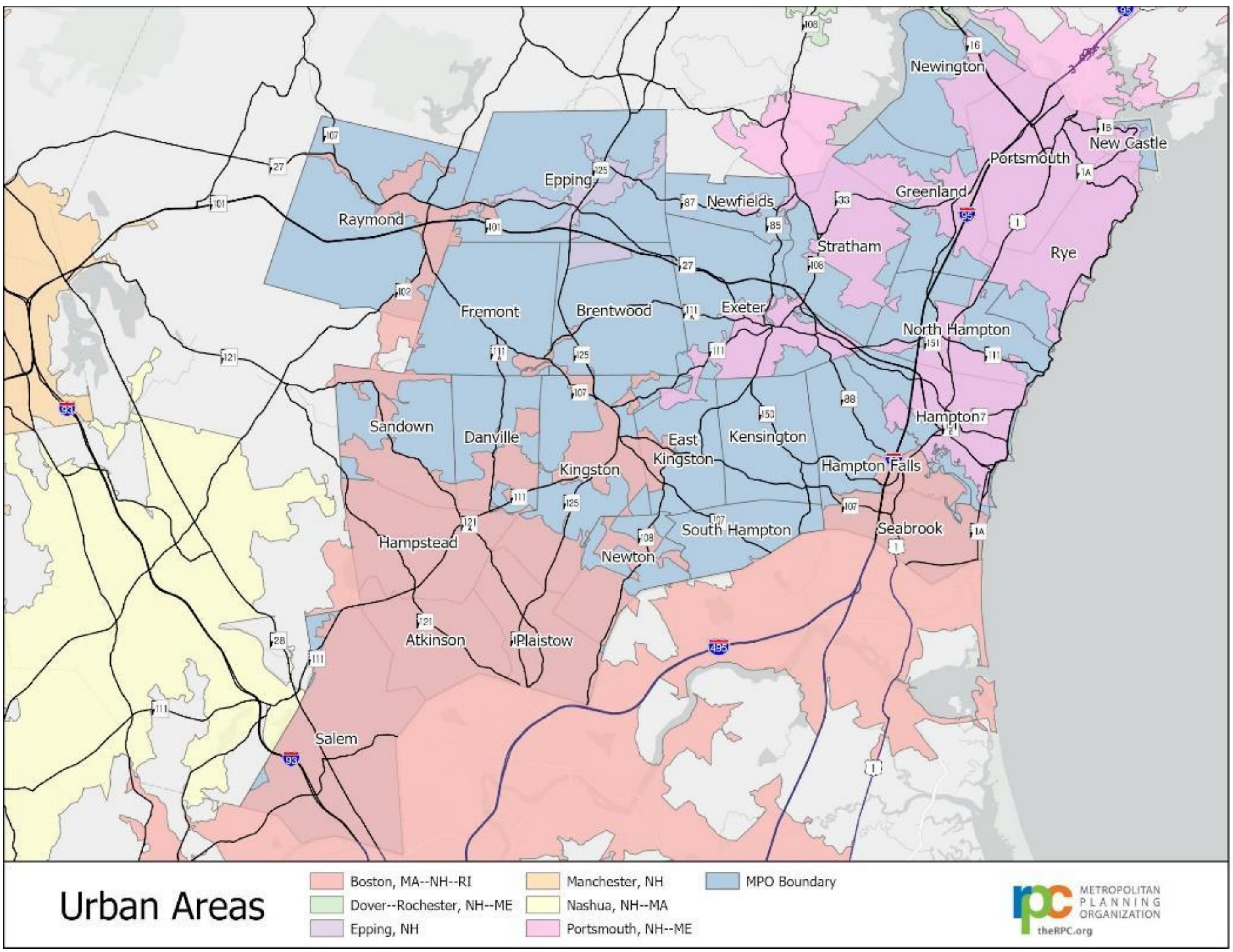
Figure 4: Congestion Management Objectives

Objective	Timeframe
Conduct travel time reliability analysis on state highways in the MPO Region utilizing data from the National Performance Management Research Data Set (NPMRDS).	Annually, beginning January 2020
Compile CMP data and analysis in an ESRI Story Map or similar format for distribution.	Annually, beginning June 2020
Coordinate with Boston Urbanized Area and other MPOs to ensure consistency across regional boundaries.	Annually
Use the performance metrics to evaluate corridors and sites in the region and recommend strategies and projects to be incorporated into the MPO LRTP and prioritized for the State Ten Year Plan.	Even years beginning Summer 2020
Integrate the outputs of the CMP into the project development and prioritization process for the LRTP, Ten Year Plan, and TIP.	Even years, beginning fall 2020
Establish permanent automatic traffic monitoring stations along all high-priority inter-regional (NHDOT Tier 1) corridors by 2025.	2025
Periodically review the contents of the CMP and update components to reflect changes in goals, data, methods, and strategies.	Every 4 years beginning in 2023
Evaluate and advocate for the use of appropriate strategies for addressing congestion to be implemented as part of project proposals currently in the LRTP and the State Ten Year Plan.	Ongoing as part of project development

Geographic Area & Defined Network

All 27 communities in the RPC region are included in the Congestion Management Process to ensure that all state highway corridors and transit systems are incorporated into the analysis. This ensures that any Urbanized Areas (UZAs) in the region are incorporated and minimizes the need to make any adjustments based on boundary changes. Urbanized Areas (UZA) boundaries are re-designated based on the outcomes of each census, and will be set sometime in 2022. Figure 5 shows the MPO boundary in comparison with the Boston and Portsmouth UZAs which are both partially in the RPC region, as well as the adjacent Manchester and Nashua UZAs. As part of the CMP, RPC will coordinate with surrounding MPOs in the Boston, Manchester, and Nashua Urbanized Areas to ensure that available data is shared and that facilities that cross regional boundaries are addressed in a consistent manner.

Figure 5: RPC Urbanized Areas



System Definition

The availability of travel time data for all state highways in the region provides the MPO with the opportunity to apply the congestion management process systemically with regard to assessing travel time reliability and related metrics. While the focus of the analyses in the CMP will primarily be on the backbone of transportation corridors that carry the majority of regional travel, spot analyses on other roadways will occur in response to identified locations of congestion.

Focus Corridors

The 2020 CMP is focused on monitoring and analyzing the routes that carry the highest volumes of people and goods in the region. These roadways tend to be on the National Highway System (NHS) and are made up of Interstate Highways, Expressways, and other Principal Arterials.

