CONGESTION MANAGEMENT PROCESS: STATE OF THE PRACTICE

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PREPARED FOR:
ATLANTA REGIONAL COMMISSION

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1.0 CONGESTION MANAGEMENT PROCESS

When Congress passed the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991, Metropolitan Planning Organizations (MPO) were required to begin examining and evaluating regional transportation by instituting a number of management systems. Among these was the Congestion Management System (CMS), which changed the planning perspective from "what do we need to build?" to "how can we best manage the system we have?" The 2005 transportation authorization, Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), replaced the CMS with the Congestion Management Process (CMP). All MPOs with population greater than 200,000 were now required to address congestion mitigation through an ongoing process. MPOs would use the CMP methodology to identify congested locations across a defined geography and across modes, and develop strategies to address the congestion. It is important to note that the law did not require MPOs to program projects identified in the CMP. Instead, the CMP would supply actions that meet the MPO's overall goal for congestion mitigation. In air quality non-attainment areas, a project that increases capacity for single-occupant vehicles may be programmed only if it is included in the CMP. Finally, the law does not specify a prescribed update cycle for the CMP. Some MPOs do an update prior to the update of the long range Metropolitan Transportation Plan (MTP), so the findings can inform the MTP, while others do so after the MTP is adopted so its goals and objectives can inform the CMP.

The process for developing the CMP is clearly spelled out in the FHWA *Congestion Management Process: A Guidebook* and was graphically depicted by WSP | Parsons Brinckerhoff as shown in Figure 1.

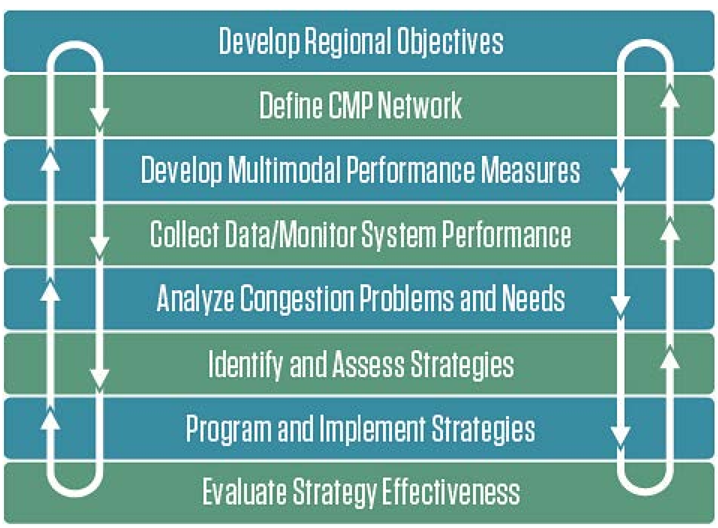

FIGURE 1 - CMP PROCESS (graphic developed by WSP | Parsons Brinckerhoff)

Although the CMP process is well defined, the flexibility it offers leaves a number of open questions that MPOs must address. These include policy issues, like the priority assigned to mitigating specific types of congestion or the types of strategies that are available for consideration. There are also content issues including the methodologies that will be used to measure congestion, and the range of mitigation strategies that will be considered for various types of congestion.

A recent initiative that came from research conducted under the Second Strategic Highway Research Program (SHRP2) Reliability topic area is the inclusion of travel time reliability in the CMP. In 2015, FHWA released *Incorporating Travel-Time Reliability into the Congestion Management Process (CMP): A Primer*. The Primer recognizes that most MPOs address only recurring congestion in the highway portion of their CMP; this may be because average daily travel and peak period volume is easy to collect and forecast. However, non-recurring congestion may account for a substantial portion of total congestion, particularly on urban freeways. As the Primer demonstrates, the strategies for mitigating non-recurring congestion are different from those that would be used to address recurring congestion.

Like all parts of the MPO planning process, the CMP is open to public involvement. An MPO may seek public input on the importance different user groups assign to various types of congestion, and where it fits in the overall priority for transportation investment. Some MPOs also report to the public, often through system performance dashboards on the agency website, so they can monitor the impact of projects or programs that have been deployed.

Finally, as stated by the Maricopa Association of Governments (MAG) in Phoenix, congestion management is complex. MAG originally anticipated that before-and-after data at a location where the region had employed a given strategy would provide clear information on that strategy's effectiveness. However, when MAG examined the data from a system perspective, it became clear that traveler behavior at a specific location is not always indicative of the overall system-level result.

