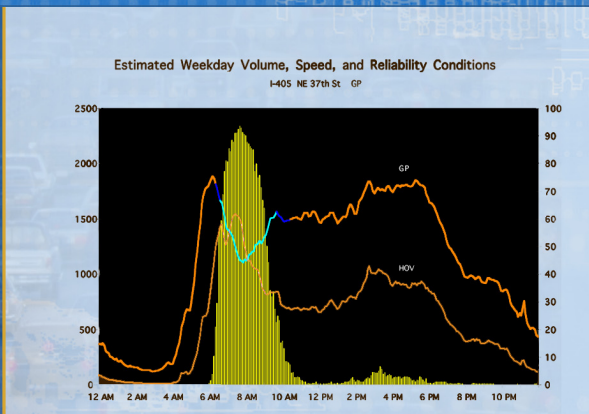
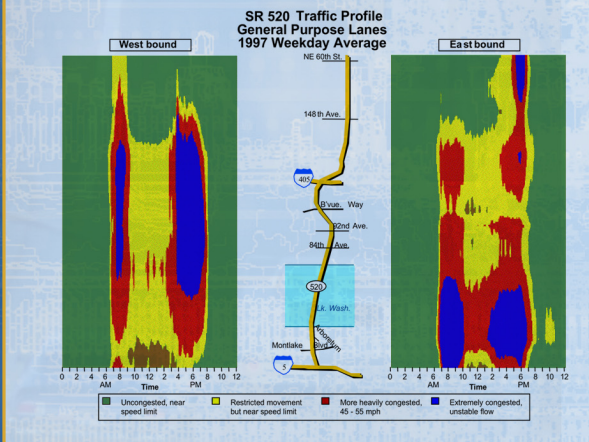
PERFORMANCE MEASUREMENT FRAMEWORK AND CONGESTION MANAGEMENT UPDATE – REVIEW OF BEST PRACTICES





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MARICOPA ASSOCIATION of GOVERNMENTS

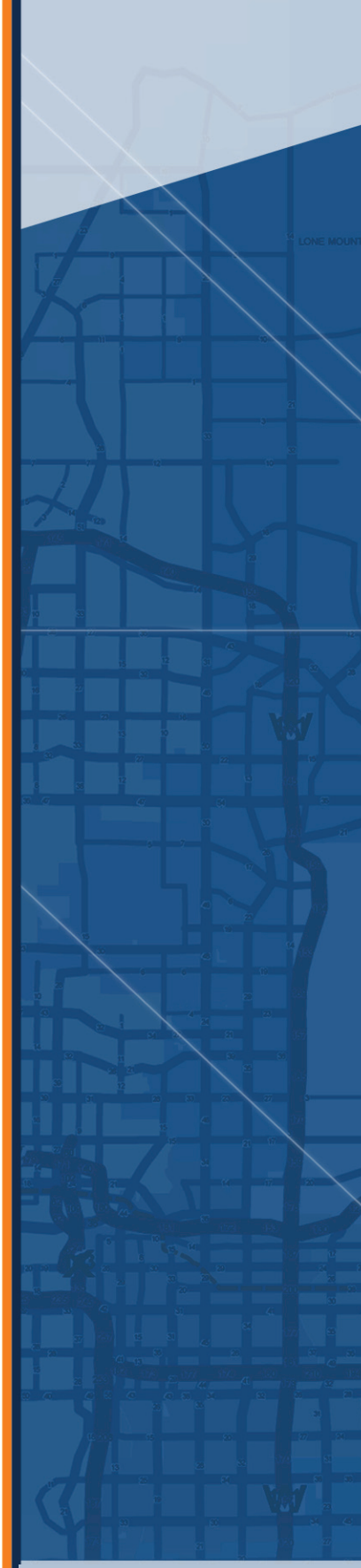
JULY 2008

Performance Measurement Framework and Congestion Management Update - Review of Best Practices

Prepared for

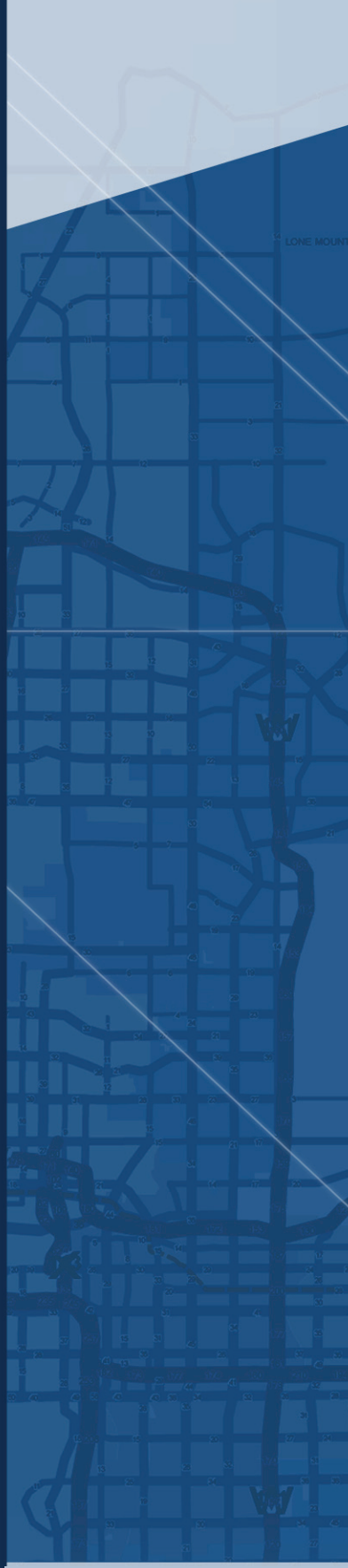
Maricopa Association of Governments
302 North 1st Avenue
Phoenix, Arizona 85003

July 2008



List of Acronyms

AADT – Average Annual Daily Traffic
AASHTO – American Association of State Highway and Transportation Officials
ADMS – Archived Data Management System
ADOT – Arizona Department of Transportation
AMPO – Association of Metropolitan Planning Organizations
ATPI – Atlanta Transportation Performance Index
BTH – Business, Transportation, and Housing Agency
BRT – Bus Rapid Transit
BTS – Berkeley Transportation Systems
Caltrans – California Department of Transportation
CATT – University of Maryland Center for Advanced Transportation Technology
CDW – Central Data Warehouse
CMAQ – Congestion Mitigation and Air Quality
CMP – Congestion Management Process
CMS – Congestion Management System
CTOC – Citizens Transportation Oversight Committee
DART – Dallas Area Rapid Transit
DOT – Department of Transportation
DRCOG – Denver Regional Council of Governments
FDOT – Florida Department of Transportation
FHWA – Federal Highway Administration
FPI – Freeway Performance Initiative
FSP – Freeway Service Patrol
FTA – Federal Transit Administration
FTC – Florida Transportation Commission
GCM – Gary, Chicago, Milwaukee
GP – General Purpose Lanes
GRTA – Georgia Regional Transportation Authority
GNB - Grey Notebook
HOV – High Occupancy Vehicle Lanes
HPMS – Highway Performance Monitoring System
HRPDC – Hampton Roads Planning District Commission
ICMA – International City/county Management Association
ISTEA – Intermodal Surface Transportation Efficiency Act
ITE – Institute of Transportation Engineers
ITS – Intelligent Transportation Systems
KPI – Key Performance Indicator
LOS – Level of Service
LRP – Long Range Plan
M&O – Management and Operations
MAG – Maricopa Association of Governments
MAP – Metropolitan Atlanta Performance Report
MARTA – Metropolitan Atlanta Rapid Transit Authority



List of Acronyms (continued)

MCDOT – Maricopa County Department of Transportation
MPH – Miles Per Hour
MPO – Metropolitan Planning Organization
MTP – Metropolitan Transportation Plan
NCRHP – National Cooperative Highway Research Program
NCTCOG – North Central Texas Council of Governments
NOx – Nitrogen Oxide
NTOC – National Transportation Operations Coalition
PeMs – Freeway Performance Measurement System
PM – Performance Measurement
PSRC – Puget Sound Regional Council
RCTO – Regional Concept of Transportation Operations
RTOC – Regional Traffic Operators Committee
RTP – Regional Transportation Plan
SAFETEA-LU – Safe, Accountable, Flexible, Efficient, Transportation Equity Act – A Legacy for Users
SANDAG – San Diego Association of Governments
TAG – Technical Advisory Group
TCRP – Transit Cooperative Research Program
TDM – Travel Demand Management
TEU – Twenty-Foot Equivalent Unit
TIP – Transportation Improvement Plan/Program
TMA – Transportation Management Area
TMC – Traffic Management Center
TRB – Transportation research Board
TRE – Trinity Railway Express
TSM – Transportation system Management
TTI – Travel Time Index
US DOT – United States Department of Transportation
VDOT – Virginia Department of Transportation
VOC – Volatile Organic Compounds
VMT – Vehicle Miles Traveled
WSDOT – Washington State DOT

1. Introduction

This memorandum represents the results of research conducted as part of the first Phase of the Maricopa Association of Government's (MAG) Performance Measurement Framework and Congestion Management Update (PM/CMP) Project. The primary objectives of this project are as follows:

- Develop a framework and prototype report as a tool for evaluating the effectiveness of regional strategies for moving people, goods, and services in relation to costs and time.
- Update MAG regional congestion management strategies to facilitate system evaluation based on performance measures developed as part of the study.
- Comply with Proposition 400 audit requirements as well as federal requirements detailed as part of the Safe, Accountable, Flexible, Efficient, Transportation Equity Act - A Legacy for Users (SAFETEA-LU).

Phase I of this project includes the development of this best practices memorandum and the initiation of the Technical Advisory Group (TAG).

Phase II will include the development of a framework for performance measurement strategies and the development of implementation plans and reporting methodologies for multi-modal transportation systems at the regional and corridor level.

Phase III will incorporate the results of the performance measurement framework developed in Phase II into the congestion management update. This update is needed to comply with federal requirements in SAFETEA-LU regarding the Congestion Management Process (CMP). The update will include development of evaluation tools that will allow for a multi-modal transportation system analysis, as well as reporting methodologies for disseminating the results.

It is anticipated that the successful implementation of this project will result in MAG achieving the following goals:

- Move toward scientific program development based on objectives-based, performance driven planning
- Enhance the TIP/other program planning decision-making processes to enable MAG to better evaluate and prioritize both existing and proposed projects
- Provide the tools necessary to support Proposition 400 audit requirements
- Enable MAG to better meet regional congestion mitigation objectives

The content of this memorandum begins with an overview of MAG's recent experiences related to performance measurement and congestion management and a discussion of the purpose of this project. This is followed by discussions of performance measurement and congestion management best practices stemming from research into the activities of a select number of key agencies, as well as a summary of other relevant performance measures-related research and data visualization examples from around the country. It concludes with a discussion of key findings relevant to MAG and recommended next steps.

It is an immutable law in business that words are words, explanations are explanations, promises are promises — but only performance is reality.

- Harold S. Geneen, former CEO Raytheon

2. Background

The Maricopa Association of Governments is the designated metropolitan planning organization (MPO) for transportation planning for the metropolitan Phoenix area. MAG's membership consists of the 25 incorporated cities and towns within Maricopa County and the contiguous urbanized area, the Gila River Indian Community, the Salt River Pima-Maricopa Indian Community, Fort McDowell Yavapai Nation, Maricopa County, the Arizona Department of Transportation (ADOT), and the Citizens Transportation Oversight Committee (CTOC). ADOT and CTOC serve as ex-officio members for transportation-related issues.

The Regional Transportation Plan (RTP) - adopted in 2003 - is a performance based comprehensive Regional Plan that covers all major modes of transportation. The Plan was adopted in conjunction with Proposition 400 - a voter approved extension of a half-cent sales tax for transportation improvements in the region. One of the key functions of the Plan is to establish and implement processes to examine and address expected congestion during the next twenty years, as well as to determine overall revenue and cost estimates for the program. Pursuant to Arizona statues, Proposition 400 requires the establishment of performance measures for all major transportation modal categories and requires performance audits of proposed transportation projects and systems starting in 2010.

MAG PM/CMP Project is framed within the context of the guiding principles adopted during 2003 and will seek to revisit and re-align the strategies and goals as they relate to new Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) guidelines for the development of Metropolitan Transportation Plans. These guidelines place a greater emphasis on the strategic integration of MAG's CMP into the multimodal regional transportation system plan. Furthermore, transportation system management and operations components are to be directly linked to improving the performance of the existing and planned surface transportation system. This project will seek to develop solutions for this integration, through the development of a performance measurement program and its comprehensive application to the CMP.

The MAG PM/CMP Project will revisit and realign strategies and goals as they relate to new Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) guidelines for the development of Metropolitan Transportation Plans.

2.1 Existing Performance Measurement Program and Next Steps

As previously indicated, the adoption of the new Regional Transportation Plan in November 2003 and the passage of Proposition 400 in November 2004, established statutory requirements for MAG, as the regional planning agency, to develop multimodal performance measures for the regional transportation system. Beginning in 2010 and every five years thereafter, A.R.S. 28-6313 requires the auditor general to contract with a nationally recognized independent auditor to conduct a performance audit of the regional transportation plan and projects scheduled for funding during the next five years.

The audit will examine the RTP projects that are scheduled for funding within each transportation mode and evaluate them using a specific set of performance measures as part of a Performance Monitoring Program. In addition, it will review past expenditures on the RTP and examine the performance of the transportation system in relieving congestion, and improving mobility and accessibility. The audit is also required to provide recommendations regarding whether further implementation of a project is warranted, warranted with modifications, or not warranted.

A preliminary process has been developed that serves as the basis for existing transportation system performance monitoring and reporting activities. Information from this process has been integrated into MAG 2007 and 2008 Regional Transportation Plan (RTP) updates, as well as the 2007 Annual Report on Proposition 400. Performance measures included as part of the existing MAG program include[1] :

- Travel Time

- Level of Service
- Delay
- Level of Congestion
- Transit Performance Indicators
- "Other" System Parameters

The goal of Phase II of MAG PM/CMP Project will be to review and enhance the tools that currently support MAG's existing performance monitoring program, facilitating the integration of performance measurement data into MAG's congestion management process, thereby improving its usefulness as a decision-making tool in the multimodal regional transportation planning and programming process.

Activities to be carried out as part of this effort will include:

- Establish a set of performance factors and measures that can be consistently applied across transportation modes and communicated to decision makers, stakeholders, and to the public on a periodic basis.
- Development of strategies and a methodology to analyze and evaluate various performance measures as they relate to the RTP, and as objectives established by the legislative mandate of Proposition 400.
- Development of reporting/visualization techniques that will communicate results to the public. The reporting function of this project will provide decision makers and the public in general with a better understanding of the progress that is being made in the implementation of the RTP and Proposition 400, and how these investments are improving the overall performance of the system. This will include close coordination of program data and findings with transit agencies, as well as detailed analysis and synthesis of the monitoring program results in preparation for the five year audit cycle.

2.2 Existing Congestion Management Strategies and Next Steps

MAG's Congestion Management System (CMS) is the current congestion management tool in place for the region. As part of the requirements promulgated under the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, the region developed a CMS that was approved by MAG Regional Council in September 1994. The CMS was primarily developed through the CMS Working Group and built on several years of analysis that culminated in a Congestion Management Systems Alternatives report published in April 1994.

MAG's CMS is a multimodal planning process that considers a variety of alternative transportation options in an effort to reduce congestion throughout the greater metropolitan region. This is an ongoing process that provides for the identification of congested areas; implements the development of system management alternatives and defines the continuing process for traffic management in the MAG Region; monitors sub-regional and regional travel patterns; and applies multi-modal transportation improvements and travel reduction efforts to the congested portions of the transportation system.

MAG's current CMS is composed of two primary elements:

- The establishment of a series of strategies to address congestion
- The development and implementation of a rating system to evaluate proposed congestion management strategies and evaluate the effectiveness of implemented strategies. As part of the ratings system process each project is given a 1 to 100 score based on criteria including: relative congestion levels, mobility zone factors, cost effectiveness, and multimodal enhancements.

"Performance measurement is a process of assessing progress toward achieving predetermined goals, including information on the efficiency with which resources are transformed into goods and services (outputs), the quality of those outputs (how well they are delivered to the client and the extent to which clients are satisfied) and outcomes (the results of a program activity compared to its intended purpose), and the effectiveness of government operations in terms of their specific contributions to program objectives."

- From NCHRP Synthesis 311: Performance Measures of Operational Significance for Highway Segments and Systems (2003), pg. 5.

[1]From Chapter 20," Performance Monitoring and Assessment," of the MAG 2007 Regional Transportation Plan Update.

In February of 2007, the US DOT, Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) issued a final rule on the development of Metropolitan Transportation Plans and Congestion Management Systems as part of SAFETEA-LU. The revised regulations changed the congestion management strategy requirement from a Congestion Management System (CMS) to a Congestion Management Process (CMP), and emphasized the strategic integration of the CMP into the multimodal regional transportation system plan.

In light of these new regulations, the goal of Phase III of MAG's PM/CMP Project will be to restructure the CMS into a CMP, and to better integrate data from MAG's Performance Measurement Program into the CMP, increasing its effectiveness as a decision-making tool to be applied as part of the regional multimodal transportation planning and programming process.

The performance measures system and CMP are viewed as additional tools to help that process. However, the PSRC has significant financial and political limitations.

3. Performance Measures Best Practices

Increased customer expectation and public sector accountability have helped to focus attention on the importance of performance measurement. Transportation agencies have instituted performance measures and the associated monitoring, evaluation, and reporting processes for a variety of reasons – to provide better information about the transportation system to the public and decision makers; to improve management access to relevant performance data; and to generally improve agency efficiency and effectiveness, particularly where demands on the transportation agency have increased while the available resources have become more limited.

As stated in *Reinventing Government*[2] :

- If you don't measure results, you can't tell success from failure.
- If you can't see success, you can't reward it.
- If you can't see failure, you can't correct it.