- ***Interstate 95 (I-95)*** is an eight lane, toll facility that crosses the southeastern portion of the RPC between Massachusetts and Maine with an Annualized Average Daily Traffic (AADT) of 100,908 (2019). The route serves as a major commuter corridor serving traffic between Maine, New Hampshire, and Massachusetts, as well as handling significant tourist traffic. Volumes on the roadway vary significantly by time of year from an average around 82,000 vehicles per day in the winter, to summer averages of 120,000 per day and peaks approaching 150,000 (2019) daily vehicles on weekends in July and August.

- ***Interstate 93 (I-93)***, a grade-separated freeway located in the western part of the RPC region facilitates north/south travel between Massachusetts and New Hampshire. The 2017 AADT was 107,300 at the NH-MA state line and surges as high as 128,000 vehicles per day. Work is nearing completion on widening I-93 to 4 lanes in each direction between the NH-MA state line and Exit 5 in Londonderry. In addition to the road and bridge work, Park and Rides were constructed at Exits 2, 3, 4, and 5, and transit service was expanded.

- ***NH 101*** is the region's primary east-west highway. The facility is a grade separated, four-lane expressway connecting I-93 in Manchester with NH 125 in Epping and I-95 in Hampton. East of the interchange with I-95, NH 101 reduces to two lanes until its end at Route 1A at Hampton Beach. Current (2018) AADT is just under 44,000 in the most western portion of the RPC region (Raymond) and then grows to over 52,000 in the vicinity of Epping and NH 125 before falling to just over 46,000 in Exeter. East of I-95, volume on the roadway drops substantially to 10,200 AADT (2018) although this portion of NH 101 also experiences greater traffic during the summer as it is the most direct route to Hampton Beach and much of the New Hampshire Seacoast.

- ***NH 16***, also known as the ***Spaulding Turnpike***, is a north-south, limited access toll roadway which carries commuter and tourist traffic between Portsmouth, Dover, and Rochester, and serves as the eastern gateway from the Seacoast to the Lakes Region and the White Mountains. AADTs on NH 16 are approximately 70,000 vehicles per day (2018) at the Little Bay Bridges between Newington and Dover. This facility has been under construction between Exits 3 and 6 with widened bridges and roadway to 4 lanes in each direction and reconfiguring the interchanges and connector roadways.

- ***NH 28*** provides a parallel route to Interstate 93 connecting between Massachusetts and Manchester. This is a heavily travelled roadway with significant retail and other commercial development in Salem. Volumes range from 23,000-25,000 Average Daily Traffic (AADT) in Salem and drop to around 15,000 vehicles at the Windham town line.

- ***NH 111*** provides a secondary east-west route through the RPC region that connects the coast in North Hampton to Salem, via Exeter, Kingston, Danville, Hampstead, and Atkinson. This facility interconnects Route 1, NH 101, NH 125, NH 28, and I-93 as well as other state highways. The roadway has two distinct regions of heavy activity located around access to I-93 in the west (18,800 AADT in Salem), and Exeter and NH 101 in the east (10,600-17,600 AADT).
- ***NH 125*** is the primary north-south roadway in the central part of the RPC region. The roadway carries traffic between I-495 in Massachusetts and NH16 in Rochester. In between, the road connects to NH 111, NH 101, and then US Route 4 (outside of the MPO region). The roadway is four lanes from near the Massachusetts border to the Plaistow-Kingston town boundary, then drops to two lanes until widening again for about a mile on either side of NH 101 in Epping before returning to two lanes again. As would be expected, AADTs are higher in the four-lane sections (22,000 in Plaistow and 18,000 in Epping) while the two lane sections are somewhat lower with AADTs that range from 8,000-14,000. NH 125 was recently improved in Plaistow with lanes and traffic signals added, access management policies implemented and other improvements.
- ***US 1*** is a heavily developed roadway that parallels the NH seacoast between Massachusetts and Maine providing access to local communities along the seacoast, connections to NH beaches, and supporting substantial commercial activity. Traffic volumes vary greatly depending on location and range from 16,000-24,000 (2018) with volumes staying above 20,000 vehicles per day through much of Seabrook and Portsmouth, and generally lower through the rest of the corridor. US 1 connects to I-95 in Seabrook, NH 101 in Hampton, and to NH16 (Spaulding Turnpike) and I-95 again in Portsmouth via the US 1 Bypass.
- ***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 provides connections to Portsmouth at Borthwick, Woodbury, and Maplewood Avenues, as well as Market Street. The roadway carries approximately 20,000 AADT (2018) on the section south of the Portsmouth traffic circle and approximately 10,000 on the north section although the bridge work has disrupted recent traffic patterns.

Other Roadways

Much of the information that is available on the primary roadways listed above is also available for the other state highways in the region. While many of these other state highways don't experience congestion on a regular basis, they provide important regional connections and may have locations that have problematic locations that cause delays.

- ***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. The roadway is two lanes except for between NH 151 in Greenland and Oxford Avenue in Portsmouth.
- ***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 at Exit 5 in Raymond. The roadway is heavily travelled between US 1 and I-95, where the roadway is also designated as NH 125 in Kingston, and in the vicinity of NH 101 in Raymond.
- ***NH 108*** is a north-south, two-lane roadway connecting from Haverhill, MA into Plaistow then through Newton, East Kingston, and Kensington, Exeter, Stratham, and Newfields. Traffic is light on the southern portions of the corridor and increases in Exeter (17,500 AADT) and Stratham (21,000 AADT), and Newfields (22,000 AADT) at the Newmarket Town line.

Transit Services

In addition to the roadway network, there are other regional transportation services that are both impacted by roadway congestion and can be assessed for capacity utilization.

- ***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.
- ***Intercity bus service*** is available in the I-95 and I-93 corridors, with an emphasis on Boston-bound commuter travel as well as access to Logan Airport. C&J, provides over 20 round trips daily between Boston and the Portsmouth Transportation Center, with northbound connections to Dover. In the I-93 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.
- ***Amtrak Downeaster*** service between Portland and Boston includes station stops in Southern Maine, Northern Massachusetts, and three New Hampshire communities – Exeter, Durham, and Dover. During FY2018 the Downeaster carried over 440,000 riders, with over 30% of passengers boarding or alighting at New Hampshire stations. MBTA commuter rail service is also available from Newburyport and Haverhill in Northern Massachusetts.

Park and Ride Facilities

There are currently seven park and ride facilities in the MPO region. Each is owned and operated by NHDOT with the exception of the I-93 Exit 2 site in Salem that is operated by Boston Express, and the Portsmouth Transportation Center which is on property owned by the Pease Development Authority, leased to NHDOT, and operated by C&J Trailways.