2.0 RESEARCHING THE CMP STATE OF PRACTICE

MPOs have now had a decade to incorporate the CMP in their overall metropolitan planning process. This provides an opportunity to investigate the current state of practice, particularly in terms of some of the areas where MPOs have flexibility in how they proceed.

The initial research began by identifying MPOs that have a demonstrated history of leadership in at least one important element of CMP development. The team reviewed the CMP for each of the following MPOs:

- Chicago Metropolitan Agency for Planning (CMAP), Chicago IL
- Delaware Valley Regional Planning Commission (DVRPC), Philadelphia PA
- Genesee Transportation Council (GTC), Rochester NY
- Hampton Roads Transportation Planning Organization (HRTPO), Norfolk VA
- Maricopa Association of Governments (MAG), Phoenix AZ
- Mid America Regional Council (MARC), Kansas City MO
- Metroplan Orlando, Orlando FL
- Metropolitan Washington Council of Governments (MWCOG), Washington DC
- North Central Texas Council of Governments (NCTCOG), Dallas-Fort Worth TX
- Puget Sound Regional Council (PSRC), Seattle WA
- Regional Transportation Commission of Southern Nevada (RTC), Las Vegas NV

Subsequent to the initial scan, the team conducted interviews with seven of the MPOs where CMP practices appeared to include noteworthy elements relevant to the Atlanta Regional Commission (ARC). They are:

- Genesee Transportation Council, Rochester NY
- Hampton Roads Transportation Planning Organization, Norfolk VA
- Maricopa Association of Governments, Phoenix AZ
- Mid America Regional Council, Kansas City MO
- Metroplan Orlando, Orlando FL
- Puget Sound Regional Council, Seattle WA
- Regional Transportation Commission of Southern Nevada, Las Vegas NV

3.0 CMP NOTEWORTHY PRACTICES

The CMP practices that are of particular interest to the ARC can be categorized into elements as described in the following sections.

3.1 | DEFINING THE CMP NETWORK: SYSTEM COVERAGE

Large MPOs are challenged in all of their planning work to accommodate a regional transportation system that is geographically extensive. As a result, these MPOs employ various methods to create CMP networks that are manageable from a data collection and analytic perspective while still encompassing facilities with the highest probability of congestion.

TABLE 1: CMP SYSTEM COVERAGE

Agency	System Coverage
CMAP	• Expressways and tollways; • Regionally important roads; • Regionally important transit systems.
DVRPC	• Congested corridors segmented into sub-corridors; • Sketch corridors likely to become congested in the future that serve key regional roles; • Corridors based on: CMP Analysis Points, Transportation Refinement Layers, and Community Refinement Layers.
GTC	• All Interstate highways, principal and minor arterials; • Collector roads in the vicinity of special event venues.
HPTPO	• Principal arterials (interstates, freeways or other expressways); • Minor arterials; • Roadways classified as collectors based on network connectivity, access to major activity centers, and input from jurisdictions; • Major roadways that are expected to be constructed in the future.
MAG	• Freeway corridors identified in the Performance Measurement Framework report; • Transit facilities and services; • Bicycle and pedestrian facilities; • Arterial streets that either currently experience significant congestion; or are projected to experience significant congestion in the future; or make up part of a corridor or activity area that is subject to current or future congestion.

Agency	System Coverage
MARC	• All National Highway System routes; • All other routes with average daily mid-block traffic volumes of 25,000 or more for segments of 2 miles or more in length; and • All routes with high levels of transit service.
Metroplan Orlando	• Level 1 - Systemwide evaluation is performed, leading to the identification of: • Level 2 - Potentially congested roadways/intersections, from which evolve: • Level 3 - Detailed corridor or intersection studies.
NCTCOG	• A corridor inventory of 25 regional limited access facilities.
PSRC	• Based on the Metropolitan Transportation System (regionally significant multimodal transportation facilities that provide access to activities crucial to the social or economic health of the region); • Additional layers added to the CMP to reflect multimodal or freight considerations, including: o Core freeway and HOV network; o Washington State Department of Transportation (WSDOT)-identified bottlenecks; o Top 25 regional "key" arterials identified by Regional Traffic Operators Committee; o Key transit corridors identified by transit stakeholders; o T1 and T2 truck freight routes identified in regional Freight and Goods Transportation System; o Critical infrastructure and significant emergency management routes.
RTC	• Major inter-regional corridors and major arterial corridors connecting cities to the base congestion management network; • Only regionally-significant corridors considered as candidates for the network; • The initial network was refined from the list of candidate corridors to include facilities with "existing or potential recurring congestion," professional judgment was used to identify corridors with existing congestion and those likely to become congested.