Performance measures are often described as input, output, or outcome measures. Input measures look at the resources dedicated to a program (e.g., infrastructure funding); output measures look at the products or services delivered (e.g., miles of roadway covered by ITS infrastructure and number of service patrol responses); and outcome measures look at the impact of the products on the goals of the agency (e.g., roadway travel times and measures of roadway congestion). Outcome measures are preferred because they directly link the agency's goals to the results of the activities undertaken to achieve them. At the same time, outcome measures are more difficult to define and measure. In deciding which measures to use, the agency needs to consider whether enough data can be collected to allow a measure to be calculated with sufficient accuracy for it to be a useful tool in guiding decision-making.

WSDOT effectively managed their urban freeway system by answering policy-oriented questions.

3.1 Introduction to Agencies Reviewed (Performance Measures)

This section provides an overview of the agencies' for which research was conducted as part of this best practices study:

- Washington State DOT - The Washington Department of Transportation (WSDOT) is among the nation's leaders in the development and implementation of transportation performance measures, and has an entire section of its web page[3] devoted to performance measures and other accountability topics. Their signature product is *Measures, Markers, and Mileposts* (also known as the Gray Notebook).

  The first stage in the development of WSDOT's congestion reporting system was possible because the NW Region (which includes the majority of the Seattle metro area) had a freeway management system in place since the late 1970s. The staff that managed that system were concerned that:
  - They would be asked to justify their expenditures for that system and its continued operations costs, and
  - They wanted those same results to help justify requests for funding to expand and improve the system.

  These interests led to the creation of a performance reporting system in the late 1990s that resulted in many of the measures now used nationally. It also resulted in development of much of the software currently used to perform ongoing data analysis.

[2]David Osborne and Ted Gaebler, Reinventing Government, Addison-Wesley Publishing Co., 1992.

[3]http://www.wsdot.wa.gov/accountability/default.htm

The second stage occurred when the original system was modified to fit the current needs of WSDOT, and became part of the Grey Notebook (GNB.) At the time (early in this decade) the WSDOT was viewed as not being accountable to the public or to the legislature. When Doug MacDonald was appointed as Secretary of Transportation, he made a significant effort to create a very public performance reporting system. One of the first areas included was congestion on the urban freeway system. As part of this effort, minor changes in reporting statistics were made to better reflect the specific needs of the different audiences (i.e., more oriented towards non-technical people).

- Puget Sound Regional Council (PSRC) - The Puget Sound Regional Council is a multi-purpose regional planning agency that includes transportation as one element in an integrated comprehensive planning portfolio. PSRC also functions as the metropolitan planning organization for the Seattle, Washington metropolitan area. The current performance measures and CMP are viewed as a progressive update to PSRC's original Congestion Monitoring System (first developed in 1995).

  The Seattle Metropolitan region has been working towards developing multi-modal solutions to regional transportation issues (with mixed success) for many years. The performance measures system and CMP are viewed as additional tools to help that process. However, the PSRC faces significant financial and political limitations. These impact the speed with which the CMP can be implemented. Thus, while the concept behind the use of performance measures and the CMP is well accepted, implementation of the "desired" strategies is constrained by available resources.

- Florida Department of Transportation - For the past several years, the Florida Department of Transportation (FDOT), the Florida Transportation Commission (FTC), and ITS Florida have been working toward the development of performance measures for use in assessing the value of Florida's ITS Program (to increase agency accountability). Until fairly recently, most of the performance measures identified as part of this effort were output-oriented, but it was decided in late 2004 to include more outcome-based measures. In the fall of 2006, a list of reliability measures was defined as part of this ongoing process. The selected measures – buffer time index, travel time index, and delay all use the same base data (either travel time or speed converted into travel time).

- Georgia Regional Transportation Authority - Congestion is a major political issue in the Atlanta region. This led to the creation of the Georgia Regional Transportation Authority (GRTA), which has a mandate to track transportation performance on a regional basis. GRTA's enabling legislation requires them to measure and report on regional transportation - highways and transit. This has resulted in the development and update of the Metropolitan Atlanta Performance (MAP) Report which sets baselines and targets for use in tracking the overall performance of the transportation system in metropolitan Atlanta. Measures and targets are set in five general categories – Mobility, Transit Accessibility, Air Quality, Safety, and overall Transportation System Performance.

- California Department of Transportation - The California Department of Transportation (Caltrans) has been working to implement a statewide transportation system performance measures program over the past several years. Since 2005, Caltrans has been reporting a select set of performance measures to the Business, Transportation and Housing Agency (BTH) on a quarterly basis. The quarterly reports submitted to the BTH include the "vital few" performance measures that Caltrans has identified as reflecting the goals and objectives in Caltrans' Strategic Plan.

  Although the performance measures program is not officially a part of the program planning process, the recent approval of Proposition 1B (The Highway Safety, Traffic Reduction, Air Quality, and Port Security Bond Act of 2006) has established requirements that Caltrans

The PSRC developed draft performance measures in support of the CMP. Because the data required to support those measures did not exist and could not be obtained within the available budget, PSRC is working towards developing those measures on a fiscally constrained basis.

"provide demonstrable congestion relief, enhanced mobility, improved safety, and stronger connectivity to benefit traveling Californians."

3.2 Performance Measures Topics

This section provides an overview of the technical characteristics and challenges associated with the performance measurement programs implemented by each of the agencies described in section 3.1, "Introduction to Agencies Reviewed (Performance Measures)."

3.2.1 Objectives/Goals

- Washington State DOT - Initial efforts were focused on evaluation of the congestion management techniques being applied to more effectively manage the urban freeway system. This quickly transformed into answering specific policy oriented questions. These included such issues as "What effects do the imposition of ramp metering have on freeway performance?," "What changes in roadway performance have occurred as a result of the addition of new capacity?," "Are the HOV lanes being used effectively?," "What impact is the incident response program having on travel times experienced by the public?," "What changes are occurring in congestion and vehicle throughput as the region grows?," and "What impact is gas price having on travel in the region?"

- Puget Sound Regional Council - The primary objective at PSRC is to support the existing PSRC planning process and especially the update of the Destination 2030 plan to the new Vision 2040 plan. An important, but secondary objective was to support the project identification, selection and prioritization function performed by PSRC.

  The larger policy questions at PSRC focus on whether the region's transportation and land use decisions are effectively supporting the State's growth management legislation, and whether the transportation projects being selected are effectively serving the region.

  Accountability is important to PSRC, given the State's political climate, but PSRC is under less direct "accountability scrutiny" than WSDOT, in large part because PSRC neither builds nor operates transportation facilities or services.

- Florida Department of Transportation – The FDOT program was initially developed to help FTC better understand and identify the results of their investments - primarily linked to accountability. However, interest in the program has grown as the realization has set in that these tools can provide FDOT staff with measures of effectiveness to help them better manage their systems and identify areas requiring improvement.

- Georgia Regional Transportation Authority – GRTA's enabling legislation mandates that they create an annual report of transportation performance for the greater metropolitan area. As stated in its 2008 MAP report, its "values" include:
  - Connect transportation with land use.
  - Remove barriers, implement best practices, and maximize the investment in transportation.
  - Operate as an open, accountable, efficient and effective public authority.
  - Operate within a decision-making framework that values public participation.
  - Base decisions upon fact-based analysis that provides the greatest public benefits for the resources invested.
  - Work for the best interest of the region in cooperation with federal, state, regional and local partners.
  - Advocate and implement a transportation system that is multi-modal, seamless and accessible to all.

The MAP report is primarily focused on highways and transit, in five general categories: Mobility, Transit Accessibility, Air Quality, Safety, and overall Transportation System Performance.

- California Department of Transportation - As part of its performance measures-related efforts, Caltrans has established the "Office of Performance Measures and Data Analysis." This organization collects and analyzes statistics related to the fiscal status, physical and geometric nature, operational performance, and condition of the State's roadway systems. Its primary function is to enable decision-makers and system users to have access to quality transportation information which facilitates performance-based decisions about transportation services and infrastructure. To this end, the office:
    - Works with federal, local, and State jurisdictions and agencies to report on transportation-related expenditures and income in order to help decision-makers better understand California's fiscal situation.
    - Supports performance-based decision-making by exercising leadership in the implementation of transportation system performance measures.

3.2.2 Performance Measures Tools/Methodologies

- Washington State DOT – Performance measures focus primarily on the evaluation of general purpose (GP) traffic, and HOV lane utilization (a combination of carpools and public transit.) Some freight analysis work has also been done - research is currently underway to determine how best to add more and better freight performance data to the reporting process. The Washington State Ferries also contribute performance measures to the GNB.

Key indicators used include:

- Peak travel times and volumes (average and 95th percentile [both in peak period]) by time of day
- Ratio of peak travel time to maximum throughput travel time
- Duration of peak period congestion
- Percentage change in peak hour travel volume
- Lost throughput productivity
- Percent of days when speeds were less than 35 mph (by time of day)
- HOV lane performance (90th percentile speeds by time of day)
- Accident rates
- Person throughput in peak periods (HOV, GP, and total).

- Puget Sound Regional Council – PSRC has access to wide ranging performance measures data from the WSDOT Gray Notebook. They would like to expand their analysis to include person throughput, but are lacking data for arterials and facing different data reporting procedures and limited data availability among transit agencies. The measures proposed for use as part of the CMP are described in the table on the following page.

The GP lanes analysis area extends to wherever data collection exists in support of the freeway management system. For HOV lanes, travel times are computed for corridors where data can be obtained. Person throughput is collected where data can be afforded.

Measure	Highway	HOV	Transit	Ferries	Freight	Non-Motorized
Travel Time and Delay	Point-to-Point Peak Travel Time	Point-to-Point Peak Travel Time	Point-to-Point Peak Travel Time by Type	Point-to-Point Peak Travel Time	Point-to-Point Mid-day (?) Travel Time	
	Point-to-Point Peak Congestion Delay	Point-to-Point Peak Congestion Delay	Point-to-Point Peak Congestion Delay	Boat Wait Time	Point-to-Point Congestion Delay	
	Congestion Delay and Duration	Congestion Delay and Duration	Congestion Duration	Point-to-Point Congestion Delay		
Travel Time Reliability	Standard Deviation of Peak Travel Time	Standard Deviation of Peak Travel Time	On-time Performance	Schedule Reliability (% on-time departures and % on-time arrivals)	Standard Deviation of Peak Travel Time	
	Travel Time Reliability Index				Travel Time Reliability Index	
System Access		Percent of Park and Ride Capacity Used	Percent of Park and Ride Capacity Used	Percent of Park and Ride Capacity Used		Sidewalk completeness
			Percent of Population within x Distance of Transit			Bicycle Route Completeness
			Percent of Ridership with 2 or More Transfers	Percent of Peak Period Transit Access Capacity Used		
				Percent of Trips Require a Ferry-to-Ferry Transfer		
Throughput	Peak Hour Person Movement	Peak Hour Person Movement	Peak Hour Person Movement	Peak Hour Person Movement		Regional Trail Segments at or Over Capacity
Crowding	Lane Density or Occupancy	Lane Density or Occupancy	Peak Hour Load Factor	Percent of Terminal Capacity Used	Lane Occupancy or Occupancy	
			Lane Density (HOV or Bus Lanes)		Percent of Terminal Capacity Used	
			Percent of Terminal Capacity Used			
Safety	Accident Rate	Accident Rate	Transit Accidents and Crimes	Accident Rate	Accident Rate	Pedestrian or Bicycle Accidents or Crimes

Gold = Data is available
Silver = Some data is available but additional refinement is needed to meet CMP uses.
Bronze = Limited or no data is available.

- Florida Department of Transportation - FDOT's ITS Reporting Objectives currently encompass the following performance measures:

  Output Measures
  - Total Annual Number of 511 Calls
  - Total Annual Number of Road Ranger (similar to Freeway Service Patrol) assists
  - Number of Miles Managed by ITS (Intrastate Limited Access vs. Non-Intrastate)

  Outcome Measures
  - Travel Time Reliability and Delay
  - Incident Duration
  - Customer Satisfaction – based on a questionnaire to determine public attitudes toward the deployed ITS services provided by FDOT.

  Originally, the FTC approached ITS Florida to pursue this effort. Workshops were held by ITS Florida and later the FDOT to select the six measures currently in use.

  Questions regarding system reliability currently under investigation include:
  - When is reliability reporting needed?
  - How should reliability be presented?
  - How should reliability measurement activities within FDOT be coordinated?
  - How should reliability measures be used?

  In addition, the FDOT planning office is investigating models for estimating statewide reliability. A project to develop a model for estimating reliability is currently being conducted by the University of Florida.

Auto occupancy counting costs approximately $200,000 per year. Other data is collected as part of existing traffic management system operations—specific budgets for the operation of these systems is not available.

- Georgia Regional Transportation Authority – GRTA initially convened a steering committee to discuss and review the measures to be used as part of the original MAP report. This steering committee continues to meet once per year to review the draft MAP report and re-evaluate its content.

  The MAP report is primarily focused on highways and transit, in five general categories – Mobility, Transit Accessibility, Air Quality, Safety, and overall Transportation System Performance.

  Mobility Measures used in the MAP include (the bulk of the MAP report focuses on this topic):
  - Freeway Travel Time Index
  - Arterial Congestion (being dropped from 2008 report due to a lack of data)
  - Daily vehicle miles traveled (VMT) per person
  - Pavement condition rating
  - Transit Passenger miles traveled
  - Annual transit passenger boardings
  - Planning Time Index (added in 2007)
  - Buffer Time Index (added in 2007)

  Transit Accessibility Measures include:
  - Population and employment within walk distance to transit,
  - Transit revenue service hours,
  - Passenger trips per transit service hour, and
  - Number of vanpools.

  Air quality measures focus on daily vehicle emissions.

  Safety measures focus on traffic crash fatalities, pedestrian/bicyclist fatalities, and roadway clearance time.

  Overall Transportation System Performance is evaluated via a series of composite indices based on the performance measures described above:
  - Roadway Services (mobility)
  - Transit Services (transit)
  - Roadway Emissions (air quality)
  - Roadway Safety (safety)
  - Overall Transportation Performance, referred to as the Atlanta Transportation Performance Index (ATPI), is based on a combination of the other four indices. It was developed as part of an effort to provide a single measure for use in tracking the state of the region's transportation system[4].

  Due to disagreement regarding the methodology used to create the ATPI it has been left out of the 2008 MAP.

- California Department of Transportation - The primary focus of the performance measures program is on freeways, but some elements of statewide transit performance are tracked as well. Caltrans' quarterly performance reports typically consist of two major sections. The first section presents key dashboard indicators for the performance measures identified in the Strategic Plan. The second section provides information on performance trends over the past several reporting cycles. The purpose of this information is to provide Caltrans management with the tools necessary to monitor progress in specific areas and make appropriate

WSDOT's initial audience was the technical staff of regional transportation agencies. Once the statistics became available, their usefulness in supporting decision-making at the political level became the highest level benefit. Currently, audiences range from engineering and planning staff, to upper level agency (WSDOT and other agency) management, to elected officials and the general public.

[4]The ATPI is composed of the following measures: Travel time index, Planning time index, Daily vehicle miles traveled, Transit revenue service hours - MARTA, Transit revenue service hours - other, Transit passenger miles traveled, Transit passenger boardings, Vehicle NOx emissions, Vehicle VOC emissions, Vehicle PM2.5 emissions, Highway fatality rate per 100 million VMT, Pedestrian and bicycle fatalities per 100,000 population.

adjustments aimed at achieving the agency's strategic goals and objectives. Performance measures are focused on the following general areas:

- Safety – traveler fatality rates, worker fatalities, and worker incident rate
- Mobility – vehicle hours of delay, system reliability, intercity rail ridership, and single occupancy vehicle use
- Delivery – project delivery costs, project delivery milestones, and project construction costs
- Stewardship – pavement conditions, financial resources, infrastructure deficiencies, management of assets
- Service – employee attrition, adequacy of training, employee satisfaction, etc.

The most current report of Caltrans' Performance Measures is posted on the Internet at Caltrans' home page[5] (under "Highlights" - the link to the document is titled "Latest Report of Caltrans' Performance Measures").

3.2.3 Selection of Geographic Areas for Analysis

- Washington State DOT - For GP lanes, the analysis area extends to wherever data collection exists in support of the freeway management system. For HOV lanes, travel times are computed for corridors for which data can be obtained, while person throughput is collected where data can be physically collected and at the number of locations allowable given the financial constraints of the person occupancy data collection budget. This includes at least one location on all freeway corridors in the Central Puget Sound region.

- Puget Sound Regional Council - The basis for the geographic coverage area is the metropolitan transportation network, which was developed as part of the PSRC's original congestion management system. That in turn was an outgrowth of the designation of the key links in the national highway system and the metropolitan transportation network.

- Florida Department of Transportation – The system is focused primarily on assessing conditions on highways, but there is some reporting on arterials (currently this is exclusively output-based).

- Georgia Regional Transportation Authority – The GRTA reports on those highways and transit facilities for which data is available.

- California Department of Transportation - The system is focused primarily on assessing conditions on freeways, but there is some reporting on transit.

3.2.4 Data Collection and Analysis

- Washington State DOT - Travel time and vehicle volume data come primarily from inductance loop detectors; although a minor amount of data comes from other detectors as well (e.g., SpeedInfo doppler radar detectors provide some speed data). These detectors are operated by WSDOT's NW Region as part of their ramp metering system. Person throughput is based on vehicle volume data and manually collected car occupancy data, plus transit ridership data collected from Automated Passenger Counting systems operated by the transit agencies. Data is not currently available from arterials.

  Data accuracy varies. Locations selected for reporting generally have vehicle volume +/- 10%. Average travel times are within the margin of error for the floating car ground truth tests performed to test their accuracy. (Roughly +/- 2 minutes.)

Performance measures are used in just about every management and operational decision made regarding urban freeway planning, operation, and construction.

[5] http://www.dot.ca.gov/

Little modeled data is used as part of the performance monitoring program. The statewide "lost productivity" computation converts available AADT measures into measures of lost productivity by assuming time of day volume distributions - an algorithmic modeling, rather than a model simulation.