- ***Portsmouth Transportation Center***: Located on NH 33 adjacent to I-95 has a 4-dock bus terminal and parking for 1248 vehicles to access ridesharing services as well as intercity bus service north to Dover and Rochester and south to Logan Airport and Boston.
- ***Salem***: This facility at I-93 Exit 2 contains parking for 470 vehicles and a bus terminal. The site is a stop on the Boston Express service between Concord, Logan Airport, and Boston.
- ***Portsmouth***: On NH 33 east of I-95, this location provides 55 parking spaces for ridesharing.
- ***Epping:*** Located on NH 125 just south of NH 101 Exit 7, the facility provides approximately 240 parking spaces for ridesharing. There is no transit service at this location although the facility is designed to accommodate buses and has pads for bus stops.
- ***Hampton:*** Located on NH 27 adjacent to NH 101 Exit 14, provides 140 spaces for ridesharing.
- ***Plaistow:*** Located just off NH 125 on Westville Road, this park and ride includes 270 spaces and is designed to accommodate transit buses. The park and ride is adjacent to the B&M railroad and could potentially be utilized as part of a train station for Amtrak or MBTA service.
- ***Hampstead:*** Locate adjacent to NH 111, provides approximately 140 spaces for ridesharing.

In addition to the facilities in the MPO region, there are park and rides nearby along the I-93, I-95, and Spaulding Turnpike corridors that will be monitored as well in coordination with adjacent MPOs.

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*.” Determining exactly at what point delay becomes excessive or performance “no longer acceptable” is dependent upon local perceptions, 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 delay, track trends, and identify locations expected to become problematic in the future. Previous experience and research have shown that congestion is the result of seven root causes[3], often interacting with one another and grouped into two types, Recurring and Non-Recurring as shown in Figure 6:

Recurring congestion is the result of traffic volumes approaching or exceeding capacity at consistent times of the day and/or days of the week. This is best illustrated by the congestion observed during the daily morning and evening commute periods and has two root causes:

- ***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 Control Devices*** – Intermittent disruption of traffic flow by control devices such as traffic signals, and railroad grade crossings also contribute to congestion and travel time variability.

Non-Recurring congestion is unforeseen or unusual travel delays that can exacerbate the daily commute trips or create disruptions during days and times where recurring congestion is usually not a concern. The essentially random nature of non-recurring congestion makes travel times unpredictable. Non-recurring congestion accounts for more than half of all congestion and there are five basic causes of this type of delay:

- ***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

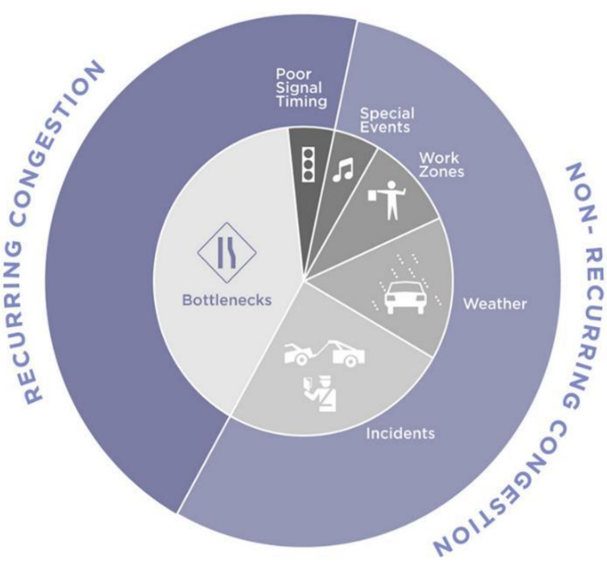


Figure 6: FHWA Causes of Congestion

Source: Incorporating Travel-Time Reliability into the Congestion Management Process (CMP): A Primer, FHWA

[3] From “Does Travel Time Reliability Matter? – Primer”, FHWA, October, 2019. https://ops.fhwa.dot.gov/publications/fhwahop19062/

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.
- ***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 or seasonal 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.

CMP Performance Metrics

The MPO Performance Measures and targets included in the Long Range Plan are also applicable to the Congestion Management Process, are shown in Figure 7. These provide guidance in the development of the objectives and strategies that form a link between the two documents.

Figure 7: Regional Performance Measures

Goal Area	Performance Measures
Road Safety	• *Number of Fatalities* • *Rate of Fatalities per 100 million vehicle miles traveled (VMT)* • *Number of serious injuries* • *Rate of serious injuries per 100 million VMT* • *Number of non-motorized fatalities and non-motorized serious injuries* • *Motorcycle Fatalities (MPO Only – Not required by FHWA)*
Pavement Condition	• *Percent of Interstate Miles in Good Condition* • *Percent of Interstate Miles in Poor Condition* • *Percent of Non-Interstate National Highway System Miles in Good Condition* • *Percent of Non-Interstate National Highway System Miles in Poor Condition*
Bridge Condition	• *Percent of Bridges by deck area on the National Highway System in Good Condition* • *Percent of Bridges by deck area on the National Highway System in Poor Condition*
Transit Asset Condition (State of Good Repair)	• *Rolling Stock: The percentage of revenue vehicles that exceed the useful life benchmark (ULB)* • *Equipment: The percentage of non-revenue service vehicles that exceed the ULB* • *Facilities: The percentage of facilities that are rated less than 3.0 on the Transit Economic Requirements Model (TERM) Scale.* • *Infrastructure: The percentage of track segments that have performance restrictions.*
Reliability of the National Highway System	• *Percent of reliable person-miles traveled on the Interstate* • *Percent of reliable person-miles traveled on the non-Interstate National Highway System (NHS)*
Freight Movement and Economic Vitality	• *Percentage of Interstate system mileage providing for reliable truck travel time (Truck Travel Time Reliability Index)*

Performance Measures & Targets

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 be 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 the intensity, duration, extent, and variability of congestion. These measures examine 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. There are two sources of this data: NHDOT Estimates based on volume counts, and the Regional Travel Demand Model.

$$VMT = volume\ x\ distance\ of\ travel$$

- ***Volume Capacity Ratio:*** 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.

$$V/C\ Ratio = \frac{Volume}{Capacity}$$

- ***Transit Load Factor:*** Measures the capacity utilization of a transit system or route. It is measured by calculating the ratio passenger-miles travelled to seat-miles available.

$$Transit\ Load\ Factor = \frac{Passenger - miles\ travelled}{Seat - miles\ available}$$

Measures of Delay

- ***Congested Speed:*** This is the speed at which traffic moves during peak periods of use. This data is derived from the average travel time observed on the roadway segment for each 5-minute period of the day aggregated to one hour averages. Knowing the length of the segment and the mean travel time the average speed can be derived.