As can be seen from the information in Table 1, there is a great deal of variation in how these peer MPOs define the CMP system coverage. Each CMP begins with the principal arterial system, including Interstate highways, freeways, and tollways. These roadways carry the highest percentage of urban traffic, and have traffic volume and speed data available to enable measurement of congestion. Some MPOs then move deeper into the functionally classified roadway system, adding minor arterial streets, and even connector streets, although the latter is unusual in that it creates a very dense network for analysis. This is typically done to ensure inclusion of roadways providing access to key destinations. For example, HRTPO includes access to all military bases in its region, reflecting their importance. Others, like MARC, include all roads that carry bus routes with high level of usage, in order to bring transit into the CMP.

The more common approach to building the CMP network is reflected in the federal guidance to include those roadways that are currently or forecasted to become congested. This approach requires an iterative process of measuring congestion systemwide in order to identify lower level facilities for inclusion. An MPO often conducts this process employing a network analysis based on the MPO's travel demand model.

3.2 | DEFINING THE CMP NETWORK: MODAL COVERAGE

The CMP is required to address congestion on the region's "multimodal transportation system". This presents a challenge for many MPOs because (1) the size of the network is prohibitive, and (2) there is little data available for non-motorized modes. Nonetheless, many of the peer MPOs include transit in their CMP, and some include pedestrian and bicycle modes. As shown in Table 2, much of the consideration, particularly of pedestrian and bicycle modes, comes not in the analysis of congestion but in the development of mitigation strategies. These may include both programmatic and project level methods to increase mode-share as a means of reducing automobile travel for shorter trips, thereby reducing roadway congestion in key locations.

> "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...through the use of travel demand reduction and operational management strategies.
>
> *23 CFR 450.320(a)*

Transit is often included in the CMP because of its importance in the regional transportation system. The focus is most often on bus transit, since the ability to provide reliable service depends in large part on the function of key arterial streets that serve as bus routes. Transit can also experience congestion, with peak period crush loads on certain routes that can result in a bus having to skip a downstream stop causing those people to wait for the next bus. There can also be crowding at terminals, stations, and stops.

TABLE 2: CMP MODAL COVERAGE

Agency	Modal Coverage
CMAP	Considers bicycle/pedestrian strategies
DVRPC	Considers bicycle/pedestrian strategies
GTC	Includes transit performance and usage. Considers bicycle/pedestrian strategies
HPTPO	Transit in defined corridors. Considers bicycle/pedestrian strategies
MAG	The presence of bicycle, pedestrian, and transit are an important criterion
MARC	Includes high usage transit routes. Considers bicycle/pedestrian strategies
Metroplan Orlando	Includes an analysis of movement on bicycle/pedestrian facilities.
MWCOG	Considers bicycle/pedestrian strategies
NCTCOG	Assesses factors that influence modal options including the presence of transit options (bus and/or rail), park-and-ride facilities, HOV/Managed lanes, and bicycle/pedestrian options.
PSRC	Includes transit: rail, bus, and ferry. Considers truck freight and bicycle/pedestrian modes
RTC	Considers bicycle/pedestrian strategies

GTC explicitly includes transit in its CMP. While they acknowledge that bus transit performance is primarily a consequence of arterial street congestion, they use on-time performance and bus load factor as congestion management performance measures. These metrics help them assess the value of transit-related strategies in different corridors.

Others, including PSRC and HRTPO, view transit as a component of corridor analysis rather than broadly including it as a separate mode to be analyzed.

Most of the peer MPOs pointed to a lack of data as the primary reason to exclude non-motorized modes from consideration in the congestion identification stage of the CMP.

3.3 | DATA SOURCES

The availability of reliable data is a critical driver of the CMP. This begins with baseline data on current conditions in order to identify congested locations.

Highway data requirements typically include:

- Traffic volume during peak periods; may include truck volumes
- Speed profiles during peak periods
- Incident data, of which crash data are a subset.