Auto occupancy counting costs approximately $200,000 per year. All other data is collected as part of existing traffic management system operations - specific budgets for the operation of these systems are not available. Statewide AADT values are paid for as part of ongoing statewide volume counting performed to support federal HPMS reporting requirements.

- Puget Sound Regional Council - Travel times and vehicle volume data on freeways are supplied by WSDOT, and are collected primarily from their inductance loop system. Auto occupancy data come from the University of Washington based on funding from WSDOT. Transit system performance data are supplied by the various transit agencies operating in the region. Traffic volume data on arterials comes from a combination of existing city/county data collection efforts, supplemented by counts paid for by PSRC. PSRC is still looking for better (and more affordable and cost effective) sources of data, particularly for arterial performance, freight movements and congestion, and non-motorized modes of travel. Four-step model output is used to develop most predicted measures.

  Data accuracy varies. In general, the data reported are "acceptably" accurate. The bigger issue is related to those measures for which data is not readily available. In some cases (pedestrian, bike, and arterial data) there is no readily available mechanism that allows such data to be collected at any reasonable expense.

  The majority of data are provided to PSRC at no charge by the agencies that actually operate the transportation facilities and services. PSRC does not have the budget to collect the data that are not already available through those agencies.

  Types of data that PSRC would like to have access to, but currently do not include:
  - Arterial data
  - Freight (primarily trucking) movement and volume
  - Pedestrian movements (volumes and travel time)
  - Bike network completion, use and travel times
  - Park and Ride utilization by time of day (peak utilization information is already available)

- Florida Department of Transportation – Raw data is provided by the various FDOT districts for analysis by the FDOT Central Office. Only measured data, no modeled data, is anticipated to be used as part of data analysis efforts. At the present time, little reliability-related data is available for use, but some data is becoming available in District 4 (Ft. Lauderdale region), District 5 (Orlando region), and District 7 (Tampa Bay Region). No assessment of data accuracy is currently available.

  Other data issues besides availability include data quality and the value of modeled data vs. measured (collected) data.

- Georgia Regional Transportation Authority – All performance measures are based on observed data, except for "population and employment within walking distance to transit." Data is available for most highways in the Atlanta region (estimated to be accurate to within 10% of actual conditions). GRTA routinely reviews the quality of the data provided to them, and works with other agencies to improve it. There are currently no data collection costs borne by GRTA as all data is collected by other agencies.

  Additional reliability data has recently become available based on real-time data from the Georgia Navigator Traffic Management System (volumes, travel times, and vehicle miles

Much of the data desired does not exist, and can not be collected with only the available budget. Creativity is needed at the agency level to cost-effectively collect the necessary data, and upper management support is needed in order to allow that creativity to take place.

traveled).

The primary data collection issue faced by GRTA is a lack of data for all geographic areas and insufficient data on area arterials (resulting in "arterial congestion" being dropped from the 2008 MAP Report).

- California Department of Transportation - Data concerning the urban freeway system is primarily from PeMS (loop detector data backed up by floating car runs). PeMS is a joint effort of the University of California - Berkeley, Caltrans, California Partners for Advanced Transit and Highways, and Berkeley Transportation Systems. Its purpose is to collect historical and real-time freeway data from freeways in the State of California in order to compute freeway performance measures. Activities are currently underway aimed at incorporating both arterial and transit data into PeMS for use in both statewide and regional reporting.

  Transit data is from the national transit database and a variety of other resources are used to support other reporting requirements. Caltrans has conducted no independent verification of the accuracy of these data sources.

3.2.5 Data Processing

- Washington State DOT – Primary data analysis tools are based on software written as part of research projects funded in the mid- to late 1990s. These feed summary outputs into Excel spreadsheet templates, which produce summary statistics.

- Puget Sound Regional Council - Most data processing is done by the collecting agencies, not by PSRC. PSRC has some self developed tools for summarizing larger data submissions into the summary statistics and presentation material needed for the CMP activities.

- Florida Department of Transportation – Data collection and travel time reliability reporting (along with other speed-related measures) will be managed by FDOT SunGuide traffic management software v3.0. Other data will be collected by FDOT's prototype central data warehouse (CDW) being developed by the University of Florida. The CDW will be fed reliability and incident data from SunGuide.

- Georgia Regional Transportation Authority – Data analysis is primarily carried out via Excel spreadsheet.

- California Department of Transportation - Most data analysis and chart/graph development is conducted using Excel.

3.2.6 Delivery/Reporting

- Washington State DOT – Distribution of performance measurement results is through formal reports, web sites, and via ftp sites when requested for interagency data transfer. The formal reports are available in printed form in limited numbers and can be downloaded from the web. The base statistics and spreadsheets used to create those summary statistics are also posted on web sites for anyone to use[6].

  Other, larger data summaries are posted to ftp sites for use by partner agencies. Visualization tools are provided via Excel and PowerPoint (techniques invented in-house, but which are now widely publicized.) They were selected because they were readily available and very flexible.

Transportation measures are being distributed to transportation professionals across the country to encourage their use. However, as this effort is still in its infancy, these measures need to be tested to determine their overall accuracy and usefulness.

[6] http://depts.washington.edu/hov/

The initial audience for this data and results was the technical staff of regional transportation agencies. However, once the statistics became available, their usefulness in supporting decision-making at the political level became the highest level benefit. They also serve a significant media relations function. Currently, audiences range from engineering and planning staff, to upper level agency (WSDOT and other agency) management, to elected officials and the general public.

- Puget Sound Regional Council - Distribution is through formal reports, web sites, and presentation material as part of the 2040 plan update. No formal material is currently presented other than as part of the 2040 plan update and related meetings.

  No particular visualization tools have been developed specifically for the CMP, however the PSRC does use its existing GIS tools for map generation.

  The audiences are primarily elected officials, planning professionals, and representatives of the general public that are involved in the regional plan update and the project identification and selection process.

- Florida Department of Transportation - Primary audiences are the FTC, FDOT Upper Management, FDOT District staff, and the general public. It is anticipated that results of the program will be made available via presentations at annual working group meetings, relevant FDOT websites, and via the FDOT newsletter (The SunGuide Disseminator). However, at the present time visualization tools remain under development and no reliability graphics have been developed.

- Georgia Regional Transportation Authority – Primary audiences for the MAP Report include: the Georgia DOT, MATRA (region's MPO), Georgia Tech, local county traffic agency staff, the general public, and the media.

- California Department of Transportation - Caltrans is unsure as to who their primary audience is/should be. This has been a stumbling block to further implementation of their program.

3.2.7 Overall Success of the Program

- Washington State DOT – Performance measures are used in just about every management and operational decision made regarding urban freeway planning, operation, and construction. These same statistics are used to inform the regional planning process, and are currently being used to calibrate the regional planning model so that it can produce measures of system reliability, as well as average performance. The very positive reception of these performance measures has led to considerable pressure to develop cost effective mechanisms that produce similar statistics for arterial performance.

- Puget Sound Regional Council – At the present time, performance measures are used only to help inform the regional plan update. Some measures are used to help inform the current project selection process, but since the CMP has not been formally finalized or adopted, its use in the project selection process is not formal.

  It is intended that these tools will provide PSRC with the ability to more effectively compare modal performance and to effectively plan for and evaluate the effectiveness/performance of multi-modal transportation improvements.

- Florida Department of Transportation – The program is currently in the final stages of development and doesn't yet have results to report.

Due to the wide variety of performance measures referenced, the FDOT study recommends potentially developing a number of different report types for use to convey these different measures to diverse audiences.

- Georgia Regional Transportation Authority – The GRTA performance report is used informally as part of decision-making, but it is not yet part of the formal planning process. For example, the GRTA Board now refers to the report when discussing TIP proposals and amendments, asking questions concerning why areas with the worst congestion aren't being addressed as a priority. However, efforts are currently underway to include the results of this report as part of future RTP development and TIP decision-making.

- California Department of Transportation - Program-related results are currently used as an informal part of the planning decision-making process, but will be used more extensively under the performance guidelines associated with the new transportation bond program.

3.2.8 Program Costs

- Washington State DOT - The initial data archive was created in 1995 by a student intern at a cost of less than $100,000. However, additional improvements have been made to the system over time, often as part of research projects or as a result of specific analysis projects funded by the WSDOT.

  The initial data analysis system that uses that archive was designed and developed as part of a research project for less than $300,000. Since that initial effort (in the late 1990's) NW Region has contributed on the order of $100,000 per year towards analyses that use that data. The WSDOT research office along with the WSDOT ITS group have funded an average of another $150,000 per year to pay for a combination of analysis and system improvements.

  In addition, WSDOT has a significant budget for the production of the GNB. It is not possible to extract the cost of the congestion monitoring portions of that document from the full costs for that report.

- Puget Sound Regional Council - The CMP is not currently complete so the development and ongoing operating cost are not currently known, and in any case, much of the data collection cost will be borne by the operating agencies, not PSRC.

- Florida Department of Transportation – FDOT estimates that they have spent approximately $300,000 - $400,000 on the program so far – primarily for consulting services to select the measures and conduct some initial data analysis.

- Georgia Regional Transportation Authority – As most of the initial program development effort was conducted internally by GRTA staff, it is difficult to determine what development costs truly were. At present, GRTA uses 50% of one senior planner's time (on an annual basis), plus approximately $15,000 - $20,000 to analyze data from the Georgia Navigator system.

- California Department of Transportation - The Caltrans Performance Measures System is highly diffuse and makes extensive use of PeMS and other resources that are funded separately. As a result, costs for system development and ongoing operation are not known.

3.2.9 Lessons Learned

- Washington State DOT - Upper management of all agencies involved need to buy-in to the need for these activities and allocate the resources necessary to bring the systems on-line. The results generated by the system then need to be widely disseminated, and marketed both inside and outside the agency.

  The results need to be used by the groups actually operating the data collection system, particularly for their internal analysis of facility/staff performance. When routinely reported statistics are used for internal decision making purposes increased attention is paid to the

Upper management of all agencies involved the need to buy-in to the need for these activities and allocate the resources necessary to bring the systems on-line.

quality of the data as it is initially collected, which in turn improves the overall quality and utility of the data.

Internal divisions between the central data collection staff and the operational groups that exist in the regional (i.e., district) offices have been difficult to overcome. It has been difficult to obtain funding to upgrade software that was written ten years ago. This increases the cost of the reporting effort, and decreases the speed with which results are available.

- Puget Sound Regional Council - Much of the data desired does not exist, and can not be collected within the available budget. Creativity is needed at the participating agency level to cost-effectively collect the necessary data. Upper management support is needed in order to allow that creativity to take place (and to supply at least limited resources for making the data collection possible.) Considerable cooperation is needed amongst the participating operating agencies.

  Although there is regional support for the system, that support does not always translate into the provision of significant new sources of funding to facilitate additional data collection.

- Florida Department of Transportation – Lessons learned include:
  - Prepare a data quality plan to improve understanding of data-related issues. Identify data-related problems and implement quality assurance protocols.
  - Involve other stakeholders to the greatest extent possible, especially those stakeholders who will be providing data to be used as part of the program.
  - Need to review data sets to ensure accuracy of data and that data from different agencies is comparable/compatible.
  - Need to ensure that you have buy-in from upper management and sufficient funding.
  - Work toward direct measurement of reliability as better data becomes available.

- Georgia Regional Transportation Authority – Lessons learned include:
  - Having a technical advisory group from the very start will be a big help. MAG may want to consider including traffic reporters on this group.
  - Start the process small and grow it over time - begin with travel time and reliability measures and expand to safety and other measures later.
  - Try to piggyback on other agencies' data sources to the greatest extent possible.
  - Great to have an agency champion for this effort and an internal staff person who takes ownership.

- California Department of Transportation - Lessons learned include:
  - It is easier, and more effective, to implement performance measures on a regional rather than a state-wide level.
  - A performance measurement program should evolve continuously – it is best to start small and expand the program over time.
  - Performance measures must be developed using broad participation and consensus-building techniques, utilizing a simple framework, and focusing on desired customer outcomes.

A performance measurement program should evolve continuously - it is best to start small and expand the program over time.

3.3 Other Performance Measures Programs and Research of Note

This section summarizes the efforts of other performance measurement programs and research that may be applicable to MAG's efforts.

3.3.1 FHWA's Office of Transportation Management – National Transportation Operations Coalition (NTOC) Performance Measures Task Force

The National Transportation Operations Coalition (NTOC) is composed of the Institute for Transportation Engineers (ITE), American Association of State Highway and Transportation Officials (AASHTO), Transportation Research Board (TRB), ITS America, International City/County Management Association (ICMA), Association of Metropolitan Planning Organizations (AMPO), other associations and the Federal Highway Administration (FHWA). The Task Force's stated goal is to identify and begin to define a candidate list of transportation performance measures commonly agreed upon by federal, state, and local transportation officials. Based on this work, the following list of ten (10) measures was created to serve as the basis for a national set of transportation performance measures[7].

- Customer Satisfaction
- Extent of Congestion (Spatial and Temporal)
- Incident Duration
- Recurring and Non-Recurring Delay
- Speed
- Throughput – Person
- Throughput- Vehicle
- Travel Time – Link
- Travel Time – Trip
- Travel Time Reliability (Buffer Index)

Detailed definitions for these performance measures can be found in Appendix A.

These measures are in the process of being distributed to transportation professionals across the country to encourage their use. However, as this effort is still in its infancy, these measures need to be tested in order to determine their overall accuracy and usefulness. As such, it is the task force's goal to work with transportation managers to determine which of these measures are most appropriate for providing comparative measurements, as well as to assist them in developing the data collection and analyses programs necessary to support their implementation. Based on the research conducted by the NTOC, the University of Maryland Center for Advanced Transportation Technology (CATT) has been working for the (National Cooperative Highway Research Program (NCHRP) as part of NCHRP project 20-7 to produce a guide for benchmarking highway operations using a set of common mobility performance measures. A report was published in early 2008[8] which included revised performance measure definitions and initial implementation guidelines.

3.3.2 FDOT District Five ITS Performance Measures Research

As part of its efforts to identify performance measures that achieve the goals laid out by FDOT as part of its statewide reporting objectives, FDOT District Five recently commissioned a study aimed at identifying a set of recommended performance measures to be used in assessing the success of the District's ITS program. The resulting memorandum outlines a set of sixty-four (64) outcome and output performance measures that could potentially be implemented in Central Florida.

One overarching recommendation for all report types is that visual representation of the data (e.g., graphs, charts, and as appropriate, maps) should be included in all reports.

[7]National Transportation Operations Coalition (NTOC), Performance Measures Initiative – Final Report, July 2005.

[8]http://www.catt.umd.edu/documents/final_report_compiled_v26.pdf

The **outcome** measures described in this study fall into the following topic areas:

- Congestion and Reliability – Measures that capture average congestion conditions and those that identify travel reliability, or the variability in performance of the selected route.
- Incident Duration – Measures that capture incident conditions and delay from travel lane blockages.
- Evacuation/Event Management – Measures that capture evacuation preparedness and performance.
- Customer Satisfaction – Measures that capture the perception of users of the transportation system and ITS infrastructure.
- User Satisfaction – Measures that capture the perception of users of the Traffic Management Center (TMC) and data archive

The **output** measures described in this study fall into the following topic areas:

- System Coverage – Measures that capture the coverage of traffic detectors, video cameras, traveler information and communications equipment.
- Traffic Flow – Measures that capture the performance of traffic flow on the roadway network.
- Incident Management – Measures that capture incident management performance.
- System Performance – Measures that capture the equipment availability and performance.
- Traveler Information – Measures that capture the use and performance of traveler information infrastructure.

Due to the wide variety of performance measures referenced, the FDOT study recommends potentially developing a number of different report types for use in conveying these different measures to diverse audiences. Recommended reports include:

a. Event Report – General summary of system performance during hurricane/other evacuations
b. Weekly Report – TMC Managers (all 64 measures)
c. Monthly Report –TMC Staff (measures focusing on Traveler Information, Incidents, Congestion and Reliability, and ITS device status).
d. Quarterly Report - FDOT District 5 management, other FDOT districts, and the FDOT Central Office (measures focusing on Congestion and Reliability, Total incident duration, Customer satisfaction survey results, Number of 511 calls, Number of incidents, Number of severe incidents (Level 3), and Traffic Flow
e. Annual Report - General public (wide variety of measures, all heavily graphically focused)
f. Required Report for Statewide ITS Measures - Measures to be included in the Performance and *Production Review of the Florida Department of Transportation* published annually (final measures have not yet been selected).

One overarching recommendation for all report types is that visual representation of the data (e.g., graphs, charts, and as appropriate, maps) should be included in all reports. Moreover, the report recommends including data from the previous reporting period and, if possible, the same period from the previous year so that readers have a point of reference with which they can better understand current conditions.

3.3.3 San Francisco Bay Area – Freeway Performance Initiative

The transportation agencies in the San Francisco Bay Area are committed to developing a corridor-based performance-driven transportation planning process (which selects the best projects and operational strategies for implementation based on performance and cost-effectiveness) based on the use of sound system management strategies as part of their efforts to maximize the efficiency of the region's existing transportation infrastructure. As part of this effort, they have initiated a Freeway Performance Initiative (FPI) "Performance and Analysis Framework," which establishes goals and objectives, expectations, needs, and issues related to the analysis of corridor-based performance measures. The objective of the framework is to ensure that performance measures and analysis methods used are consistent across corridors; are consistent across different levels of analysis (e.g., existing/future); are consistent across different transportation modes; and take into account recurrent

The objective of the prioritization framework will be to develop a roadmap for selection of the most appropriate projects and operational strategies for the major freeway corridors in the Bay Area.

and non-recurring congestion.

The performance measures proposed for use as part of the FPI Framework focus on three key areas:

- ***Mobility*** – (travel time and delay) describes how well the corridor moves people and freight
- ***Reliability*** – (buffer time index) captures the relative predictability of the public's travel time
- ***Safety*** - captures the safety characteristics in the corridor, including crashes (fatality, injury, and property damage)

Other measures, such as those that are difficult to assess quantitatively, may be used as additional information (e.g., traveler information or roadside maintenance), and can be reported qualitatively in the narrative for each corridor.