$$Congested\ Speed = \frac{Distance\ Travelled}{Mean\ Travel\ Time}$$

- ***Person-Hours of Delay:*** A measure of delay that indicates the total extra time all travelers (drivers and passengers) spent travelling on a segment due to congestion.

$$Person\ Hours\ of\ Delay = \frac{VMT}{Measured\ Speed} - \frac{VMT}{Free\ Flow\ Speed}\ x\ vehicle\ occupancy$$

- ***Vehicle-Hours of Delay***: A measure of the aggregate amount of delay to all vehicles on a segment due to congestion.

$$Vehicle\ Hours\ of\ Delay = \frac{VMT}{Measured\ Speed} - \frac{VMT}{Free\ Flow\ Speed}$$

Travel Time Reliability Measures

- ***Travel Time Index:*** The Travel Time Index (TTI) is the ratio of measured period travel time (can be peak period or other) to free flow (ideal) travel time. 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. NPMRDS provides this information for passenger vehicles, trucks both separately and together.

$$Travel\ Time\ Index\ (TTI) = \frac{Travel\ Time}{Free\ Flow\ Travel\ Time}$$

- ***Planning Time:*** The total time that a traveler should plan for to ensure on-time arrival 95 percent of trips (95th percentile travel time). The 95th percentile is the highest value left when the top 5% of a numerically sorted set of data is discarded. This accounts for the near-worst-case scenario for the time to traverse the link.

$$Planning\ Time = 95th\ Percentile\ Travel\ Time$$

- ***Planning Time Index:*** This measures the amount of time a traveler should plan on for a trip compared to light traffic conditions for a 95 percent probability of arriving on time. This accounts for both expected and unexpected delays by incorporating all but the most extreme travel times in the equation.

$$Planning\ Time\ Index = \frac{95th\ Percentile\ Travel\ Time}{50th\ Percentile\ Travel\ Time}$$

- ***Buffer Time:*** The extra time that travelers must add to their average travel time when planning to ensure on-time arrival for 95% of trips.

$$Buffer\ Time = 95th\ Percentile\ Travel\ Time - Average\ Travel\ Time$$

- ***Buffer Index:*** Buffer time is the additional travel time cushion that users must budget to ensure an on-time arrival in 95 percent of trips. It is expressed as the ratio of extra minutes to the average travel time.

$$Buffer\ Index = \frac{95th\ Percentile\ Travel\ Time - Average\ Travel\ Time}{Average\ Travel\ Time}$$

- ***Level of Travel Time Reliability (LOTTR):*** The ratio of the 80th percentile travel time to the normal (average) travel time. Data are collected in 15-minute periods between 6:00 AM and 8:00 PM.

$$Travel\ Time\ Index = \frac{80th\ Percentile\ Travel\ Time}{50th\ Percentile\ Travel\ Time}$$

Other Measures

- ***Transit Travel Time***: 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***: A measure of how often a particular transit service arrives and departs destinations according to advertised schedules. Routes experiencing congested travel may reflect this in poor on-time performance.

$$On - time\ Performance\ Rate = \frac{Number\ of\ Trips\ Arriving\ on\ Time}{Total\ Number\ of\ Trips}$$

- ***Crash Rate:*** The crash rate is the number of motor vehicle crashes per 100 million miles of travel. Combined with other measures, this may provide insight into the causes of non-recurring congestion as the location and timing of crashes can significantly disrupt travel times on some corridors.

$$Crash\ Rate = \frac{Number\ of\ Crashes\ for\ Period * 100{,}000{,}000}{Vehicle\ Miles\ of\ Travel\ for\ Period}$$

- ***Crash Frequency:*** The frequency at which crashes occur in a particular geographic area. Of particular interest are crashes that occur during peak periods of travel as they can play an important factor in the travel time reliability expectations that users have of a particular roadway. While a corridor may have a relatively low crash rate overall, even a few incidents can create lasting disruptions if timed during peak travel times. Examining the frequency at which crashes are happening can provide insight into the amount of disruption that travelers face on roadways and the resulting variability in travel times.

$$Crash\ Frequency = \frac{Number\ of\ Crashes}{Time\ Period}$$

- ***Work Zone and Special Event Identification:*** The identification of work zones and special events that impact traffic along 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 when and where special events or construction is occurring during other data collection activities such as travel time studies can provide important context to changes in travel time or travel speeds over time.

Performance Monitoring Plan

The transportation planning process, as required by the Federal Highway and Federal Transit Administrations, requires that an MPO have "a coordinated program for data collection and system performance monitoring to assess the extent of congestion, to contribute in determining the causes of congestion, and evaluate the efficiency and effectiveness of implemented actions." In addition, other aspects of the transportation planning process require coordination of efforts with DOTs and other state agencies, surrounding MPOs and adjacent planning regions. The goal of the CMP performance monitoring plan is to further develop and enhance the existing MPO data collection system to better understand congestion in the region.

Annual Traffic Count Program

Currently, the 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 (Figure 8). The second component consists of seventy-two-hour automatic directional traffic volume counts conducted with the number and location of counts established on a cycle determined by NHDOT. Through this, the RPC conducts 140-160 ADT counts each season with a portion of these including vehicle classification and/or speed data collection. The final component of the data collection program consists of manual turning movement counts or automatic traffic volume counts conducted as needed for communities, NHDOT, or for regional planning projects. Turning movement counts are generally conducted during peak periods (unless otherwise needed) and volume counts can be anywhere from 72 hours to a full 7 days or longer. As part of the Congestion Management Process, data collection efforts will need to be modified and expanded in several ways.

Figure 8: 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 101	Candia at Raymond TL (Exit 3-4)
NH 101	Exeter East of NH 88 (Exit 11-120
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
NH 125	None
NH 111	None
NH 33/108	None

- Increase the number of classification counts procured to better track truck volumes in the region.
- Shift count locations as necessary to areas more advantageous for monitoring congestion.
- Procure special equipment to enable the collection of data at locations with many lanes of travel or high volumes of traffic (>20,000 vehicles per day).
- Pursue opportunities to expand the number of permanent traffic volume counters, especially on National Highway System roadways and other major regional corridors.

Travel Time Data

The Federal Highway Administration procured and sponsored the development of the National Performance Management Research Data Set (NPMRDS) that catalogues speed and travel time data on the National Highway System. FHWA has made this data available to states and MPOs as part of the requirement to develop and maintain travel time reliability and other congestion performance measures and targets. In addition, RPC has purchased access to the "Full TMC Network" providing speed and travel time data for all state highways in the region, as well as the "Enhanced Tools" which provides the MPO with access to the full analytic suite provided and enables the creation of additional summary metrics, statistics, and graphics to better understand the performance of the roadway system.