Transit data may be limited to bus routes on arterial streets that are in the CMP network, and include:

- Ridership
- On-time performance
- Capacity passenger loading

If pedestrian and bicycle modes are included in the CMP, data include:

- Peak period counts at key locations and intersections

Data are often available from MPO member agencies that are partners in developing the CMP. State and local transportation agencies typically maintain traffic count databases. Traffic Management Centers (TMC) are often a source of archived traffic data. For traditional measures like volume/capacity ratio, count data are sufficient.

Speed data, which MPOs use to document both recurring and non-recurring congestion, can be more difficult to obtain. The traditional methodology is a floating car study. This involves one or more test-vehicles conducting multiple driving runs on a given roadway segment and recording the time to drive between two know points (i.e., know distance). It is labor intensive and provides a snapshot of travel times and speeds on a given facility. This approach may be useful as a means of determining the extent and severity of recurring congestion on roadways that are known to be congested.

Advances in technology now provide automated means of collecting speed or travel time data by use of cell phone or toll tag probe data collection. There are private vendors, including INRIX and HERE that collect this data and can provide it to MPOs for a fee. There is also a database called the National Performance Management Research Data Set (NPMRDS) that is a source of speed data. FHWA purchases this data from HERE and is making the dataset available to states and MPOs at no cost. It covers the National Highway System, providing speed in 5-minute slices for all traffic, and separately for passenger vehicles and trucks. HERE has recently introduced a Predictive Traffic tool that uses both real-time and historic data to predict travel time up to 12 hours in advance.

The University of Maryland Center for Advanced Transportation Technology (CATT lab) has developed a platform called the Regional Integrated Transportation Information System (RITIS). RITIS automatically fuses, translates, and standardizes data obtained from multiple agencies in order to provide an enhanced overall view of the transportation network.[1] This includes everything from raw HERE data and real-time TMC data feeds to archived traffic data. The system produces reports and visualizations.

If travel time reliability is included in the CMP, time series data are required. Typically travel time is measured on a given segment of roadway for a specified period of the day (AM peak, for example), over a number of months or a year. The analysis will document the range of variability and various performance measures like the Travel Time Index or Planning Time Index.

Since the root causes of non-recurring congestion include incidents, work zones, weather, and special events, it is useful to have data on those factors to match to the travel time profiles. For example, if speed data shows an unexpected slow or stop condition, the analyst may match the time to a TMC incident log to determine if there was an incident and the number and duration of lane closure. Some MPOs use geo-coded crash data, which is readily available, as a surrogate for all incidents.

Peer MPO experience with common datasets includes the following:

- Metroplan Orlando began with traffic count data from Florida DOT (FDOT) and its three constituent counties. They have moved beyond that, and now use RITIS with HERE and INRIX data. The agency currently relies on HERE data, citing that INRIX is a comparable data source. Data analysis occurs first at the regional level and subsequently for travel time and bottleneck evaluations on arterial roadways. Specific segment and time-of-day detail analysis is ad-hoc. FDOT is also contracting with Waze, but the MPO is not yet sure how that data will be used. The MPO used consultant services to collect Bluetooth data for travel times on specified signalized roadways to assist with optimization. FDOT will be deploying Bluetooth readers on a specific set of roadways. Metroplan is updating its ITS Master Plan, which will include commercial vehicle/freight applications. The freight data source has not yet been determined.
- MAG relies on the Arizona DOT freeway management system for the portion of the system that has data collection infrastructure. They have added to that database by purchasing HERE data. HERE data are analyzed at the corridor-level for most highway operations projects. For alternative mode projects, data analysis occurs at the intersection- or segment-level. They note that all raw data requires Quality Assurance/Quality Control (QA/QC) routines to identify anomalies. They acknowledge that the HERE data are not necessarily more accurate than other sources. MAG is in the process of identifying a specific source for freight data.
- MARC evolved from a history of regional travel time floating car studies to examining various data sources. MARC compared INRIX and NPMRDS data. The INRIX data are clean of outliers, but the methodology is unknown, which raised some concerns. INRIX data were analyzed at the TMC segment level for the CMP. For a specific travel time study, MARC aggregated segments for analysis at the corridor level for select highway