The goal is to comprehensively describe existing traffic conditions in the corridor by identifying the following characteristics:

- Location and causes of bottlenecks
- Location of congestion
- Magnitude of congestion (maximum travel times and vehicle hours of delay)
- Duration of congestion at each bottleneck
- Travel time reliability
- Accident trends

It is anticipated that the assessment of existing conditions will make use of available collected data or field observations. In most cases, this assessment will not involve modeling or simulation. The results of this effort will be summarized in an "Existing Conditions Technical (ECT) memorandum."

Upon completion of all corridor analyses, the agencies involved will undertake a prioritization effort based on the performance measures and a comparison of the cost- effectiveness across the identified mitigation strategies and projects across all FPI corridors. This analysis will estimate the economic value of project impacts, benefits, and costs in a consistent analysis framework. The objective of the prioritization framework will be to develop a roadmap for selection of the most appropriate projects and operational strategies for the major freeway corridors in the Bay Area.

3.3.4 Transit Cooperative Research Program (TCRP) Report 88: A Guidebook for Developing a Transit Performance-Measurement System

The Guidebook developed as part of this research effort presents an eight step process for establishing a performance-measurement program or for refining an existing one. These steps are[8] :

- Define goals and objectives
  - Develop or update a set of agency goals and objectives
  - Include customer and community input when developing goals
  - Select an initial set of goals without worrying about potential measurement issues
  - Revisit the performance-measurement program each time the agency goals are updated

- Generate management support
  - Select and initial set of goals without worrying about potential measurement issues
  - Educate the board of directors and senior management regarding the value of a performance-measurement program
  - Create a limited number of aggregate performance measures or key performance indicators (KPIs) that are easily understood and representative of the transit system's performance in key functional areas
  - Provide periodic performance reports to senior management
  - Provide senior management and board directors with the opportunity to shape the development of the performance measurement program

[8]Source: TCRP Report 88

- Identify users, stakeholders, and constraints
  - Determine who will be utilizing the performance-measurement program on a regular and periodic basis
  - Evaluate existing and expected human, financial, and technical resources for the performance-measurement program

- Select performance measures/indicators and develop consensus
  - Determine KPI categories
  - Review KPIs utilized throughout the industry
  - Consider data collection constraints
  - Select KPIs
  - Develop targets or standards for the selected measures
  - Develop consensus among the key stakeholders involved

- Test and implement the program
  - Develop a pilot project for the performance-measurement program
  - Test the agency's data collection and analysis capabilities through the pilot project. Develop alternative KPIs if needed.
  - Assign program responsibilities to transit staff
  - Implement the performance-measurement program
  - Periodically review technological developments that may improve data collection capabilities

- Monitor and report performance
  - Establish a schedule for regular performance reporting
  - Consider system requirements, as these will affect the manner in which performance is monitored and reported
  - Monitor system performance at agreed-upon intervals
  - Check results for reasonableness
  - Develop a KPI report format
  - Develop KPI indices for each major category or dimension and one general index to cover all dimensions

- Integrate results into agency decision making process
  - Develop a preferred approach for result integration
  - Consider the desired frequency of system evaluation
  - Compare the performance results to the goals set for each measure
  - For measures not meeting their goals, identify action items for improving performance
  - For measures consistently exceeding their goals, consider increasing the target, if cost-effective

- Review and update the program
  - Periodically evaluate the KPI program
  - Based upon the evaluation, make an assessment of whether an update is necessary
  - If an update is necessary, return to the first step and repeat the steps presented above

As there is considerable overlap between them, none of the steps in this process should be viewed in isolation. This is especially true as the outcomes from each step will influence the others and play an important role in determining the program's overall success.

3.3.5 *Federal Highway Administration Research Concerning Travel Time Reliability*

For readers interested in learning more about the basics of travel time reliability, the FHWA has developed a webpage on its operations-related website that provides an overview of this concept[9]. A short "brochure" providing a layperson's introduction to travel time reliability can also be downloaded from this website[10].

3.4 Data Visualization Examples

"Visualization" refers to the use of graphic depictions of quantitative or qualitative information to aid the viewer in understanding complex issues. This section provides some examples of how visualization is used by different agencies around the country.

Figure 1 - WSDOT Speed Analysis

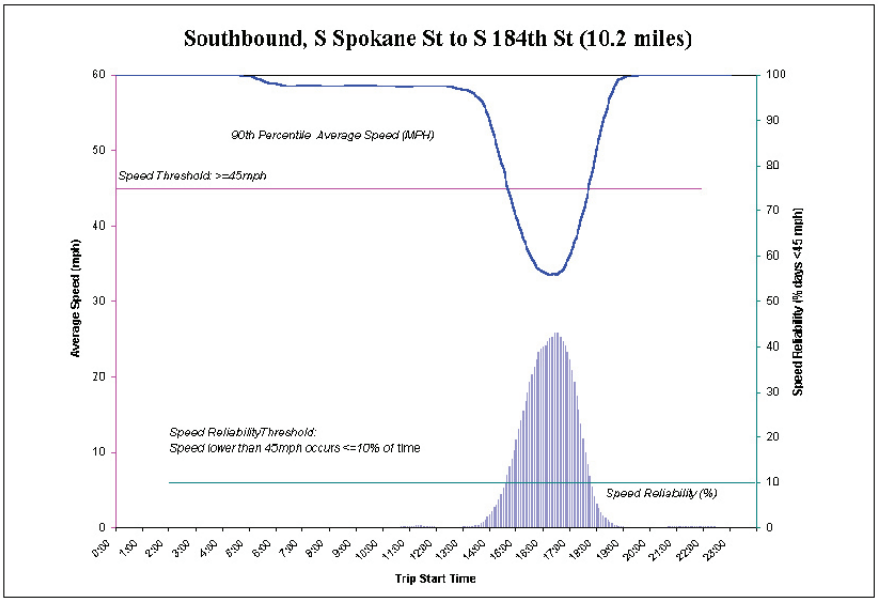


Figure 1 shows how speed data can be used to report measured speeds against an adopted standard[11]. In the case of Figure 1, the 90th percentile corridor speed for an HOV lane (shown by the blue line) is compared against the adopted performance standard (45 mph – the pink line) by time of day. Thus illustrating during which periods of the day, the standard is, or is not, being met. (In this case, the standard is not met between roughly 15:00 and 18:00.) This graphic also illustrates the percentage of days that speeds drop below that standard (as indicated by the histogram on the bottom of the graph).

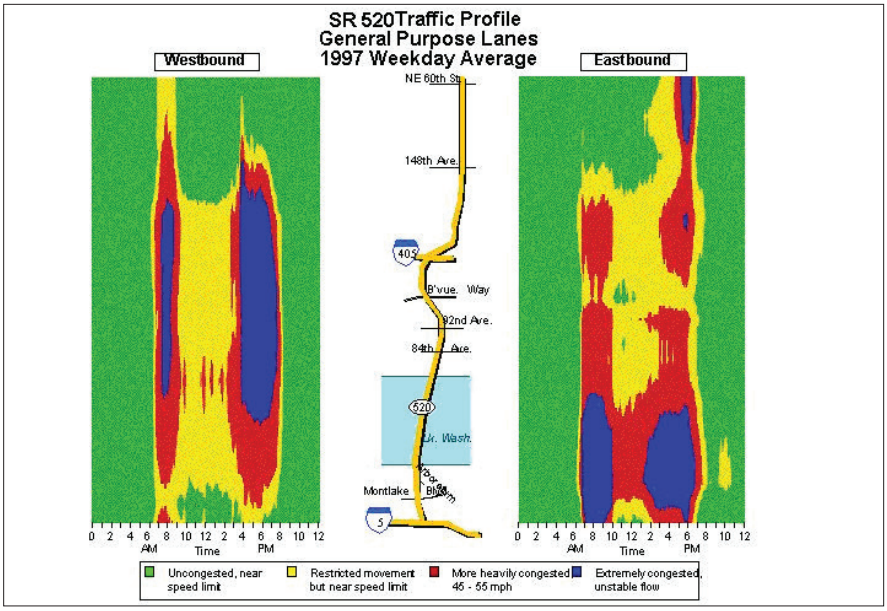
"Visualization" refers to the use of graphic depictions of quantitative or qualitative information to aid the viewer in understanding complex issues.

[9] http://ops.fhwa.dot.gov/perf_measurement/reliability_measures/index.htm

[10] http://ops.fhwa.dot.gov/publications/tt_reliability/brochure/ttr_brochure.pdf

[11] The adopted performance standard states that HOV lanes should operate at 45 mph or faster 90 percent of the time.

Figure 2 - WSDOT Congestion Graphic



The color bands in the chart represent speed thresholds. The horizontal axis shows time of day, and the vertical axis shows distance along a roadway segment.

Figure 2 shows one of WSDOT's most innovative tools for communicating the performance of its roadway system. The color bands in the chart represent speed thresholds. The horizontal axis shows time of day, and the vertical axis shows distance along a roadway segment. As a result, this figure is able to convey speed/congestion information in both temporal and spatial terms. For example this graphic illustrates that congestion is present on this roadway in both peak periods in both directions. This figure also shows that in the westbound direction (the left side of the graphic) the evening congestion period lasts considerably longer than the morning congestion period, even though the afternoon movement is the "reverse" commute. (That is, it consists primarily of people who live in the central city returning to their homes after spending the day working in the suburbs.)

Figure 3 - WSDOT Congestion Graphic Before, Immediately After, and One Year After Improvements

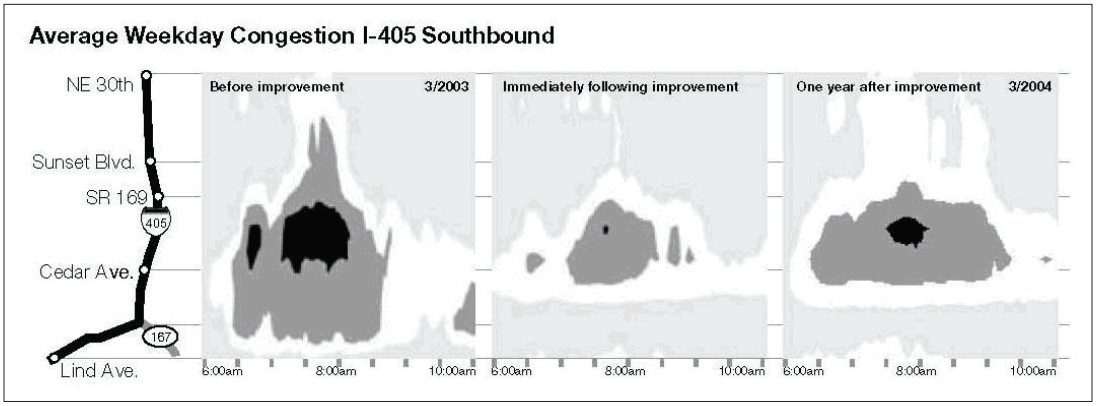


Figure 3 takes the information in Figure 2 to the next logical step. Rather than simply describing conditions over a period of time, it uses a historical approach to assess the effect of capital improvements to the freeway by showing traffic conditions before the improvement, immediately afterwards, and one year afterwards.

Rather than describing conditions over a period of time, Figure 3 uses a historical approach to assess the effect of capital improvements to the freeway by showing traffic conditions before the improvement, immediately afterward, and one year afterward.

Figure 4 - GCM NB I-294 (Cermak/Roosevelt to Touhy Av/O'Hare) Travel Time Analysis

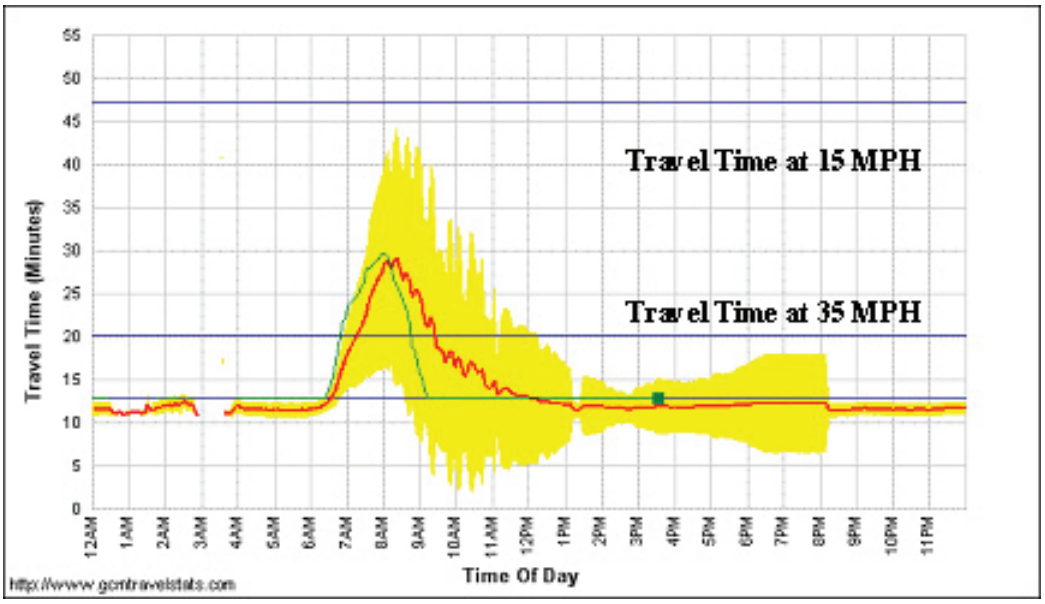


Figure 4 (NB I-294 from Cermak/Roosevelt to Touhy Av/O'Hare) shows travel time information, by time of day, for specified segments of the toll system. The green line shows the travel times for the current day; red indicates the mean annual travel time by time of day; and the yellow line shows the range in which travel times are less than one standard deviation above or below the annual mean. Finally, the dark blue lines show what travel times would be if traffic is moving at: 35 MPH (the bottom blue line); and 15 MPH (the top blue line).

Figure 5 - Estimated Weekday Volume, Speed, and Reliability Conditions

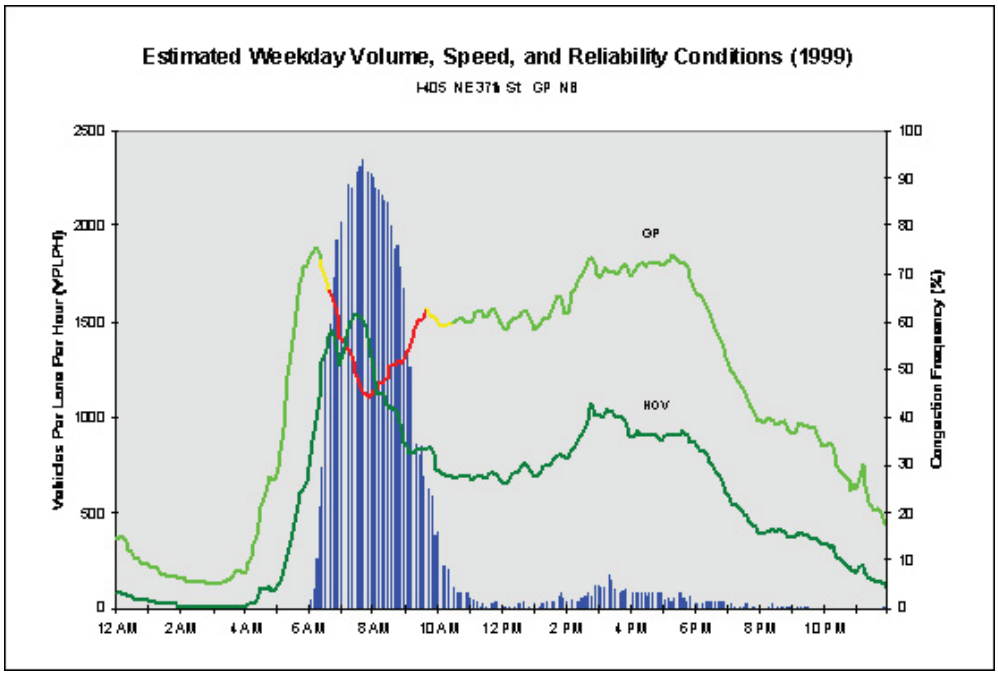


Figure 5 - compares average weekday volume per lane by time of day for a High Occupancy Vehicle (HOV) lane and the neighboring General Purpose (GP) lanes. In this case, the GP lane is also color coded according to average traffic speed (green = above 55 mph, yellow = above 45 and below 55 mph, and red is below 45 mph.) Finally, this figure uses the blue histogram to illustrate how frequently (the percent of days) the GP lane experiences LOS F (stop and go) conditions at this location. In the graphic, we can see the effect persistent congestion has on GP volumes, where slow speeds cause actual vehicle throughput to drop below vehicle throughput levels maintained on the HOV lane. The graphic also shows very well, how GP congestion can help encourage HOV use.

In this table, we can see the effect persistent congestion has on GP volumes. It also shows how GP congestion can help encourage HOV use (particularly during the morning peak).