Crash Data

The MPO currently aggregates fatal and serious injury crash data for the region to produce crash numbers and rates to address the safety performance measures. The information will be further applied to corridors as part of the CMP to better understand the impact of crashes on congestion.

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 conducting 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

Coordinate with adjacent MPOs to gather current data on use of regional park and ride facilities both within and near the MPO region. This includes the seven in the MPO as well as those on the Spaulding Turnpike and I-93 north of the region, and along I-95 in Maine and Massachusetts. Of particular interest is assessing multi-day use vs. daily use by commuters and the impacts of that use on daily capacity.

Mode Share & Vehicle Occupancy

This data is provided by the US Census Bureau and travel behavior surveys. This data is monitored to understand the extent to which people are utilizing various travel options and provide a basis for understanding the number of people served.

Implementation and Monitoring Plan

The RPC has already began implementing the CMP through efforts to establish baseline information and track federal performance metrics for travel time reliability on the Interstates and National Highway System roadways. The update of the CMP brings the implementation of the CMP in line with the requirements of the FAST Act and modernizes our approach to account for the widespread availability of travel time and speed data on regional corridors. The CMP will be implemented through the following steps:

1. ***CMP Definition:*** The transportation facilities included in the CMP must be established, and based on available data, evaluated for changes in traffic volumes and patterns over time. Occasionally, facilities will be evaluated for addition or subtraction from consideration in the CMP.

2. ***Data Collection:*** Basic information regarding each transportation facility should be collected through available data sources. This data 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 will supplement travel time and speed information gathered via the NPMRDS, cyclical vehicle volume and classification counts, and other data as available.

3. ***CMP Performance Summary:*** The CMP will be summarized and kept current via an online portal using ESRI Story Map or similar format. Users will be able to see the basic information regarding the CMP included in this report as well as statistics and metrics updated on an annual basis. Areas that are identified as "congested" and in need of improvement will also show strategies best suited to addressing the specific circumstances at the site as well as any projects identified in the State Ten Year Plan or MPO Transportation Improvement Program (TIP) and Long Range Transportation Plan (LRTP).

4. ***System Performance Report:*** Information from the CMP will be incorporated into the regional System Performance Report included in the LRTP with each update and the Transportation Improvement Program (TIP).

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 via ESRI Story Maps or similar format.
- As part of each Long Range Transportation Plan update, review the CMP data collection efforts and modify as necessary.
- Every 10 years review and update all aspects of the CMP as necessary. This should include a review and assessment of the utility of any 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 will be made available to the decision-makers in the region through the corridor summaries and regional report to:

- Use the CMP data to identify congestion management strategies for all monitored facilities.
- Use the CMP to identify improvement project needs and implementation strategies.
- Use the CMP metrics as inputs for MPO LRTP and State Ten Year Plan project selection criteria.
- Use the strategies identified in the CMP data to aid in the project prioritization process for including projects in the MPO LRTP, State Ten Year Plan, and the TIP.
- Use the CMP to convey information to the general public through the Story Map.

- Utilize reviews of the CMP to assess the effectiveness of any implemented strategies in the region.
- Coordinate CMP data collection, tracking, and reporting with NHDOT and surrounding MPOs in New Hampshire, Maine, and Massachusetts.

Next Steps

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 metrics and summary reports. Work will also continue on the coordination of data collection efforts with other agencies and on expanding data collection capabilities.

- Utilize CMP data in the project selection process.
- Incorporate the CMP into the MPO LRTP.

Congestion Management Strategies

There are a variety of potential strategies that can be utilized to address locations and corridors experiencing congestion issues in the region. The CMP is required to identify and encourage ways to deal with congestion and mobility problems beyond simply expanding roadway capacity. This section includes a broad variety of strategies that can be utilized as the starting point for evaluating project alternatives and will act 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 work, it could then be evaluated in detail as part of the project development process. The current list began as information developed by the Mid-America Regional Council (MARC) and Cambridge Systematics for a congestion management toolbox but has been modified significantly from that original 2001 document. The strategies are grouped into the general categories listed below, although there is some overlap between them in many cases. Each category includes a brief description of the intent of the strategies listed within it, as well as potential analysis methods and tools that can be utilized.

- **Active Transportation:** Strategies that promote cycling and walking as alternatives to driving.
- **Goods Movement:** Strategies that address deficiencies in the freight transportation network.
- **Traveler Information & Incentives:** Strategies that look to better inform travelers and provide motivations to modify the method and timing of travel to reduce congestion.
- **Transit:** Strategies that promote the use of transit as an alternative to driving.
- **Community Development & Design:** Strategies that reduce the need for motor vehicle travel through development patterns and design decisions.
- **Roadway Capacity Expansion:** Strategies that increase the capacity of roadways to manage additional demand for travel.
- **Systems Management & Operations:** Strategies that look to efficiently and effectively manage the transportation network to reduce congestion.

In addition, following the descriptions, there is a table of all strategies (Figure 9) that provides a comparison between approaches, timeframes, as well as types of costs/benefits. The table includes the following information:

- **Approach**: This calls back to the framework discussed in the Framework, Goals, and Objectives section of the document. Each strategy lists whether the intent is to ***avoid*** the need for travel, ***shift*** trips to more efficient modes, or ***improve*** the function of the existing system.
- **Timeframe**: This is categorized into three groups based around the expected timeframe necessary to implement the type of project; Short – projects that can be implemented in under 5 years, Medium – those that will take 5-10 years to bring to fruition, and Long – those that will take more than 10 years to implement. More than one timeframe can be considered.
- **Types of Costs**: This portion of the table examines the types of implementation costs associated with each strategy.
- **Types of Benefits**: This section provides an assessment of the types of benefits that can be expected from each strategy.

Active Transportation Strategies

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 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.

- **New Sidewalks and Designated Bicycle Lanes on Local Streets:** Expanding the availability of safe bicycle and pedestrian accommodations along local streets promotes walking and cycling and can reduce motor vehicle trips. In some cases bicycle shoulders can be accommodated with something as simple as restriping the existing pavement.

- **Improved Bicycle Facilities at Transit Stations and Other Trip Destinations:** Bicycle racks and bike lockers at transit stations and other trip destinations increase security and usage. Bicycle accommodations on transit vehicles and workplace amenities such as showers provide further incentives for commuter use of bicycles.

- **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 and lead to increased cycling and walking and less driving.

- **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 for cyclists. These bike trails can be designed to be connected to adjacent commercial, retail, industrial, and residential land uses to serve as a viable alternative to driving. By removing bicycle (and some walking) traffic from arterials, these types of facilities can provide traffic flow and highway safety improvements as well.