[1] See more on RITIS at http://www.cattlab.umd.edu/?portfolio=ritis

and arterial corridors, which ranged from 9 to 25 miles in length. In addition to corridor summaries, MARC examines certain measures by functional classification. The NPMRDS data are free, but limited to the NHS, which does not include their entire CMP network. Further, MARC experienced challenges with in-house resource demands to process the NPMRDS data into their GIS. Missouri DOT has a contract for RITIS that is available to the MPOs. This gives MARC the HERE data that is processed to produce performance measures and useful visualizations. This has proven valuable in supporting the CMP. In terms of freight data, MARC applied freight tonnage from the publicly available Freight Analysis Framework (FAF) dataset provided by FHWA for their past performance measurement reports. The agency is considering eliminating freight tonnage as a performance measure. Freight tonnage is not influenced by the MPO planning process; rather it is a function of economic activity in the region. MARC's performance measures will most likely focus on truck delay and bottlenecks in the future.

- HRTPO uses INRIX data, but finds that it does not provide complete coverage for the CMP network. They use VDOT and local traffic count data to develop AADT and peak period directional distributions to identify congested locations for the part of the network not covered by INRIX. They extract the following information from INRIX: travel speed/travel time indices, potential for intersection congestion alleviation, congestion duration, total delay, and travel time reliability. Analysis of the INRIX data occurs on a CMP roadway segment basis, as HRTPO breaks down CMP roadways into segments based on interchanges on the freeway system and on major intersecting roadways on the arterial system. The average CMP roadway segment is about one mile in length, with some segments in urbanized areas shorter than in rural areas. For the areas with the highest levels of congestion, HRTPO uses INRIX data at the corridor level. These corridor-level analyses typically involve approaches to the region's major bridges and tunnels. HRTPO noted that the 2015 INRIX dataset will include the INRIX XD dataset, a higher quality version of the data. Freight data used for the HRTPO CMP comes from VDOT traffic counts.
- GTC also uses INRIX data, which they began purchasing two years ago. They find it straightforward and reasonably easy to use. When compared to TMC surveillance data, there appeared to be inaccuracies especially with special event traffic, so QA/QC is important. GTC's analysis of INRIX occurs at the corridor-level. GTC noted that analysis of INRIX data must be by TMC code or by groups of TMC codes. Therefore, they cannot look at segment lengths by mile unless a TMC code is, by chance, one mile exactly in length. GTC looks at traffic patterns on an exit-by-exit basis for both at-grade and grade-separated roadways. The agency prefers to evaluate traffic operations on sections between intersections rather than on incremental stretches of mileage. GTC uses the standard Analytics platform of INRIX, but may look into obtaining the INRIX XD dataset in the future. GTC's current source of freight data is FAF, but the agency may look into using NPMRDS or proprietary Transearch data in the future.

When transit performance is included in the CMP, the peer MPOs all report that they acquire data from the regional transit operator(s). There has been a longstanding requirement that transit operators report a number of data elements to the National Transit Database, including ridership and on-time performance.

Data analytics are straightforward among the peer MPOs. These MPOs identify congested locations on principal arterials from volume and speed data. Performance measures include v/c ratio as a measure of recurring congestion during peak periods on a statistically average day and Planning Time Index or Travel Time Index as a measure of travel time reliability. The latter requires time-series data for given freeway segments over a lengthy period.

3.4 | EFFECTIVE CMP STRATEGIES

The value of the CMP lies not simply in identifying congested locations among various modes on the defined network, but implementing agreed upon mitigation strategies. This latter step can present a number of challenges.

Establishing congestion mitigation priorities is the first step, and always involves managing public and decision maker expectations. While the CMP goals should come from the MTP, there are many considerations within the goal statements.

- Which elements/subareas/corridors of the CMP network have the highest priority?
- From a programmatic perspective, how do capacity solutions rank against operational strategies?
- Is addressing recurring congestion or non-recurring congestion a higher priority?
- How does managing demand compete against managing supply (i.e., capacity)?
- When modes compete, which are favored? For example, is transit signal priority favored even if it contributes to automobile congestion?
- How does funding availability and eligibility affect choices?
- Are land use and development decisions addressed proactively or reactively?

Addressing congestion in metropolitan regions is very complex. The federal requirements for CMP do not specify “correct” answers to any of these questions. It is here that the cooperative MPO process must be used to sort through different choices and opportunities. Some of the peer MPOs have developed resources to identify potential strategies and means to develop preferred alternative packages.