Figure 6 - Effect of Ramp Metering in Minneapolis

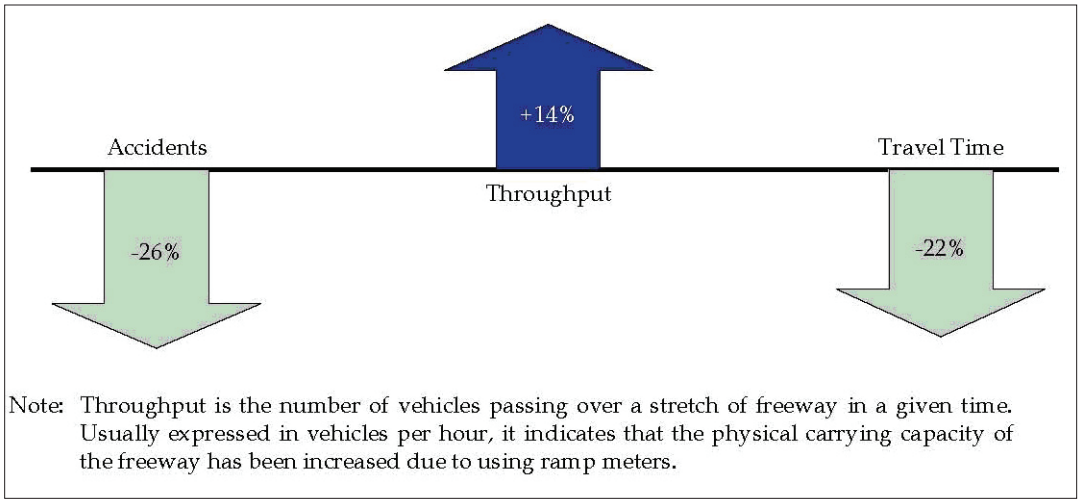
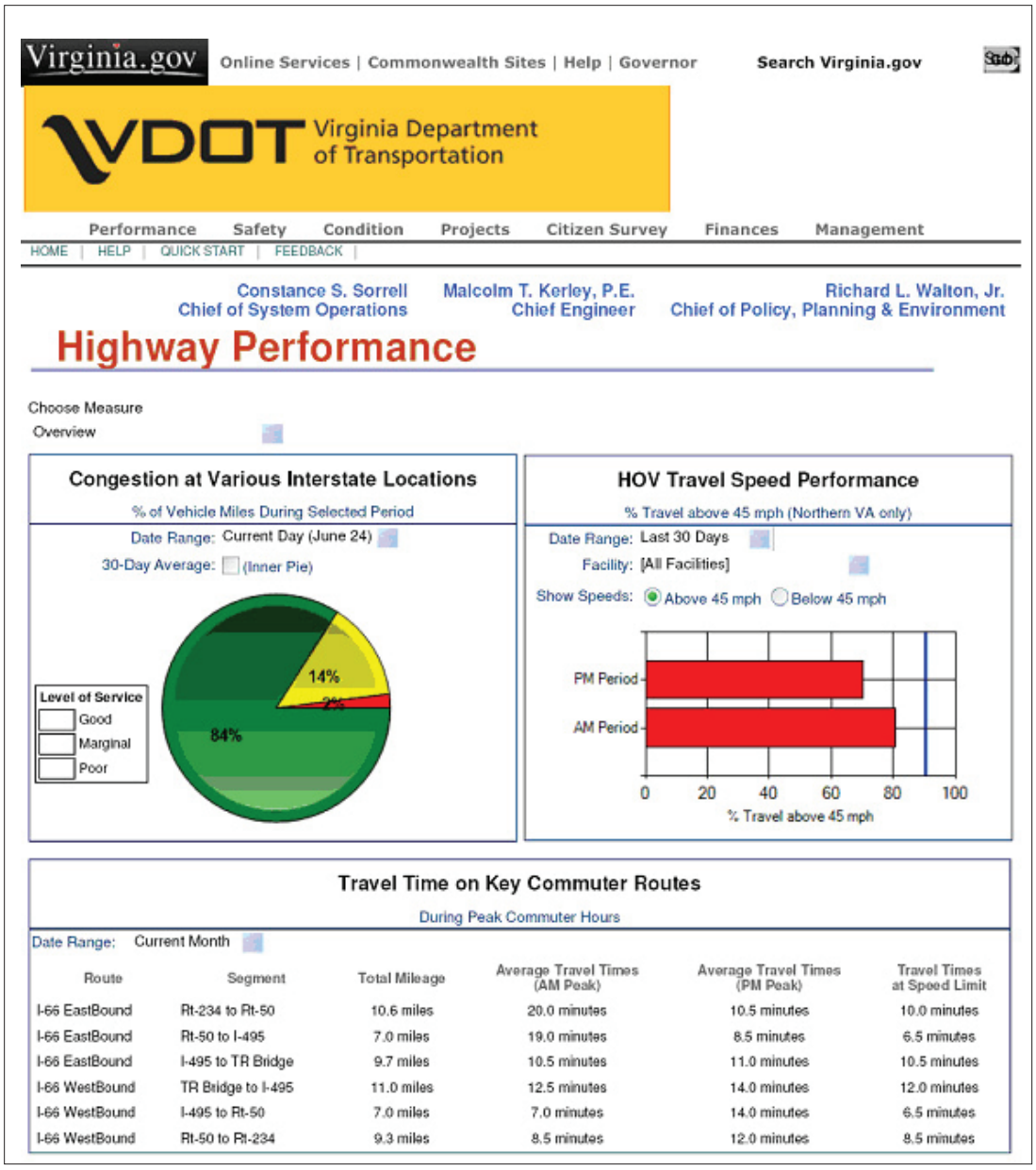


Figure 6 explains the impact of ramp metering in the Minneapolis area. (Cambridge Systematics, Inc. Traffic Congestion and Reliability: Linking Solutions to Problems.)

Figure 7 -Virginia DOT Performance Measures Dashboard



Route	Segment	Total Mileage	Average Travel Times (AM Peak)	Average Travel Times (PM Peak)	Travel Times at Speed Limit
I-66 EastBound	Rt-234 to Rt-50	10.6 miles	20.0 minutes	10.5 minutes	10.0 minutes
I-66 EastBound	Rt-50 to I-495	7.0 miles	19.0 minutes	8.5 minutes	6.5 minutes
I-66 EastBound	I-495 to TR Bridge	9.7 miles	10.5 minutes	11.0 minutes	10.5 minutes
I-66 WestBound	TR Bridge to I-495	11.0 miles	12.5 minutes	14.0 minutes	12.0 minutes
I-66 WestBound	I-495 to Rt-50	7.0 miles	7.0 minutes	14.0 minutes	6.5 minutes
I-66 WestBound	Rt-50 to Rt-234	9.3 miles	8.5 minutes	12.0 minutes	8.5 minutes

Figure 7 highlights three key highway system performance measures tracked by the Virginia DOT. These include: a) Congestion at Various Interstate Locations, b) HOV Travel Speeds, and c) Travel Times on Key Commuter Routes. Each measure can be researched in more detail by either selecting it from a drop-down list, or by clicking the title box for the measure. There are two additional measures available that are not shown on this overview page – Incident Duration, and Annual Hours of Delay[12].

Each measure can be researched in more detail by either selecting it from a drop-down list, or by clicking the title box for the measure.

[12] http://dashboard.virginiadot.org/Pages/Performance/Performance.aspx

Figure 8 -SANDAG Comparison of Travel Demand vs. Congestion

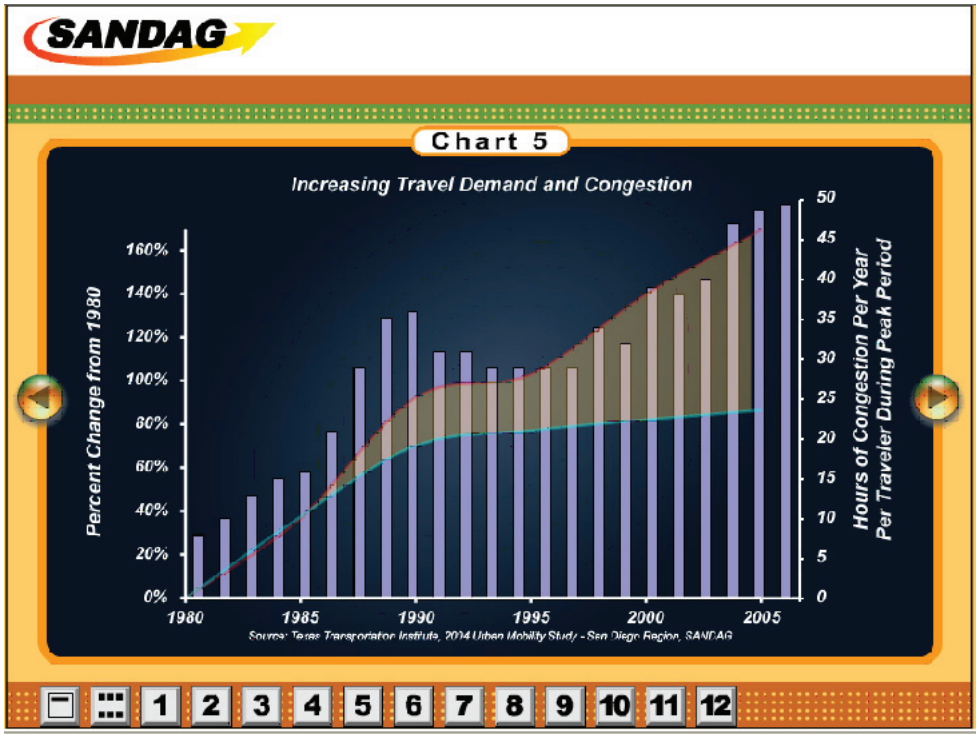


Figure 8 – was developed by the San Diego Association of Governments (SANDAG) to demonstrate the how congestion levels/delay have grown over time (blue bars) as the growth in highway travel (red line) has outpaced the growth in construction of new highway miles (blue line).

Figure 9 -SANDAG Comparison of Travel Demand vs. Congestion

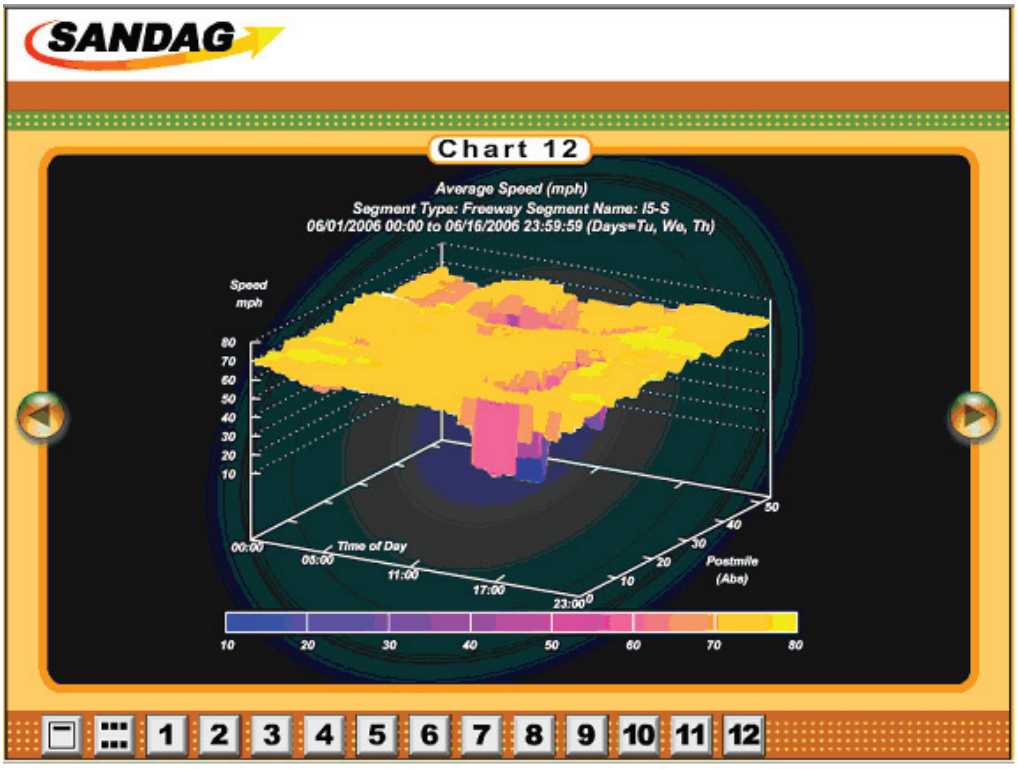


Figure 9 – provides a 3-D representation of average highway speeds according to both time of day and milepost. The data contained in this figure is very similar to that described in figures 2 and 3.

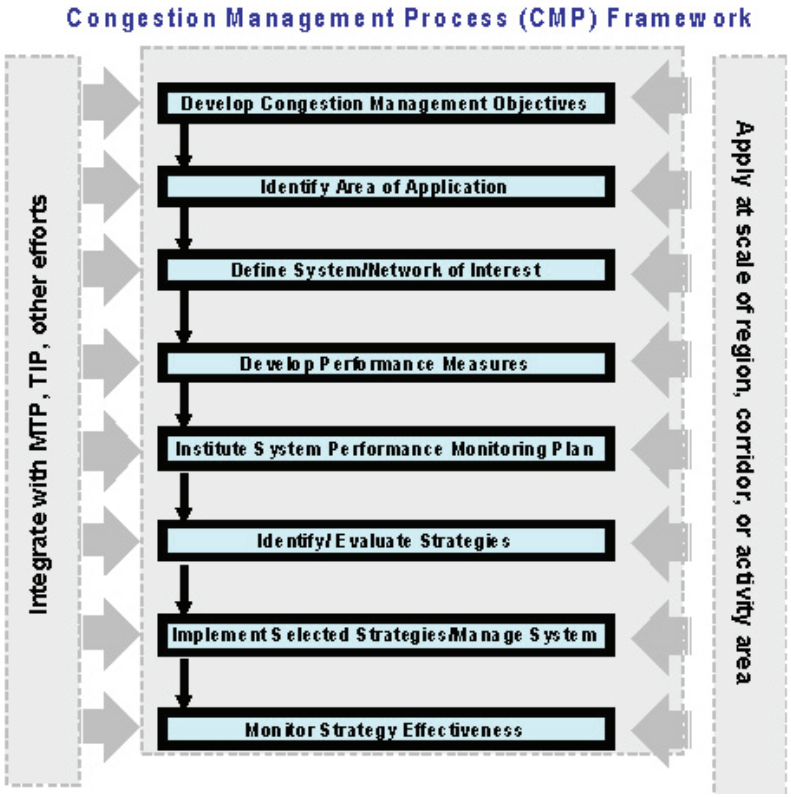
4. Congestion Management Process Best Practices

4.1 Overview of FHWA CM Handbook

The Congestion Management Process (CMP), which has evolved from what was previously known as the Congestion Management System (CMS), is a systematic approach, collaboratively developed and implemented throughout a metropolitan region, that provides for the safe and effective management and operation of new and existing transportation facilities through the use of demand reduction and operational management strategies. Transportation Management Areas (TMAs) – urbanized areas with a population over 200,000, or any area where designation as a TMA has been requested – are required to develop and implement a CMP as an integral part of the metropolitan planning process. The CMP represents the state-of-the-practice in addressing congestion, and can contribute to improvements in travel time reliability and reductions in delay in metropolitan areas that are facing current and future congestion challenges.

The Congestion Management Process is an "8 Step" process, as follows:

Figure 10 -SANDAG Comparison of Travel Demand vs. Congestion



The CMP represents the state-of-the-practice in addressing congestion, and can contribute to improvements in travel time reliability and reductions in delay in metropolitan areas that are facing current and future congestion challenges.

A well-designed CMP should help the MPO to:

- Identify congested locations;
- Determine the causes of congestion;
- Develop alternative strategies to mitigate congestion;
- Evaluate the potential of different strategies;
- Propose alternative strategies that best address the causes and impacts of congestion; and
- Track and evaluate the impact of previously implemented congestion management strategies.

Once congestion management strategies have been identified and selected as part of the Metropolitan Transportation Plan (MTP), the CMP can also be used to:

- Set priorities among projects for incorporation into the Transportation Improvement Program;
- Provide information for environmental analysis of proposed projects;

- Develop more detailed assessments of the potential for congestion reduction at the corridor or activity-center level; and
- Assist in the ongoing monitoring and evaluation of projects and programs implemented throughout the region.

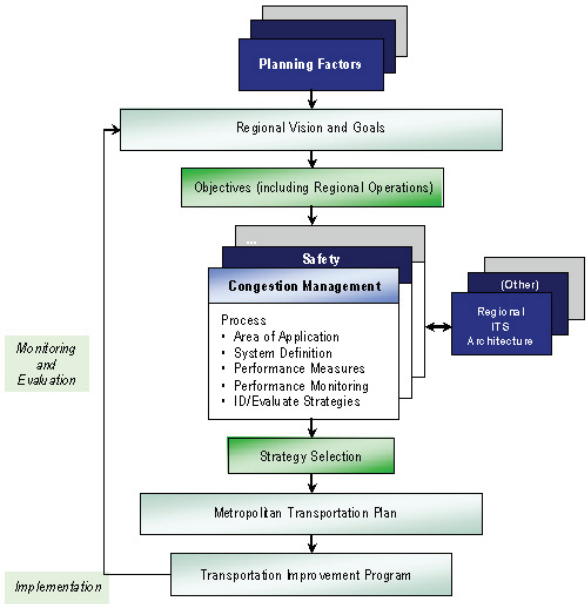
The Maricopa Association of Governments seeks to build upon the basic concepts of the CMS to develop a CMP that is:

- Objectives-driven; and
- Draws upon performance measures, operations data, and existing processes such as the regional Intelligent Transportation Systems (ITS) architecture.

Titles III and VI of SAFETEA-LU, Sections 3005 and 6001, updated the requirement for addressing congestion in Transportation Management Areas (TMAs), mandating the incorporation of CMP within the metropolitan planning process. TMAs are defined as metropolitan areas with a population greater than 200,000, but metropolitan areas can be designated TMAs at the request of the Governor and the MPO responsible for that region. In TMAs, SAFETEA-LU requires that the MPO "shall address congestion management through a process that provides for effective management and operation, 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." The Final Rule on Statewide and Metropolitan Transportation Planning, published on February 14, 2007, states that "The development of a congestion management process should result in multimodal system performance measures and strategies that can be reflected in the metropolitan transportation plan and the Transportation Improvement Program (TIP)."

The Congestion Management Process is intended to be an integral part of the metropolitan planning process, rather than a stand-alone program or system. The CMP can be used to identify specific strategies that make the best use of new or existing transportation facilities, including but not limited to travel demand management, such as changes to land use, mode shifts, or changes to the time of day for travel; transportation systems management and operations, including approaches such as incident management through improved response to crashes, freeway management systems like ramp metering, improvements to arterial management such as traffic signal coordination, and improvements to transit operations; better travel information to help system users plan their trips in advance or respond to changing conditions; or capacity expansion through existing or new facilities as appropriate.

Figure 11 -Objectives-Driven CMP in the Planning Process



"The development of a congestion management process should result in multimodal system performance measures and strategies that can be reflected in the metropolitan transportation plan and the Transportation Improvement Program (TIP)."