Goods Movement

These are approaches to addressing congestion that look toward removing bottlenecks in the freight network or those improvements that increase the viability of products moving to and through the region via rail or ship.

- **Truck Parking:** The provision of both short and long-term truck parking in designated areas can prevent idling violations and can improve general traffic flows by allowing deliveries at off-

peak periods. Additional safety and operational factors for overnight parking as changes to driver hours-of-service regulations have increased the demand for this type of facility.

- **Short Sea Shipping:** The practice of shipping from major US ports to locations closer to their destinations. In this case, rather than utilizing trucks to travel to or through the region, goods would arrive at the Port of New Hampshire and be dispersed from there.

- **Grade Crossing Separations:** Grade crossing separations eliminate the stoppage of vehicles for rail movement and improve safety by reducing motor vehicle/train interaction.

- **Railroad Infrastructure Expansion and Bottleneck Removal:** Expanding the rail capable of carrying freight and addressing bottlenecks such as single-track sections, which limit the number of trains that can travel through each day, and low bridges which limit the capacity of the individual trains by disallowing "doublestack" rail cars.

- **Intermodal Freight Facilities:** This was the traditional way to deal with congestion but has become tremendously expensive.

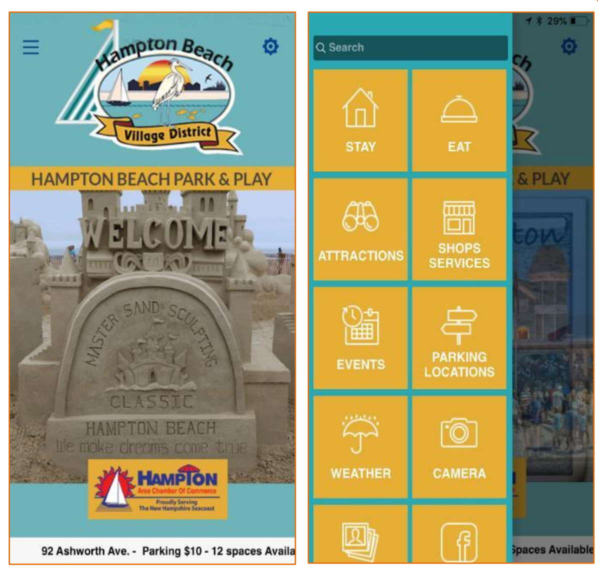
- **Port Facility Expansion:** Expansion of existing marine terminals helps to maximize the use of waterways to move goods by providing more capacity to load and unload, additional storage, and other improvements.

Traveler Information and Incentives

Approaches that expand the information available to travelers can provide low-cost methods of managing congestion through helping users decide when and where to travel to avoid congestion. This can take the form of information provided by communities and agencies or "crowd-sourced" data provided by users as they are experiencing it. This category of strategy also includes direct incentives to travelers to:

- **Highway Information Systems:** These systems provide travelers with real-time information that can be used to make trip and route choice decisions.

- **Advanced Traveler Information Systems:** This provides an extensive amount of data to travelers, such as real time speed estimates on



Hampton Beach Parking App

the web or over wireless devices, and transit vehicle schedule progress.

- **Ridesharing:** This is typically arranged/encouraged through employers or transportation management agencies (TMA), which provides ride-matching services.

- **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.

- **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.

Transit Strategies

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. 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.

COAST Transit Service

- **Reducing Transit Fares:** This encourages additional transit use, to the extent that high fares are a barrier to transit. This can be implemented system-wide or targeted to peak commute hours.

- **Increasing Bus Route Coverage, Route Frequencies, or Hours of Operation:** This provides better accessibility to transit to a greater share of the population. Increasing frequency makes transit more attractive to use.

- **Express Transit Routes:** Modifying existing routes or adding new routes that stop only at major stops to transport people more rapidly.

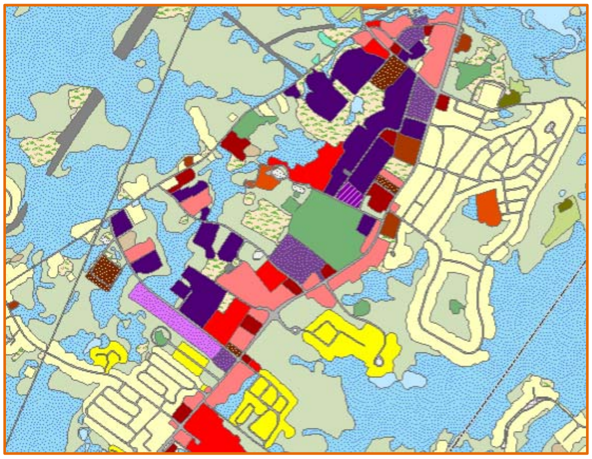
- **Advanced Transit System Management:** Automatic Vehicle Location systems, automatic fare payment systems, smart bus stops, and other technologies that aid riders and coordinated transit management.

- **Park-and- Ride Lots:** Park and Ride lots are locations where drivers can congregate to access transit, carpools, vanpools, and other ridesharing opportunities. 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 or areas where parking is constrained.

- **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. Limited essentially to areas with existing active railroads.

- **Constructing bus pull-outs:** On many routes, buses remain in the roadway to load and unload passengers which can slow and stop traffic behind the vehicle. Bus pullouts allow buses to remove themselves from traffic to load/unload passengers and allow traffic to continue moving.

Community Development and Design Strategies



Land development strategies that work to minimize the number of motor vehicle trips that are necessary 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. The most effective strategies involve designing walkable communities that mix and concentrate uses and allow people to reach destinations by walking, cycling, or using mass transit.

- **Mixed-Use Development:** The practice of mixing commercial, retail, residential and other land uses close together. This can occur at the building, street, neighborhood, or larger community level and increasing the mix of uses tends to reduce the distances that residents must travel for various reasons and allows for greater use of walking and bicycling. Employees who work in mixed-use commercial areas are more likely to commute by alternative modes.

- **Infill and Densification:** This is the practice of developing or redeveloping land that has been bypassed, remained vacant, or is underutilized. This conserves land and takes advantage of existing infrastructure, rather than necessitating the construction of new infrastructure on previously undeveloped property on the fringes of the area. Increasing density improves the viability of transit, cycling and walking as modes of transportation and minimizes the expansion of the roadway network.

- **Transit-Oriented Development:** This is a version of mixed-use development that clusters housing units and businesses near transit stations to bring potential riders closer to transit facilities. The intent is to maximize access to transit and encourage the use of non-motorized transportation. TOD can be implemented in both large and small communities using bus or rail transit systems.

- **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.