MARC developed a CMP Toolbox[2] that establishes nine categories of strategies, including highway, transit, transportation management & operations, access management, active transportation, TDM, land use, parking, and regulatory. Each of these has a number of specific strategies for consideration. MARC begins its examination of identified congested locations in terms of the dimensions of place, time, severity, and variability. Because MARC

[2] http://marc.org/Transportation/Plans-Studies/Transportation-Plans-and-Studies/Congestion-Management-Process/CPM-pdfs/CMT-Update_Toolbox_Dec2013.aspx

includes arterial streets in its CMP network, the MPO developed Operation Green Light, an ongoing activity to optimize and coordinate traffic signal timing throughout the metropolitan area.

HRTPO also uses a CMP toolbox[3] approach. Their nine categories are somewhat different from MARC's, and include growth management, congestion/value pricing, HOV lanes, TDM, transit capital improvement, transit operational improvement, bicycle & pedestrian improvement, highway operational improvements, and construct general purpose lanes. Similar to MARC, each category includes a number of specific actions for consideration.

MAG and PSRC tend to take a corridor-based approach to CMP implementation. This perspective facilitates a better understanding of the various contributors to congestion in the corridor, which in turn helps direct the selection of strategies. For example, an urban commercial corridor with bus transit service will have different needs than a suburban corridor that carries a high percentage of peak-period commuting traffic. PSRC is also specifically interested in freight movement in their CMP, so they can focus on corridors with higher percentage of truck volume.

Most of the peer MPOs view ITS as a critical tool for congestion mitigation, both for collecting real-time information on system operations and for disseminating traveler information to system users as a means to manage demand. This relates to the broad goal of TDM strategies, which is to influence the behavior of travelers in a way that minimizes congestion. Advanced travel demand management techniques seek to modify people's choice of time of day, mode, and route of travel to spread out peak demand.

3.5 | AGENCY COORDINATION IN THE CMP PROCESS

The cooperative MPO process involves constant communication across member agencies and organizations holding a stake in the CMP throughout a metropolitan region. Data sharing is critical, particularly in areas with independent transit agencies. Further, these partner agencies are helpful in gathering a complete understanding of why both recurring and non-recurring congestion occur at specific corridors and intersections. Local, on-the-ground knowledge provides a quality assessment tool for ensuring that underlying CMP data sources provide an accurate picture of what actually happens on roadways in the region.

MAG involves their member agencies, AZDOT, and Valley Metro in their planning process through group meetings, on-on-one meetings, workshops, conference calls, and webinars. They find that group meetings with an agenda and deliverables is one of the most effective strategies in gaining useful, implementable feedback from these partners.

GTC provides their completed draft of the CMP document to the Transportation Management Committee for review and feedback. The Committee consists of representatives from several agencies involved in managing and operating the regional transportation system, including the New York State Department of Transportation (NYSDOT), the New York State Thruway Authority, the City of Rochester, Monroe

[3] http://hrtpo.org/uploads/docs/CMP%20Report%20Final%20Version.pdf p 56

County, the Transit Authority, law enforcement, and other local stakeholder agencies. GTC finds that having operations personnel at each of these agencies review the CMP, it ensures that the process is applicable to the region's congestion issues and needs.

HRTPO's coordination with partner transportation agencies primarily occurs through their TPO Board Subcommittees, specifically the Transportation Technical Advisory Committee (TTAC). The agency also held a number of meetings and conference calls with localities regarding heavily congested corridors to gain a comprehensive understanding of the causes of congestion and potential mitigation strategies. HRTPO also discusses the CMP itself with these localities to learn what aspects of the CMP are useful and what to consider in terms of additions to the process.

Metroplan Orlando collaborates with each jurisdiction and operating agencies within their region. Metroplan had created a Management and Operations Subcommittee, consisting of various local traffic engineers, which was recently elevated to a full committee and renamed the Transportation System Management and Operations Advisory Committee. Members of the Committee collaborate to identify mutual challenges and opportunities for managing traffic demand using technology, information, and communication strategies.

MARC works with local governments, Missouri and Kansas DOTs, federal agencies, transit agencies, and traffic management officials (KC Scout) in the planning process. MARC coordinates with these partner agencies through their established planning committees and ad-hoc workgroups. Committee meetings are helpful for information sharing, but MARC this is often an unfavorable venue for stakeholder feedback. It is often difficult to achieve a regional agreement on how to define congestion.