- The Final Rule on Statewide and Metropolitan Transportation Planning

The Congestion Management Process is very closely aligned with the integration of transportation systems management and operations into the metropolitan planning process. Management and operations (M&O) has emerged as a vitally important approach to addressing both short-range and long-term transportation challenges. SAFETEA-LU specifically requires con¬sideration of M&O in the metropolitan transportation planning process; "Promote efficient system management and operation" is identified as one of eight planning factors that must be taken into account in the development of the MTP (see Section 6001(h)). MPOs must also include "operational and management strategies to improve the performance of existing transportation facilities to relieve vehicular congestion and maximize the safety and mobility of people and goods." The CMP is intended to fit neatly within objectives-driven, performance-based planning, and emphasizes management and operations as a new focus for metropolitan transportation planning.

The CMP is as much a way of thinking about congestion-related issues as it is a set of technical tools. To put it another way, the CMP uses a number of analytic tools to define and identify congestion within a region, corridor, activity center or project area, and to develop and select appropriate strategies to reduce congestion or mitigate the impacts of congestion. There are several common characteristics of "state-of-the-practice" congestion management processes, including:

- Links to operations objectives, driven by the goals expressed in the MTP;
- Defines systematic methods to monitor and evaluate system performance;
- Focuses comprehensively on management and operations, demand management, land use, and new capacity as ways to manage congestion;
- Uses performance measures to identify, evaluate, and monitor congestion and congestion management strategies;
- Defines a program of data collection and management, preferably incorporating existing data sources (including archived ITS data if available), and coordinated with system operations managers throughout the metropolitan area;
- Details technical capabilities for evaluating the potential effectiveness of demand management and operational strategies;
- Defines implementation schedules or timetables for delivery of M&O strategies, including assignment of resources and responsibilities;
- Defines procedures for periodic review of the effectiveness of strategies selected for implementation, as well as assessments of the usefulness of per¬formance measures and supporting data; and
- Considers congestion, its causes, and possible remedies in a holistic way, encompassing a broad range of multimodal transportation and non-transportation elements.

The CMP benefits greatly from a systematic approach to collecting and managing data for performance measurement. The Congestion Management Process also requires analysis and strategy development components. The CMP may yield reports on congested locations, congestion mitigation strategies, and system performance, but such stand-alone "congestion management plans" are not the focus of the Congestion Management Process. The CMP is intended to provide strategies for inclusion in the metropolitan long-range transportation plan, and may also be used for intermediate and short-term planning purposes.

The congestion management process contributes to achievement of regional congestion management objectives, and can deliver a number of collateral benefits as well. By addressing congestion through a comprehensive process, the CMP provides a framework for responding to congestion and other operational issues in a consistent, coordinated fashion. The CMP also enables MPOs to bring an objective basis to the process to pinpoint those congestion management strategies that will allow the region to target the most congested areas and achieve the greatest benefit by targeting the investment.

The CMP comprises a number of different elements that add up to a coherent, objectives-driven, performance based approach to solving congestion problems. These components are described in the Final Rule on Statewide and Metropolitan Transportation Planning. The Rule states that the CMP shall

The CMP is intended to fit neatly within objectives-driven, performance-based planning, and emphasizes management and operations as a new focus for metropolitan transportation planning.

include:

- Methods to monitor and evaluate the performance of the multimodal transportation system, identify the causes of recurring and non-recurring congestion, identify and evaluate alternative strategies, provide information supporting the implementation of actions, and evaluate the effectiveness of implemented actions;
- Definition of congestion management objectives and appropriate performance measures to assess the extent of congestion and support the evaluation of the effectiveness of congestion reduction and mobility enhancement strategies for the movement of people and goods. Since levels of acceptable system performance may vary among local communities, performance measures should be tailored to the specific needs of the area and established cooperatively by the State(s), affected MPO(s), and local officials in consultation with the operators of major modes of transportation in the coverage area;
- Establishment of 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. To the extent possible, this data collection program should be coordinated with existing data sources (including archived operational/ITS data) and coordinated with operations managers in the metropolitan area;
- Identification and evaluation of the anticipated performance and expected benefits of appropriate congestion management strategies that will contribute to the more effective use and improved safety of existing and future transportation systems based on the established performance measures. The following categories of strategies, or combinations of strategies, are some examples of what should be appropriately considered for each area:
    - Demand management measures, including growth management and con¬gestion pricing;
    - Traffic operational improvements;
    - Public transportation improvements;
    - ITS technologies as related to the regional ITS architecture; and
    - Where necessary, additional system capacity.
- Identification of an implementation schedule, implementation responsibilities, and possible funding sources for each strategy (or combination of strategies) proposed for implementation; and
- Implementation of a process for periodic assessment of the effectiveness of implemented strategies, in terms of the area's established performance measures. The results of this evaluation shall be provided to decision-makers and the public to provide guidance on selection of effective strategies for future implementation[13].

Since levels of acceptable system performance may vary among local communities, performance measures should be tailored to the specific needs of the area.

4.2 Introduction to Agencies Reviewed (CMP)

This section provides an overview of the agencies for which research was conducted as part of this best practices study:

- North Central Texas Council of Governments – The North Central Texas Council of Governments (NCTCOG) is the MPO for the Dallas-Fort Worth region. The Regional Transportation Council (RTC) is the regional transportation policy body associated with the MPO and is a forum for cooperative decisions on transportation related items. In 1993, the NCTCOG developed a CMS Work Plan (as part of the North Central Texas RTP) outlining the relationship of the CMS with regional transportation planning and programming procedures and provided a scope for CMS implementation.

- San Diego Association of Governments - The San Diego Association of Governments (SANDAG), serving as the Regional Transportation Planning Agency (RTPA), is responsible for developing the Regional Transportation Plan (RTP) and the Regional Transportation Improvement Program (RTIP) for the San Diego region. SANDAG has integrated CMP Capital

[13] 523 CFR 450.320(c)

Improvement Program (CIP) requirements into its existing programming responsibilities under the TIP. The RTP, TIP, and the CMP CIP are developed jointly as integrated programs designed to meet the region's growing travel needs, to mitigate congestion, and to improve air quality through the reduction of motor vehicle emissions.

- Hampton Roads Planning District Commission – The Hampton Roads Planning District Commission (HRPDC) manages an ongoing Congestion Management Process. In December 2004, the HRPDC published "Congestion Management System, Part 1- The State of Transportation in Hampton Roads", and in April 2005 the PDC published "Congestion Management System, Part 2- Bridges and Tunnels, Roadway Congestion Analysis, and Mitigation Strategies and Evaluation." With regard to coordination between the CMP and the long range plan, the current level-of-service (LOS) values for candidate 2030 project roadways were extracted from the CMP for use in evaluating the effectiveness of candidate projects to aid decision-makers in making funding decisions.

- Puget Sound Regional Commission - The Seattle Metropolitan region has been working towards multi-modal solutions to regional transportation issues for many years. The performance measures system and CMP (which is currently incomplete) are viewed as additional tools to assist that process. However, the Puget Sound Regional Commission (PSRC) has significant financial and political limitations which impact the implementation of the CMP. As a result, while the concept behind the use of performance measures and the CMP is well accepted, implementation of the "desired" strategies is currently constrained by available resources.

  The current RTP, Destination 2030, is in the processing of being updated. As part of this effort, PSRC staff is actively working to incorporate the existing congestion monitoring system into the planning process. This includes revision of the current modeling process to produce reliability measures as an outcome of the traditional 4-step model.

- Denver Regional Council of Governments – The Denver Regional Council of Governments (DRCOG) has documented transportation system management and operations strategies for the region as part of the "Denver Regional Transportation Operations Strategy" produced in December 2007. In addition, the current RTP vision and goal statement references the integration of mobility, land use, and social and economic development as part of the regional planning process.

- Washington State DOT - The Washington State DOT is motivated by political need to be accountable to the State Legislature and the general public. This was one of the key instructions given to Secretary of Transportation Doug MacDonald when he took over the Department six years ago.

While the concept behind the use of performance measures and the CMP is well accepted, implementation of the "desired" strategies is currently constrained by available resources.

4.3 CMP Topics

This section provides an overview of the technical characteristics and challenges associated with the congestion management programs implemented by each of the agencies described in section 4.2, "Introduction to Agencies Reviewed (CMP)."

4.3.1 Objectives/Goals

- North Central Texas Council of Governments - NCTCOG has adopted goals which include Mobility, Quality of Life, and Financial/Air Quality, to be accomplished via the following improvements:
  - Maintain current transportation system
  - Improve efficiency of existing systems through transportation system management, travel demand management, bicycle and pedestrian activities, and intelligent transportation system applications

- Provide public transportation options such as bus, light rail, and commuter rail
- Increase auto occupancy by encouraging ride-sharing through an aggressive region-wide system of HOV and managed lanes
- Provide additional capacity for single occupant vehicles through freeway/tollway lanes and arterial streets

NCTCOG tracks the deployment and effectiveness of congestion management strategies using a combination of their regional travel model and other analysis techniques.

- San Diego Association of Governments - In evaluating highway, freeway to freeway connection, arterial, and transit projects proposed for funding, SANDAG has established both quantitative and qualitative criteria to evaluate and rank project submittals. The criteria related to the CMP include: Congestion Relief – Does the project provide current and future congestion relief? Transit Mobility – Does the project benefit a facility used by public transit as measured by number of routes and frequency of service? Smart growth – Is the project in an area targeted for smart growth or does it support smart growth strategies? Encourages In-Fill Development – Does the project support in-fill development?

- Hampton Roads Planning District Commission – One of the primary objectives of having the CMS is to support project selection and justification. As a result, the HRPDC has incorporated the goals of its long range plan into the CMS.

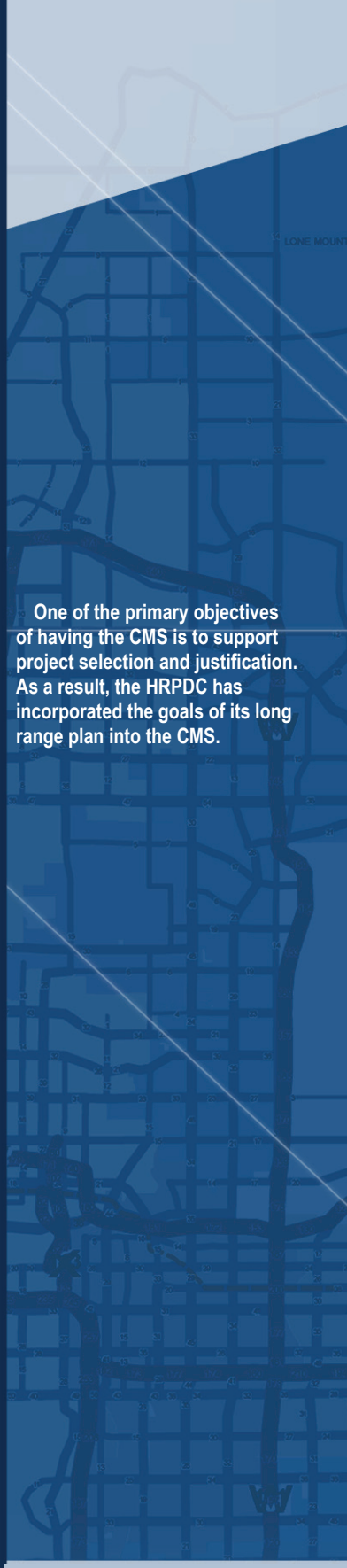
- Puget Sound Regional Commission – The primary objectives of the PSRC's CMP include:
  - To better inform the decision-making process for the programming of transportation funds
  - To focus investments on the locations with the greatest problems (congestion, mobility and safety)
  - To achieve the greatest cost effectiveness in addressing problem areas
  - To give consideration to all reasonable solution options including multimodal options, operational strategies, demand management, pricing and capacity expansion
  - To give consideration to the movement of people and goods

  As part of its efforts to develop the CMP, PSRC is attempting to "map" CMP goals and objectives to the policies articulated in the LRP.

- Denver Regional Council of Governments – The goal of the CMP is to enable the DRCOG to take a new look at congestion - considering where, when and why the roadways in the Denver region have become congested. The CMP seeks to improve, not solve, congestion using the 3 A's: avoid, adapt, and alleviate. Although the DRCOG doesn't have data driven objectives at this time, the RTP could be used as the basis for developing such goals in the future.

- Washington State DOT - The basic vision of WSDOT's Congestion Management program is stated as follows: "Our goal is to make strategic improvements to achieve greater efficiency of the state's transportation system." This is accomplished through a balanced investment plan of programs and services that include:
  - Capacity improvements in both general purpose and HOV lanes
  - Transit and support facilities, such as Park and Ride and direct-access ramps
  - Passenger rail and light rail (link to Sound Transit)
  - Bicycle and pedestrian facilities
  - Incident response
  - Ramp metering
  - Freight mobility improvements
  - Communication system improvements for travel and commute information
  - Congestion pricing is an area we are beginning to gain experience

One of the primary objectives of having the CMS is to support project selection and justification. As a result, the HRPDC has incorporated the goals of its long range plan into the CMS.



4.3.2 Cooperation with Other Partners

- North Central Texas Council of Governments (NCTCOG) - Four transportation systems are identified in the current CMP - the freeway system, regional arterial system, intermodal/freight system and the passenger rail system. Regional partners representing each of these areas are involved in the implementation of congestion management strategies. Additionally in 1998, the RTC adopted a resolution that supports the development of Travel Demand Management (TDM) strategies as part of major investment studies. As a result, there is a Travel Demand Management/Congestion Management Process (TDM/CMP) Task Force, which provides technical support and coordination for the implementation of travel demand management and congestion mitigation strategies.

- San Diego Association of Governments - Partners include local jurisdictions, Caltrans, and transit districts involved in developing project lists. Others who are asked to provide input include the San Diego Regional Traffic Engineers Council, local public works directors, and planning directors.

- Hampton Roads Planning District Commission - HRPDC brought together a number of agencies through its Regional Concept of Transportation Operations (RCTO) process. This includes, as members of the RCTO Working Group, the VDOT Smart Traffic Center; Virginia State Police; Virginia Association of Chiefs of Police; VDOT Traffic Engineering (District and Central Office); VDOT Operations Management (Central Office); VDOT Environmental Office; FHWA Virginia Office; HRPDC; Local fire chiefs (York County, Hampton, Newport News, Chesapeake); local police departments (Hampton, Newport News, Norfolk); local traffic engineers (Hampton, Newport News, Norfolk, Virginia Beach); and members of the towing community.

- Puget Sound Regional Commission - Partners in the CMP development process have included the larger cities, regional and county transit agencies, state DOT, and the four counties in the region. Of particular importance is the Regional Traffic Operators Committee (RTOC), an ad hoc advisory committee made up of key staff from these agencies. This ad hoc committee vetted the draft CMP manual developed by PSRC's consultant.

- Denver Regional Council of Governments - Partner agencies and system operators have active roles in the ITS Stakeholder Committee, Signal Coordination Stakeholder Committee, and TDM Workgroups, all of which fall under the umbrella structure of DRCOG's Congestion Mitigation Program.

- Washington State DOT - Within the regional and statewide planning processes, considerable effort has been made to involve a wide variety of agencies and customers in planning and programming congestion management and mitigation projects.

4.3.3 Support Provided by Performance Measures Program

- North Central Texas Council of Governments - Performance measures have been identified to accommodate various modes of surface transportation, including personal vehicles, transit vehicles, passenger rail, and freight rail. However, there are currently no performance measures in the CMP for non-motorized modes of travel such as bicycling and walking.

  The CMP relies heavily on data already collected or planned to be collected by other agencies. For controlled access facilities, performance measures include level of service and reliability/ speed. For the regional arterial system, performance measures include volumes (7-day and 24-hour vehicle counts). For intermodal/freight systems, performance measures include freight rail forecast, truck traffic forecast, and vehicle classification counts. For passenger rail transportation, performance measures include DART Light Rail Ridership, Trinity Railway

Within the regional and statewide planning processes, considerable effort has been made to involve a wide variety of agencies and customers in planning and programming congestion management and mitigation projects.

Express (TRE) average weekday ridership by station, and TRE Ridership from Ft. Worth to Dallas.

- San Diego Association of Governments - CMP legislation requires that a level of service standard be established for the CMP system.

  For public transportation, measures of effectiveness include service levels (headways), travel speeds (average speeds or travel times), and service utilization (ridership).

  Data is collected automatically for many freeway segments using loop detectors. In cooperation with the University of California, Berkeley, SANDAG and Caltrans are archiving and using this data under a program titled "Performance Monitoring Systems (PeMS)" to provide ongoing freeway performance monitoring data.

  However, an expansion of automated traffic monitoring to include conventional highways and arterials would be beneficial to the region. First, the data would be collected automatically, thus reducing manual data collection-related costs. Second, data would be collected on an ongoing basis, allowing continuous monitoring of traffic to assist in identifying trends in traffic growth.