- **On-Street Parking and Standing Restrictions:** Instituting parking and stopping restrictions along arterial roadways during peak travel times can eliminate congestion caused by vehicles making parking maneuvers. In some circumstances, the space for parking can be repurposed as extra general-purpose travel lanes, turning lanes, or special bus or HOV “diamond” lanes.

- **Location-Specific Parking Ordinances:** Parking requirements can be adjusted for factors such as transit availability, land use mix, or pedestrian-oriented development and other factors that may reduce the need for on-site parking. This encourages transit-oriented and mixed- use development and reduces the land required for parking lots.

- **Traffic Calming:** This is the practices of implementing areawide or corridor specific design features and strategies intended to reduce vehicle speeds on roadways to be more compatible with adjacent land uses. These strategies use context sensitive design to balance community values with traffic flow to create areas safer for cyclists and pedestrians.

- **Road Diets:** This type of improvement typically involves converting four lane roadways to three traffic lanes, with one center turn lane and bicycle lanes and is suitable for roadways of up to about 20,000 vehicles per day. Studies have shown that road diets smooth traffic flow and reduce both crash frequency and severity.

- **Roundabouts:** A roundabout is an intersection built with a circular island around which traffic rotates in one direction, traffic yields on entry, vehicles are "deflected" to slow entry speeds, and they are limited in size to one-to-two lanes. Compared to signalized intersections, roundabouts reduce vehicles stops and delays and substantially improve safety.

- **Preferential or Free Parking for HOVs:** Communities and employers can establish programs to incentivize carpooling and vanpooling. This provides an incentive for workers to carpool. Can be utilized at Park and Ride lots as well as individual businesses.

- **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.

Highway Capacity Strategies

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.

Photo: NHDOT

- **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 to create additional travel lanes. These lanes can be permanent or only utilized during peak periods.

- **Local and Arterial Street Connectivity:** Enhancing the connectivity between local streets and arterials to access areas can disperse traffic and reduce overall congestion by providing multiple routing options.

- **Geometric Design Improvements:** This includes widening to provide shoulders, additional turn lanes at intersections, improved sight lines, auxiliary lanes to improve merging and diverging. Small improvements to the geometry of the existing system can reduce disruptions from vehicles slowing to turn or entering the roadway from driveways or side streets.

- **New Highways or Adding Lanes to Existing:** Expansion of the capacity of the roadway network through the addition of new travel lanes or entirely new facilities has been the traditional way to deal with congestion. In recent decades this approach has become tremendously expensive as right-of-way and construction costs increase.

System Management and Operations 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.

- **Timing of Construction Projects:** Scheduling construction projects to avoid exceptionally busy times of the day or of the year can minimize the impacts of construction zones on traffic flow. This can mean utilizing overnight construction hours to minimize impacts on commuters, or scheduling construction to avoid closures during busy summer months with substantial tourist traffic in addition to the normal day-to-day.
- **Event Planning:** Traffic management planning for events that draw large volumes of traffic can mitigate excessive delays and queues from the event traffic competing with regular travel needs. This can include active traffic management by police or others, temporary closures or access points, contraflow traffic, one-way traffic, and shuttles to remote parking to manage access and egress.
- **Transit Signal Priority:** Operational improvements that use technology to reduce dwell time for transit vehicles at traffic signals. This does not allow transit vehicles to pre-empt signals as emergency vehicles do however the system shortens time waiting for signal changes to continue the route.
- **Work Zone Shuttle Services:** In some cases, construction may cause the disruption of bicycle and/or pedestrian traffic and this can be mitigated through the use of a shuttle system that makes regularly scheduled trips through or around the work zone to facilitate continued access by cyclists and/or pedestrians.
- **Access Management:** 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.
- **Traffic Signal Coordination:** Synchronizing adjacent traffic signals to allow traffic to progress through a group of signals with minimal stopping. This improves traffic flow and reduces emissions by minimizing stops on arterial streets.
- **Adaptive Signal Control:** This is an advanced version of traffic signal coordination that continuously monitors arterial traffic conditions and queuing at intersection and dynamically adjusts signal timing to optimize traffic flow.

- **Reversible Traffic Lanes:** In instances where traffic flow is highly directional, lanes from the opposing direction can be temporarily utilized to provide additional capacity in the heavy traffic flow direction. This can be utilized for peak-period commute travel or to provide additional capacity to serve large events.

- **Incident Detection and Management Systems:** These systems are intended to shorten the time to detect and respond to crashes and other traffic incidents. By reducing response time, the closure time of lanes can be reduced and normal traffic flow resumed more quickly resulting in less congestion. These systems typically include video monitoring, dispatch systems, and sometimes roving service patrol vehicles.

Photo: I-93 Corridor Service Patrol (NHDOT)

- **Ramp Metering:** This strategy addresses congestion caused by vehicles entering a crowded freeway in groups. Deploying signals on ramps regulates the rate at which vehicles enter the freeway helping to maintain optimal flow rates, thereby speeding travel and reducing collisions. These signals can be pre-timed or dynamic.

- **Variable Speed Displays:** Instead of static speed limits, variable speed displays provide the opportunity to dynamically adjust traffic speeds or advise motorists of downstream conditions, incidents, or congestion and providing advanced warning of the need to reduce speeds.

- **Construction Traffic Mitigation Planning:** Preplanning to minimize the impacts of construction projects on travel in the immediate vicinity. Agencies and communities can develop guidelines to ensure that pedestrians, cyclists, transit vehicles, cars and commercial vehicles can navigate safely through work zones and that adequate accommodations have been made to ensure access to adjacent land uses. This can also include consideration of time of day and time of year of construction.

- **Work Zone Traffic Management:** Integration of traffic management techniques to minimize disruption during active construction. This can include the use of signals to automate the two-way flow of traffic through lane restrictions, use of flaggers or follow vehicles.

- **Integrated Corridor Management:** Integrated Corridor Management is the technique of joint and cooperative roadway, transit, and other transportation asset management along a corridor to collectively address congestion and improve overall operations.