These examples underscore the importance of collaboration among agencies in the CMP process and also illustrate the willingness and propensity of partner agencies to get involved in addressing regional congestion issues.

3.6 | CHALLENGE: SELECTING THE PREFERRED STRATEGIES

The peer MPOs, as well as others in the transportation planning community, recognize how difficult it can be to select the most effective package of congestion mitigation strategies. While reasonably good information exists on the outcomes of many common strategies, such as creating an HOV or priced lane, or implementing ramp metering, little information is available on others, like potential mode shifts from SOV to bicycle due to constructing a network of separated bike lanes. Operational strategies, like improving an incident management program to reduce the duration of lane closures on a freeway, may have a nearly immediate impact. Conversely, the congestion reduction benefits from TDM strategies, such as encouraging major employers to offer flexible work hours or remote work locations, may develop over an extended period. Similarly, land use strategies may require years to play out before a congestion-related benefit is realized. The MARC CMP Toolbox includes descriptive information on costs and benefits of each strategy, but these would have to be fine-tuned and monetized (quantified in a dollar amount) to be more useful.

CMP recommendations are often categorized across more than one dimension. For example, they can be sorted in terms of:

- Funding: source (federal, state, local, other); one-time or ongoing
- Geography: areawide, subarea, or corridor
- Mode
- Timing: short, mid, or long-term
- Type: operations, capital, or policy

For example, the incident management program improvement cited above could be classified as short-term, operations, highway, corridor, state and local funding.

While congestion mitigation on the supply side of the transportation system is well defined in terms of costs and benefits, the demand side is very much dependent on traveler behavior, which is more difficult to predict.

4.0 IMPROVING THE ARC CMP

The purpose of this scan of CMP practice among a set of peer MPOs is to assist the ARC in recognizing how they might improve their CMP. This is by no means a blank slate effort. Table 3 provides a summary of the conclusions derived from the peer agency review.

TABLE 3: CMP COMPONENT SUMMARY

CMP Component	Recommendations
Network/Modal Coverage	Strategic Regional Thoroughfare Network sufficient for the CMP Process Consider including transit routes that are on the Regional Thoroughfare Network Consider addressing locations of pedestrian congestion using pedestrian counts and visual observations
Data Sources	Consider follow up discussions with CATT on RITIS program inputs, outputs, and cost Consider TMC incident logs or geocoded crash records to inform non-recurring congestion analysis
Congestion Mitigation Strategies	Consider developing a CMP Toolbox to act as a guide/ reference for congestion mitigation strategies
Process	Establish selective and strategic performance measures that address regional priorities and consider online visual reporting Emphasize coordination and the *process* as a whole

4.1 | NETWORK AND MODAL COVERAGE

The ARC Strategic Regional Thoroughfare Plan (SRTP) created a network that underlies the CMP. Thoroughfares are those arterials that serve regional functions of connectivity for major employment or residential centers, support regional and statewide travel needs, are significant to truck and transit usage, and provide redundancy by paralleling freeways. Combining the Interstate and freeway system with these regional thoroughfares, ARC has a network that meets the primary needs of the CMP while remaining manageable.

ARC may consider a more multimodal approach to the CMP by including transit. Transit usage is certainly key to urban mobility. The linkages to congestion mitigation are clear on both the supply and demand side. In order to shift travel from auto to transit mode to reduce congestion, service must be reliable and convenient. When arterial congestion results in poor on-time performance, or high load factors make it difficult to board the first available bus, people who are not transit-captive are less likely to shift away from a private automobile mode. While rail transit is important, it is less directly involved in the CMP except as part of the mode shift demand strategy.

If ARC chooses to include transit, it would be logical to include only those routes that are on the Regional Thoroughfare Network. A further consideration is the availability of data from the transit operators, especially ridership and on-time performance on the routes in question.

Most of the peer MPOs use non-motorized modes as strategies to reduce automobile travel by improving safety and convenience for walking and cycling. For ARC, it may be appropriate to go beyond this basic approach to consider addressing specific locations of pedestrian congestion, often directly adjacent to transit stations or stops. ARC could use pedestrian counts and visual observation to understand the problem's severity and suggest solutions in modifying the built environment.