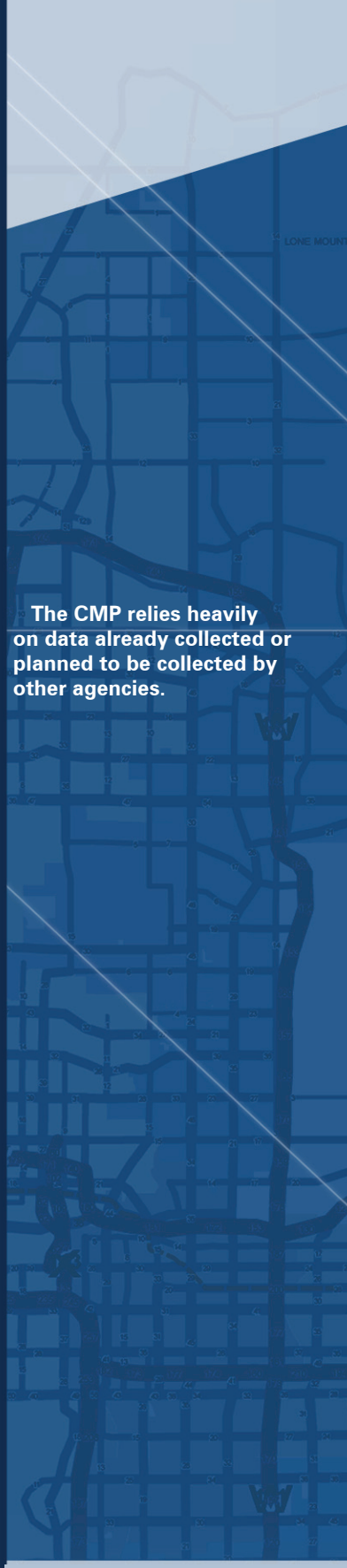
- Hampton Roads Planning District Commission - Congestion is identified primarily through level of service and travel time/speed, although many other performance measures are documented in the "State of Transportation" update. As part of this update, performance measures are provided for:
  - Air travel (passenger boardings, cities served through direct flights)
  - Marine transport (general cargo tonnage, container traffic in TEUs, cruise passenger boardings, ferry traffic, both passenger and vehicular)
  - Rail traffic (freight tonnage, intercity passenger boardings)
  - Roadway usage (VMT, registered vehicles, licensed drivers, TTI data—delay, congestion costs, Travel Time Index)
  - Commuting data (journey-to-work distance and travel time, inter-jurisdictional travel, journey-to-work mode and vehicle occupancy)
  - HOV usage (persons per HOV lane, average vehicle occupancy in HOV lanes)
  - Safety (number and rate of crashes, injuries, fatalities, incidents, as well as Highway Service Patrol activities)
  - Truck data (truck mode share, volume by route, hourly distribution)
  - Transit usage (passenger miles, unlinked trips, per capita usage)
  - Bicycle and pedestrian facilities (miles of bicycle lanes, multi-use paths, and signed shared roadways)
  - Intelligent Transportation Systems/Operations (freeway miles instrumented, Smart Traffic Center coverage)

  HRPDC uses data collected from the VDOT Smart Traffic Center, local "smart traffic centers" (in Chesapeake, Virginia Beach, Norfolk, and Hampton, and soon in Newport News), and the data archive at the University of Virginia's Smart Travel Labs' Archived Data Management System (ADMS).

- Puget Sound Regional Commission – Performance measures are developed for all modes of travel - cars, mass transit (carpools, vanpools, bus, light rail, streetcar, BRT, traditional bus), bike, walk, and freight (both rail and truck.)

  The CMP remains under development. The PSRC worked with a consultant to develop draft performance measures in support of the CMP. However, it quickly became apparent that the data required to support those desired measures did not currently exist, and could not be obtained within the available budget. As a result, PSRC is now in an implementation mode working towards developing those measures on a fiscally constrained basis. In addition, PSRC is actively working with its member jurisdictions and transportation operating agencies to put in place management systems that include data collection functions which meet the needs of the proposed CMP

The CMP relies heavily on data already collected or planned to be collected by other agencies.



documentation.

PSRC is:

- Using tools that already exist
- Modifying their existing analytical tool set to more effectively model and forecast the desired/selected CMP performance statistics

The strategic goal is to be able to support regional political discussions and decision-making processes, through an improved ability to describe current conditions, better predict the effects of alternative improvement strategies, and monitor the effectiveness of the selected improvements.

- Denver Regional Council of Governments - Performance measures are currently used on a more indirect basis to identify congested corridors. It is anticipated that as DRCOG gets more data, they will be able to conduct more performance driven planning and analysis. Performance measures currently tracked include:
  - Vehicle measures - vehicle miles of travel, vehicle hours of travel, average travel speed, vehicle hours of delay, and travel delay in minutes per driven registered motor vehicle.
  - Person measures - person miles of travel, person hours of travel, person hours of delay, and travel delay per resident (minutes).
  - Other measures - percent of travel time in delayed conditions, travel time variation (peak vs. off-peak), lane miles of roads congested for 3+ hours (and percent of total lane miles), and traffic crashes.

In order to identify the most critically congested corridors in the region, a "congestion mobility grade" was devised based on a total congestion score (1-20 points) that incorporates travel time variation, number of hours per day severely congested, percent of travel time in delay during peak hour, total daily vehicle delay per mile, and crashes per mile per year.

DRCOG has a Regional Traffic Count Program that supplies traffic count data and traffic forecasts for use in performance monitoring. However, there are limitations in that there are only a handful of sites with year round monitoring. The performance measures themselves are calculated from general delay formulas linked to the ADT and capacity on the 1,100 segments making up the regional roadway system.

- Washington State DOT - WSDOT has access to wide ranging performance measures data from the WSDOT Gray Notebook – see sections 3.2.2 and 3.2.4. Even so, the DOT continues to seek out additional sources of data that will facilitate cost effective expansion and improvement of the existing data collection program. Areas of particular interest for additional data include arterials and rural roads.

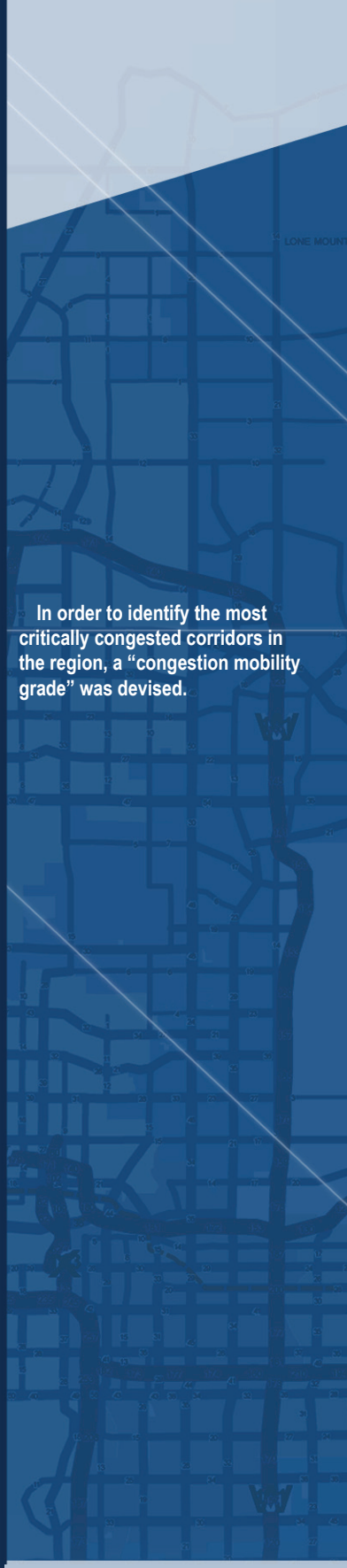
4.3.4 Development of Effective CMP Tools

- North Central Texas Council of Governments – Four transportation systems are identified within the CMP: the freeway system, regional arterial system, intermodal/freight system, and passenger rail system. Congestion mitigation strategies identified for implementation cover the following modes of travel: single occupancy vehicle, shared ride, transit, intermodal connections, and non-motorized means.

Specific congestion mitigation strategies identified in the most recent transportation plan include:

- Transportation System Management - intersection improvements, traffic signal enhancements, removal of freeway and arterial bottlenecks, special event management, and access management.
- TDM strategies - employer trip reduction programs, vanpool programs, park-and-ride

In order to identify the most critically congested corridors in the region, a "congestion mobility grade" was devised.



facility development, and the creation of the transportation management association.
    - ITS strategies - public transportation, traveler information, traffic management, commercial vehicle operations, emergency management, archived data management, and maintenance and construction management.

- San Diego Association of Governments – The primary focus of SANDAG's CMP is on recurring congestion (e.g., bottlenecks). The principal tool currently used to determine which activity areas and corridors require the greatest focus is the "System Wide Deficiency Plan," which uses the regional travel demand model to assess system performance at 10-year intervals, integrating the benefits from programmed/planned projects over time. SANDAG intends to evaluate the impact of CMP-related projects in the future, with a primary focus on the reduction of vehicular congestion.

- Hampton Roads Planning District Commission – The CMP addresses both recurring and non-recurring congestion using a variety of mitigation strategies, including: incident management, ramp metering, signalization improvements, transit signal preemption, and other measures.

  The CMP "Part 2" document contains "operational and management strategies to improve the performance of existing transportation facilities" as required by SAFETEA-LU. In particular, it contains a "Congestion Mitigation Strategy Toolbox" (see Appendix B) which provides specific recommendations for action on individual congested roadway segments. These recommendations address all thoroughfare segments that are currently operating at severely congested conditions and are expected to remain congested through 2026.

  HRPDC has conducted post-implementation studies to assess the impact of several CMP projects, particularly those that were implemented with CMAQ funds. The overall results indicate that no one category of congestion mitigation project has performed better than the others and that successful projects utilized a mix of congestion mitigation strategies.

- Puget Sound Regional Commission – PSRC places a strong emphasis on the implementation of congestion management tools. Strategies implemented as part of the CMP include (in this order of importance): roadway pricing/tolling, TDM, transit, TSM (including operational improvements), and lastly, increases in capacity. Some of the techniques implemented as part of these strategies include:
    - Roadway Operational Improvements - access management, traffic signalization and control, one-way streets, reversible lanes, hard shoulder running, HOV lanes, ramp metering, road pricing, advanced parking systems, dynamic messaging, incident management systems, and special event and work-zone planning.
    - Alternative Mode Support Strategies - public education, ridesharing programs, transit, park & ride lots, "Guaranteed Ride Home," car-sharing programs, pedestrian-oriented design, and bicycle infrastructure.
    - Other Demand Management - traveler information, public relations and marketing, parking management and pricing, telecommuting programs, and distance-based insurance.

- Denver Regional Council of Governments - The CMP addresses recurring congestion through the identification of critically congested corridors, arterial-arterial intersections, arterial-freeway ramp intersections, and bottleneck slow-down points. In general, congestion management strategies focus on the following modes of transportation: single occupancy vehicle, shared ride, bus and rapid transit, intermodal connections, and non-motorized. Specific congestion mitigation strategies identified in the CMP include TDM, traffic operations, and ITS strategies.

  For roadway projects, a thorough capacity analysis is conducted as part of the ranking/scoring process used to identify projects for inclusion in the TIP (this analysis factors in the location of a project relative to important intermodal centers). For TDM & ITS projects, benefits are

estimated using available tools/resources, but the methodology is not as robust and is subject to engineering judgment.

- Washington State DOT - Research is underway to define the relative size of both the causes of non-recurring congestion and the effectiveness of the adopted mitigation programs (e.g., the incident response program and its components). Information about related activities can be found at: http://www.wsdot.wa.gov/Traffic/Congestion/default.htm#2

4.3.5 Delivery/Reporting

- North Central Texas Council of Governments - The CMP document is posted on the NCTCOG website. The agency also developed a summary of the CMP and published it in their Regional Mobility Initiatives brochure. Maps are used to display the status of Transportation Corridor Studies, deployment of ITS Technology, traffic signal projects, intersection improvement projects, and the Thoroughfare Assessment Program. An online commuter participation application developed by NCTCOG, www.tryparkingit.com, is used to track TDM strategies that are being used by the general public.

- San Diego Association of Governments – The SANDAG State-of-the-Commute Report (map-based) is the key mechanism for communicating congestion-related information to the general public.

- Hampton Roads Planning District Commission - HRPDC produces a macro-level "State of the System Report" directed at elected officials and the general public. Copies of the report have been distributed to civic leagues, planning commissions, churches, and the General Assembly. Presentations are also made to many of these groups. The HRPDC also produces a "Special Report" (glossy brochure) aimed at the public, which focuses on providing information on congested roadways and activity areas. This report includes time contour maps for activity centers, maps indicating delay by facility, traffic volume maps, LOS maps, maps showing "CMS Congested Areas", and various other charts and graphs.

- Puget Sound Regional Commission - In the past, as part of the CMS process, reports and newsletters - including maps of congested locations and trend reports (tables and graphs) were produced. Although PSRC is exploring the possibility of developing web-based tools, there are no CMP-specific reports, web-based tools, or other documents currently produced.

- Denver Regional Council of Governments - The CMP and its associated component documents are posted on the DRCOG website. The agency also publishes a Congestion Matters newsletter. Audiences include the public, media, the PSRC board of directors, internal staff, other committees, and stakeholder groups.

- Washington State DOT - Results are disseminated via the WSDOT Gray Notebook and via other mechanisms described in section 3.2.6 of this memorandum.

4.3.6 Integration of Results into Program Development/Planning

- North Central Texas Council of Governments (NCTCOG) - The CMP is fully integrated into the region's transportation planning and programming processes. The seven components of the CMP include; system identification, development of performance measures, monitoring & evaluation of performance, strategy identification, strategy selection, project implementation, and project performance evaluation. As part of the plan development process, available funds are allocated first to the lower cost emissions-reducing projects and programs and then to the more traditional major capital projects.

The SANDAG-State-of-the-Commute Report (map-based) is the key mechanism for communicating congestion-related information to the general public.

The CMP gives priority to strategies that increase the efficiency of the existing transportation system and reduce drive-alone travel through TDM, including bicycle and pedestrian strategies. The goal is to manage the region's growing traffic problems by developing and implementing lower cost strategies that complement major capital projects and strategies, in turn offering opportunities to stretch available transportation resources.

- San Diego Association of Governments – Project planning-related evaluation criteria are the same as those used in the CMP.

- Hampton Roads Planning District Commission - CMP activities are documented as part of the LRP and through stand-alone reports such as the State of Transportation System report. The LRP incorporates material produced by the CMS/CMP as justification for projects identified through the metropolitan planning process. Analysis of congestion through the CMP has affected project selection for the LRP and been a major factor in the CMAQ project development and selection process.

- Puget Sound Regional Commission - The goals and objectives of the CMP are being actively pursued within the current regional project identification, analysis, selection, and prioritization process. The CMP measures for which data are currently available are actively used in the decision making process. However, since the CMP has not yet been formally adopted, the CMP itself does not directly impact the TIP process.

- Denver Regional Council of Governments - The CMP is generally used as supporting documentation to evaluate the inclusion of projects in the TIP.

- Washington State DOT – Congestion mitigation strategies have been incorporated directly into both the Statewide Transportation Plan and various regional plans. Congestion management-related activities are an integral part of WSDOT decision making. For example, WSDOT will be placing Active Traffic Management technology on the I-5 corridor just south of downtown Seattle as part of their construction mitigation plans for the combined I-5 pavement reconstruction project, and as construction mitigation for the replacement of the Alaska Way viaduct (SR 99.) The intent is to support improved traffic operations, with an emphasis on the reduction of recurring and non-recurring congestion.

4.3.7 Overall Success of Program

- North Central Texas Council of Governments (NCTCOG) – CMP-related efforts have provided the tools necessary to help allocate transportation dollars based on congestion levels by mode. Although not all decisions end up being based on CMP-based data, agency staff are now better able to justify the project-related recommendations they make to decision-makers.

- San Diego Association of Governments – The tools developed as part of this effort enable SANDAG to analyze the impact of RTP improvements on congestion, including the effectiveness of funds programmed in the TIP. As part of this effort, future versions of the SANDAG State of the Commute Report will address the impact of funds programmed for transportation improvement on congestion levels.

- Hampton Roads Planning District Commission – The CMP has been especially useful in supporting project justification.

- Puget Sound Regional Commission – PSRC views the CMP as an improvement over the existing Congestion Management System (CMS). It views the multi-modal nature of the CMP as better fitting with the goals and objectives of the long range regional plan. However, PSRC is currently examining ways to improve integration of the CMP with other parts of the planning process. In addition, different local agencies have used some of the tools developed as part of

The CMP is generally used as supporting documentation to evaluate the inclusion of projects in the TIP.

the CMP to conduct project-related before/after studies to aid in the process of evaluating the investment of funds.

- Denver Regional Council of Governments – The CMP is being used to help make policy decisions concerning the allocation of funding for ITS/Traffic Operations and TDM-related projects. Related tools have enabled staff to conduct before/after studies and "what if" analyses concerning changing capacity, volumes, etc.

- Washington State DOT - The CMP has resulted in more integrated thinking amongst Departmental staff and decision-makers. In addition, WSDOT maintains a "Congestion Working Group," which meets quarterly to discuss all aspects of congestion monitoring, mitigation, and reporting.

4.3.8 Program Costs

- North Central Texas Council of Governments (NCTCOG) - The development of the CMP cost approximately $200,000. Ongoing efforts typically require 1.5 staff persons and 1/2 of a manager's time.

- San Diego Association of Governments – In the past, no effort has been made to break out CMP-related costs. However, they are planning to track staff hours required to conduct the CMP update.

- Hampton Roads Planning District Commission - $120,000 has been budgeted for CMP efforts during the next budget cycle -- all in-house staff, except possibly report production

- Puget Sound Regional Commission - Costs are not broken out separately from system management and operations-related activities. However, the level of staff commitment required to maintain the system is approximately one full-time person and part of a supervisor's time, plus some additional level of consultant effort.

- Denver Regional Council of Governments - 1.5 - 2 full time staff equivalents are needed to support ongoing efforts, not including support personnel used to support related TDM and transportation operations activities.

- Washington State DOT - WSDOT has not tracked congestion-related costs on an independent basis, and thus cannot answer this question.

4.3.9 Lessons Learned

- North Central Texas Council of Governments (NCTCOG):
  - Try to get as many partners as possible involved. Get partners involved early - the longer they are involved, the easier it is to get buy-in.
  - Buy-in concerning performance measures is critical. Performance measures must be understandable and trackable. If an agency likes a performance measure but does not have the data to support it properly, it will not work.
  - NCTCOG had access to a lot more data than they thought they would at the start of the CMP update. This data is not necessarily data that NCTCOG collected, but data that others were collecting and provided to them. Consider creation of a process to gather data from outside agencies on a regular basis.

- San Diego Association of Governments:
  - Look for ways to streamline the CMP -- what functions are currently being performed elsewhere in your organization that can be transferred to CMP-related efforts?
  - We need to work on expanding our focus to arterial portions of the network.

The CMP is being used to help make policy decisions concerning the allocation of funding for ITS/ Traffic Operations and TDM-related projects.