Figure 9: Costs Benefits of Congestion Management Strategies

Area	Strategy	Approach	Timeframe: Short (1-5 Years)	Timeframe: Medium (5-10 Years)	Timeframe: Long (> 10 Years)	Costs: Construction	Costs: Operations & Maintenance	Costs: Facilities & Equipment	Costs: Enforcement	Costs: Public Policy Changes	Costs: Economic Incentives	Costs: Private Sector	Benefits: Efficiency	Benefits: Capacity	Benefits: Safety	Benefits: Accessibility	Benefits: Reliability	Benefits: Trip Reduction	Benefits: Mode Shift	Benefits: Resiliency & Sustainability	Benefits: Fuel/Emissions Reduction
Active Transportation	New Sidewalks and Designated Bicycle Lanes on Local Streets	Shift	●	●		●	●	●	●	●			●		●	●		●	●	●	●
	Improved Bicycle Facilities at Transit Stations and Other Trip Destinations	Shift	●			●	●	●					●		●	●		●	●	●	●
	Improved Safety of Existing Bicycle and Pedestrian Facilities	Shift	●				●	●					●		●	●		●	●	●	●
	Exclusive Non-Motorized Rights-of-Way	Shift		●		●	●	●					●	●	●	●		●	●	●	●
Goods Movement	Railroad Infrastructure Expansion and Bottleneck Removal	Shift		●		●							●		●			●	●	●	●
	Short Sea Shipping	Shift		●									●		●			●	●		●
	Intermodal Freight Facilities	Shift			●	●						●	●		●			●	●	●	●
	Port Facility Expansion	Shift		●		●	●	●					●		●			●	●	●	●
	Truck Parking	Improve	●			●	●	●		●		●	●		●						●
	Grade Crossing Separations	Improve			●	●	●	●					●	●	●		●				●
Traveler Information and Incentives	Ridesharing	Avoid	●				●			●	●	●	●		●			●	●	●	●
	Alternative Work Hours	Avoid	●							●	●	●	●		●		●	●	●		●
	Telecommuting	Avoid	●							●	●	●	●		●		●	●	●		●
	HOV Lanes	Avoid		●	●	●	●	●	●		●		●				●		●		
	Congestion Pricing	Shift		●			●	●		●	●		●		●		●	●			
	Dynamic Routing	Shift	●			●	●	●					●		●		●	●		●	
	Highway Information Systems	Improve		●		●	●	●	●				●		●		●			●	●
	Advanced Traveler Information Systems	Improve		●		●	●	●	●				●		●		●			●	●

Figure 9: Costs Benefits of Congestion Management Strategies

Area	Strategy	Approach	Timeframe: Short (1-5 Years)	Timeframe: Medium (5-10 Years)	Timeframe: Long (> 10 Years)	Costs: Construction	Costs: Operations & Maintenance	Costs: Facilities & Equipment	Costs: Enforcement	Costs: Public Policy Changes	Costs: Economic Incentives	Costs: Private Sector	Benefits: Efficiency	Benefits: Capacity	Benefits: Safety	Benefits: Accessibility	Benefits: Reliability	Benefits: Trip Reduction	Benefits: Mode Shift	Benefits: Resiliency & Sustainability	Benefits: Fuel/Emissions Reduction
Transit	Reducing Transit Fares	Shift	●				●			●			●		●	●	●	●	●	●	●
	Increasing Bus Route Coverage, route frequencies, or hours of operation	Shift	●	●			●	●					●	●	●	●	●	●	●	●	●
	Express Transit Routes	Shift	●				●	●					●	●	●	●	●	●	●		●
	Advanced Transit System Management	Shift	●				●	●					●				●		●	●	●
	Park-and- Ride Lots	Shift	●	●		●	●	●					●			●	●	●	●		●
	Rail Transit	Shift		●	●	●	●	●					●	●	●	●	●	●	●		●
	Constructing bus pull-outs & stops	Improve	●	●		●	●						●		●	●	●				●
Community Development & Design	Mixed-Use Development	Avoid	●	●						●	●	●	●		●	●		●	●	●	●
	Infill and Densification	Avoid	●	●	●					●	●	●	●		●	●		●	●	●	●
	On-Street Parking & Standing Restrictions	Avoid	●						●	●			●				●				
	Traffic Calming	Avoid	●	●		●	●			●			●		●			●	●	●	●
	Road Diets	Avoid	●	●		●	●						●		●		●	●	●	●	●
	Roundabouts	Avoid	●	●		●	●						●	●	●		●			●	●
	Transit-Oriented Development	Shift		●	●					●	●	●	●		●	●		●	●	●	●
	Design Guidelines for Pedestrian-Oriented Development	Shift	●						●	●		●	●		●	●		●	●	●	●
	Location-Specific Parking Ordinances	Shift	●	●						●	●	●	●					●	●		●
	Preferential or Free Parking for HOVs	Shift	●							●	●	●	●					●	●		●
	Employer/Landlord Parking Agreements	Shift	●							●	●	●						●	●		●

Figure 9: Costs Benefits of Congestion Management Strategies

Area	Strategy	Approach	Timeframe: Short (1-5 Years)	Timeframe: Medium (5-10 Years)	Timeframe: Long (> 10 Years)	Costs: Construction	Costs: Operations & Maintenance	Costs: Facilities & Equipment	Costs: Enforcement	Costs: Public Policy Changes	Costs: Economic Incentives	Costs: Private Sector	Benefits: Efficiency	Benefits: Capacity	Benefits: Safety	Benefits: Accessibility	Benefits: Reliability	Benefits: Trip Reduction	Benefits: Mode Shift	Benefits: Resiliency & Sustainability	Benefits: Fuel/Emissions Reduction
Roadway Capacity Expansion	Increasing Lanes without Highway Widening	Improve	●	●		●	●						●	●			●				
	Local and Arterial Street Connectivity	Improve		●	●	●	●							●			●			●	
	Geometric Design Improvements	Improve	●	●		●	●							●	●		●				
	Open Road Tolling	Improve	●	●		●	●	●					●	●	●		●				●
	New Highways or Adding Lanes to Existing	Improve		●	●	●	●							●			●				
Systems Management & Operations	Construction Timing	Avoid	●			●	●						●				●				
	Event Planning	Avoid	●				●	●					●		●		●		●		
	Transit Signal Priority	Shift	●			●	●	●					●			●	●		●		●
	Work Zone Shuttle Services	Shift	●				●	●					●		●	●	●		●		
	Access Management	Improve	●	●	●	●	●		●	●		●	●	●	●		●				●
	Traffic Signal Coordination	Improve	●			●	●						●				●				●
	Adaptive Signal Control	Improve		●		●	●						●				●				●
	Reversible Traffic Lanes	Improve	●			●	●	●					●	●			●				
	Incident Detection and Management Systems	Improve	●	●		●	●	●					●		●		●			●	●
	Ramp Metering	Improve		●		●	●						●		●		●				●
	Variable Speed Displays	Improve	●			●	●	●	●				●		●		●				●
	Construction Traffic Mitigation Planning	Improve	●				●	●					●		●	●	●		●		
	Work Zone Traffic Management	Improve	●				●	●					●		●	●	●				
	Integrated Corridor Management	Improve		●	●	●	●	●		●			●		●		●			●	