4.2 | DATA SOURCES

Peer MPOs rely on relatively few data sources to identify roadway congestion in terms of location, time of day, duration, severity, and variability. TMCs are a common source of locally generated and archived traffic volume data. The need for speed and travel time data has led MPOs to proprietary data sources including INRIX and HERE; and to the use of the NPMRDS dataset, a subset of HERE data available at no cost from FHWA. In each of these cases, MPOs have had to address questions of coverage, reliability, and post-processing including data cleaning. Two of the peer MPOs are considering INRIX XD.

The RITIS platform from the University of Maryland CATT lab appears to provide several advantages, according to those MPOs who are using it. RITIS will utilize local data sources as well as national datasets to generate a robust set of travel information. It can also generate visualizations of the information output, which MPOs have reported to find particularly useful in communicating the CMP to decision makers and the public. ARC may consider follow up discussions with CATT on program inputs, outputs, and cost.

When MPOs address non-recurring congestion in relation to travel time reliability on urban freeways, archived speed and travel time data can support the appropriate indices. However, in order to devise appropriate strategies to improve reliability, it is also important to have information on the cause of non-recurring congestion incidents. A lane closure that results from an incident is different from one caused by a short-term work zone, special event, or severe weather. TMC incident logs can be useful, but may also require a great deal of processing to match the cause of delay. Some MPOs use geocoded crash records as a simple first step; identifying roadway segments with a higher than average crash experience can help focus incident management resources.

4.3 | CONGESTION MITIGATION STRATEGIES

As noted, even with a good understanding of congestion in terms of location, duration, severity, variability and cause, an MPO can still find it difficult to select the best package of congestion mitigation projects, programs, and policies. While ARC has explored a range of solutions in its CMP, the CMP Toolbox approach used by some peer MPOs has value. The example toolboxes provided in Section 3 provide definitions/typologies of congestion and describe a variety of congestion mitigation strategies. The toolboxes then link the strategies to the different congestion typologies to establish the optimal scenarios for implementation of each strategy. MARC's toolbox, for example, includes a breakdown of 'congestion and mobility benefits, costs and impacts, implementation timeframes, analysis methodologies, and strategy-grouping possibilities. These toolboxes are helpful as a reference to jurisdictions interested in identifying strategies that will best work with their unique congestion issues.

Evaluating alternative solutions in terms of benefits and costs can be challenging, but must be based on the best information available. The fact that the effectiveness of many strategies relies on changing traveler behavior, the CMP will always carry a measure of uncertainty.

4.4 | A PROCESS, NOT A PLAN

While some MPOs think of the CMP as a plan that is periodically updated, it is important to recognize that the CMP is actually a process. The requirement in MAP-21 that MPOs institute performance based planning and programming may facilitate the recognition of the CMP as a continuous process. While rulemaking related to MAP-21's national performance goals is not yet final, it is clear that monitoring mobility on a continuous basis will be important. "How is the regional freeway/arterial/transit system functioning over time? Is congestion increasing or diminishing? Are demand management/traffic operations/traveler information strategies having a measurable outcome?" In order to answer these sorts of questions, MPOs must have both credible data streams and adequate resources to manage, analyze, and report it.

ARC must look ahead to understand and decide how congestion mitigation will fit in a broader performance based planning program. Part of that is responding to and managing public expectations. Many MPOs use visual reporting of performance on their websites, including congestion or mobility dashboards. These include DVRPC[4], Boston MPO[5], MTC, and others. Periodic updating is required to keep the information fresh, and to support the MPO's ongoing monitoring of performance metrics. Quarterly updates are typically sufficient to keep the public engaged and manageable from a staff resource perspective.

ARC will decide which performance measures are the most important to report. These may include vehicle-hours of delay on key corridors as a measure or recurring congestion, planning time or travel time index as a measure of reliability, transit ridership and on-time performance on key routes.

In sum, a well-managed CMP is one designed to be an effective tool that the MPO can use to address mobility, but it can also be resource intensive. The depth and breadth of the CMP should reflect the MPO's priorities for congestion mitigation by mode and geography within the overall planning process.

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[4] See http://www.dvrpc.org/LongRangePlan/RegionalIndicators/Transportation.htm
[5] See http://www.ctps.org/map/www/apps/expressHighwayPerformanceDashboard/index.html