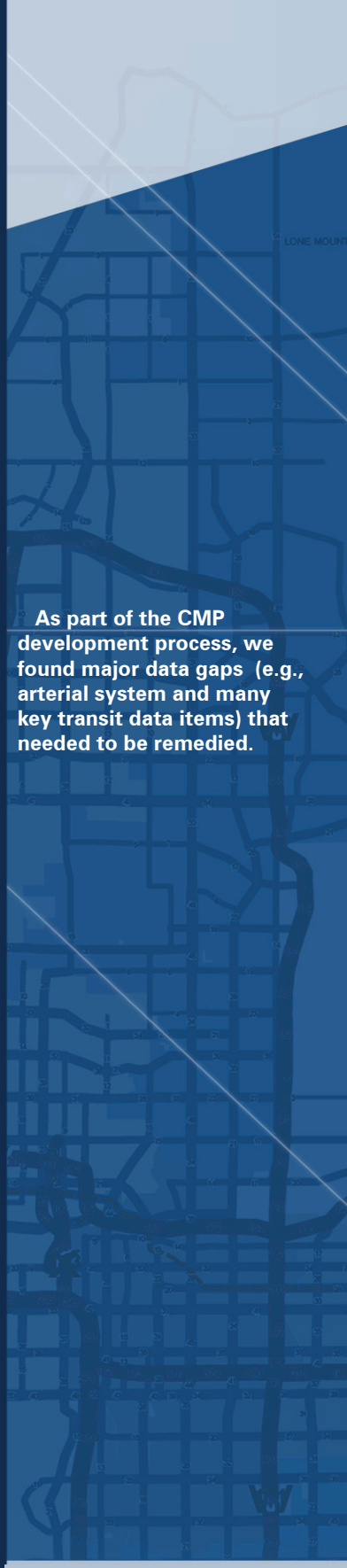
- Hampton Roads Planning District Commission:
  - Close coordination and cooperation with stakeholders is essential for an effective CMP.
  - Data quality and integrity is a major concern, both for highway loop detectors and arterial monitoring.

- Puget Sound Regional Commission:
  - As part of the CMP development process we found major data gaps (e.g., arterial system and many key transit data items) that needed to be remedied.
  - The importance of getting buy-in from other participants cannot be overstated.
  - Solicit operations experts from participating agencies to contribute in order to get a better understanding of real-world challenges and opportunities.

- Denver Regional Council of Governments:
  - Reevaluate the program every year.
  - Everyone involved in the process needs to work to gain a better understanding of the interrelationships between their programs, e.g., TDM, transit, ITS, transportation operations, etc.

- Washington State DOT:
  - Take advantage of the availability of traffic management system data and make sure that the operators of those systems get useful information out of the systems built for the CMP.
  - Actively publishing results will help to establish credibility and support for the process.

As part of the CMP development process, we found major data gaps (e.g., arterial system and many key transit data items) that needed to be remedied.



5. Key Findings Relevant to MAG

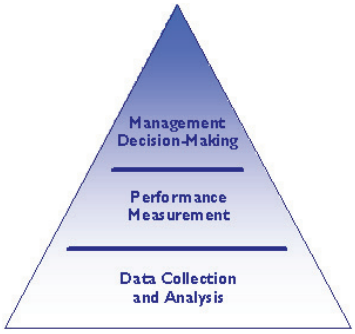
5.1 Performance Measures Findings and Recommendations

Improved monitoring of transportation system performance provides information that can be used to support improvements in operations-related strategies, improved investment decisions, and program justification. However, in order for a performance measures program to truly be useful, it must meet certain criteria, including:

- **Performance measures program must have a narrow, strategic focus** - It is neither possible nor desirable to measure everything. As a result, the performance measures that MAG sets should be narrowly focused to a critical few that best indicate whether the agency is fulfilling its vision, goals, and objectives and meeting customer-focused needs.

- **Performance measures are a means, not an end** – Performance measures should be used by MAG's staff to help achieve the agency's vision by gauging where goals are/are not being met. Even so, the focus of this effort needs to remain on the agency's goals themselves, and not on the measurement-related activities.

- **Implementation of a performance-based planning methodology in the transportation planning process is an evolutionary process** - Most agencies that have implemented a performance-based approach have made many changes along the way, including fundamental changes in the structure of their processes and in the way performance measures are used. As part of this, performance measures need to be periodically reviewed to ensure that they are still relevant.



Improved monitoring of transportation system performance provides information that can be used to support improvements in operations-related strategies, improved investment decisions, and program justification.

Consequently, getting started requires development of an overarching implementation and evaluation strategy that will support proper use of performance data. Such a strategy includes the following steps[14]:

1. Determine how performance measures will be used
    a. Define the structure and content of the program
    b. Quantify benefits for key decision-makers
2. Develop a performance measurement plan based on uses and users:
    a. Define primary modes (highway, arterial, transit, etc.), days, and times of interest
        - Establish system-wide spatial and temporal levels of analysis
        - Identify the roadways, segments of road, transit routes, etc., that will be focused on
    b. Define data sources to be used
        - Identify what is usable and what is not
    c. Develop communication/visualization tools and templates to convey results
3. Collect and process required data
4. Calculate reliability and other measures:
    a. Quality check data to assure accuracy
    b. Produce all performance measures based on availability of quality data
5. Communicate measures in meaningful way:
    a. Develop graphics and tables that accurately convey conditions and system status while avoiding "tech-speak."

[14]Based on steps outlined in "Travel Time Reliability: Making It There On Time, All The Time," U.S. Department of Transportation – Federal Highway Administration
http://www.ops.fhwa.dot.gov/publications/tt_reliability/TTR_Report.htm#monitoring

This memorandum has provided background information to serve as a springboard for revision of MAG's performance measurement program. Information developed as part of this program can be used in two primary ways: a) to provide decision-makers and transportation managers with an enhanced ability to monitor the performance of the system over time and evaluate the effectiveness of their congestion management initiatives, and b) to provide transportation system users with the ability to better understand the level of service being provided (highways, arterials, transit, etc.)

Examples of internal (system management) benefits of having a well managed performance measures system include:

- Improves information provided to decision-makers in support of strategic planning
- Facilitates improvements in operations and planning
- Improves the level of service being provided to agency customers
- Documents accomplishments – provides a method for justifying the value of program investments and system improvements
- Helps agency staff better understand the impact of their efforts in achieving departmental and organizational goals

This system can also be leveraged to evaluate transportation network conditions from a customer-centric perspective to answer questions such as:

- Is my commute getting longer, staying the same, or improving?
- How reliable is my commute?
- How has a recent infrastructure project or operational change affected my trip?

Challenges that will have to be overcome as part of the design and implementation of such a system will almost certainly include: a) the potential to be overwhelmed by the volume of data, and b) the need to select tools capable of providing the necessary support to decision-makers.

Should MAG agree in concept with the implementation strategy described above, the next steps would be to develop a more detailed description of the program (one that more specifically addresses MAG's current/future performance measurement plans) and to determine which performance measures will best assist in meeting its goals. This undertaking would require that MAG first define the program's scope:

- Geographically – the portions of the regional transportation network, including corridors, roadways, transit, etc. for which performance will be evaluated
- Temporally – times of day/days of the week for which data will be analyzed
- Contextually – metrics to be used to assess performance

Finally, as part of its ongoing performance monitoring-related efforts, MAG should continue to participate in one of the nationally oriented performance monitoring research initiatives currently underway. Participation in such an initiative both helps to publicize MAG's successes in this area, as well as ensure that its findings are included as part of national discussions on this topic.

5.2 Congestion Management Findings and Recommendations

The Maricopa Association of Governments has already implemented many of the required elements of a Congestion Management Process through its existing system monitoring and congestion analysis processes. Initiatives like the Regional Concept of Transportation Operations and past congestion studies have created a solid groundwork for dealing with congestion in a comprehensive fashion.

The greatest challenge is to integrate the Congestion Management Process fully into the regional regional transportation planning process. The CMP must be based upon the performance objectives identified through the regional transportation planning process. By keying off these system performance objectives, the CMP will reflect the priorities established by the planning process and achieve the desired linkage to project development and program prioritization.

The Maricopa Association of Governments has already implemented many of the required elements of a Congestion Management Process through its existing system monitoring and congestion analysis processes.

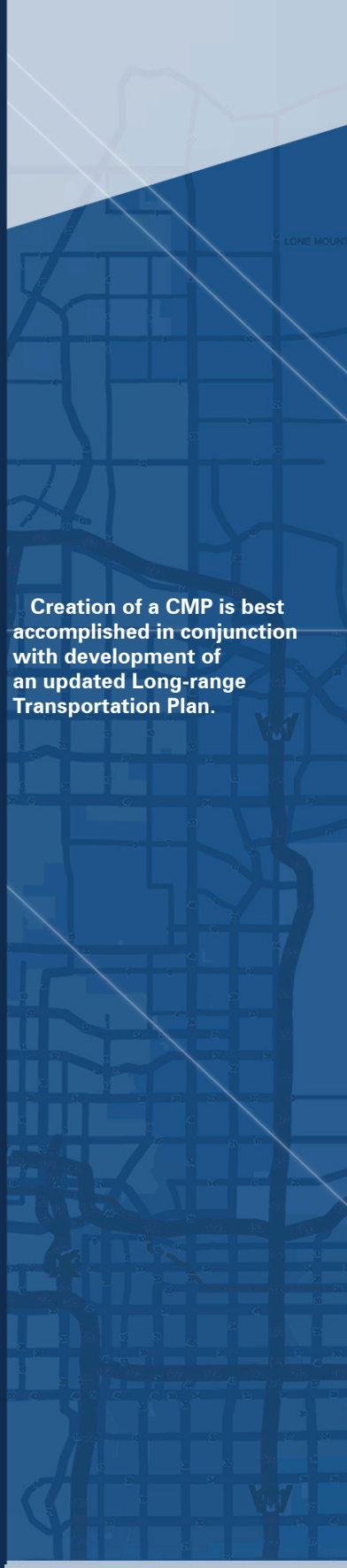
Several critical elements should be kept in mind as MAG creates a CMP. These considerations emerged from reviews of the experiences of other agencies engaged in the creation or updating of their congestion management processes:

- Creation of a CMP is best accomplished in conjunction with development of an updated Regional Transportation Plan (RTP). This contributes to the close coordination of congestion-related performance objectives, which must be tightly linked to the regional vision and goals derived from the RTP. However, the CMP can be developed even if out of phase with the development of a new or updated RTP, if the performance objectives for congestion management can be closely linked to the vision and goals of the existing RTP.

- The involvement of operating agencies in the creation of the CMP is vitally important. A major reason to involve operating agencies in developing the CMP is to obtain their buy-in and ownership of the process. Not only will the transportation system managers and operators provide a critical perspective on the potential for the success of various congestion management strategies that involve their facilities, they are in the best position to contribute knowledge of how to measure success.

- Data availability is crucial to the success of the CMP – but it is important that performance objectives drive the development of performance measures and data collection plans. The CMP can be rendered ineffectual if the data available does not conform to the performance objectives.

- The CMP is not a static process, but a dynamic one. As conditions continually change, and as new strategies are implemented, it will be necessary to continually renew and update the CMP. The CMP can also be exercised to assist in project prioritization, with congestion mitigation as one of the factors driving project selection for both the regional transportation plan and the transportation improvement program.



Creation of a CMP is best accomplished in conjunction with development of an updated Long-range Transportation Plan.

Appendix A - Performance Measure Definitions

Customer Satisfaction: A qualitative measure of customers' opinions related to the roadway management and operations services provided in a specified region.

Extent of Congestion (Spatial and Temporal)[a]:

- Spatial: Miles of roadway within a predefined portion of the network and time period (e.g., morning and evening peaks) for which average travel times are 30% longer than free flow travel times.
- Temporal: The percentage of each day during which more than 20% of roadway sections in a predefined area are congested (i.e., average travel times are 30% longer than free flow travel times).

Incident Duration: The time elapsed from the notification of an incident until all evidence of the incident has been removed from the incident scene.

Planning Time Index: indicates the 95th percentile travel time (the travel time for any given segment or trip faster than 5% and slower than 95% of all trips). It is referred to as the planning time index because it is the time that a driver needs to allocate for their trip to ensure that they are on time nineteen out of twenty days. (Somewhat overlaps the Buffer Index)

Recurring Delay: Vehicle delays that are repeatable for the current time-of-day, day-of-week, and day-type.

Speed: The average speed of vehicles for a single direction of flow, at a specific location on a roadway.

Throughput – Person: Number of persons (including vehicle occupants, pedestrians, and bicyclists) traversing a roadway section in one direction during a unit of time.

Throughput- Vehicle: Number of vehicles traversing a roadway section in one direction during a unit of time. This is a useful measure in that it enables a comparison of demand to capacity.

Total Delay: the total amount of additional time incurred when actual travel times exceed free-flow travel times (e.g., the number of hours spent in traffic beyond what would normally occur if travel were to occur at free-flow speeds).

Average Travel Times and Speeds: They can be based on specific road segments or be more complex and be calculated between any origin and destination covered by the system (by aggregating interconnected links) even if the trip makes use of multiple facilities and/or modes. In cases where there are viable alternate routes between specific origin and destinations, the performance measure could include travel times for all of the possible trips. This information could be provided in graphical format for days of the week/times of day to demonstrate the locations/times of the worst congestion.

- Travel Time – Link (Facility): The average time required to traverse a section of roadway in a single direction.
- Travel Time – Trip: The average time required to travel from an origin to a destination on a trip that might include multiple roadways and/or modes of travel.

Travel Time Index: is a comparison between actual peak travel times and free-flow travel time for any combination of roadways. It is represented as a ratio of the two values, and is generally regarded as a good indicator of the amount of extra time (over what is expected during ideal travel conditions) that will be spent driving during a trip.

Travel Time Reliability (Buffer Index): indicates the amount of extra "buffer" time need that a traveler needs to build into a trip's average travel time in order to be on-time 95% of the time (nineteen out of twenty days). This index is calculated for each road segment involved in a trip, with an overall weighted average calculated for the trip itself based on the vehicle-miles associated with each segment.

[a]National Transportation Operations Coalition – Performance Measures Initiative Final Report, July 2005, pages 8-10. http://www.ite.org/management/ntoc_final_report.pdf

Appendix B - HRPDC Congestion Mitigation Strategy "Toolbox"

Strategy #1 Eliminate Person Trips or Reduce VMT	**Growth Management/Activity Centers**	
	1-1 Land Use Policies/Regulations Encourage more efficient patterns of commercial or residential development in defined areas. Specific land use policies and/or regulations that could significantly decrease both the total number of trips and overall trip lengths, as well as making transit use, bicycling and walking more viable include, but are not limited to the following: • Encouraging development in existing centers and/or communities (i.e. infill development) • Discouraging development outside of designated growth areas • Promoting higher density and mixed uses in proximity to existing or planned transit service • Establishing a policy for new and existing subdivisions to include sidewalks, bike paths, and transit facilities where appropriate	
	Congestion/Value Pricing	
	1-2 Road User Fees/HOT Lanes Includes area-wide pricing fees, time-of-day/congestion pricing, and tolls. Most appropriately applied to freeways and expressways and requires infrastructure to collect user fees. High Occupancy Toll (HOT) lanes – combines HOV and pricing strategies by allowing single occupancy vehicles to gain access to HOV lanes by paying a toll.	
	1-3 Parking Fees Market-based strategy designed to modify mode choice by imposing higher costs for parking private automobiles. Most appropriately applied to parking facilities in urban environments.	
	Transportation Demand Management	
	1-4 Telecommuting Encouraging employers to consider telecommuting options full- or part-time to reduce travel demand.	
	1-5 Employee Flextime Benefits/Compressed Work Week Encouraging employers to consider allowing employees to maintain a flexible schedule - thus allowing the employee the option to commute during non-peak hours.	
Strategy #2 Shift Trips from Auto to Other Modes	**Public Transit Capital Improvements**	
	2-1 Exclusive Right-of-Way - New Rail Service Includes heavy rail, commuter rail, and light rail services. Most appropriately applied in a dense context serving a major employment center.	
	2-2 Exclusive Right-of-Way - New Bus Facilities Includes Busway, Bus Only Lanes, and Bus Bypass Ramps. Most appropriately applied to freeways and expressways with high existing transit ridership rates.	
	2-3 Fleet Expansion Expansion of existing rail and/or bus capacity to provide increased service.	
	2-4 Improved Intermodal Connections Improve the efficiency and functionality of intermodal connectors where several modes of transportation are physically and operationally integrated.	
	2-5 Improved/Increased Park & Ride Facilities & Capital Improvements Identifying any facilities that are in any phase of planning along corridors.	
	Public Transit Operational Improvements	
	2-6 Service Expansion Improvements to the service frequency and service area provided in throughout the region.	
	2-7 Traffic Signal Preemption Improve traffic flow for transit vehicles traveling through signalized intersections.	
	2-8 Transit Fare Reductions Plan/Reduced Rate of Fare Includes system-wide reductions, off-peak discounts, and deep discount programs.	
	2-9 Transit Information Systems Improved in-vehicle and station information systems to improve the dissemination of transit-related information to the user.	
	Bicycle and Pedestrian Modes	
	2-10 Improved/Expanded Bicycle Network Includes on-road facilities, pathways, and greenways.	
	2-11 Bicycle Storage Systems Providing safe and secure places for bicyclists to store their bicycles.	
	2-12 Improved/Expanded pedestrian Network Includes sidewalks, pedestrian signals and signs, crosswalks, overpasses/tunnels, greenways, and walkways.	

Strategy #3 Shift Trips from SOV to HOV	**Encouraging High Occupancy Vehicle (HOV) Use**
	3-1 Add HOV Lanes Most appropriate use of freeways and expressways.
	3-2 HOV Toll Savings Preferential pricing to multi-occupant vehicles. Needs infrastructure to administer toll collection.
	Transportation Demand Management
	3-3 Rideshare Matching Services Providing carpool/vanpool matching and ridesharing information resources and service**s.**
	3-4 Vanpool/Employer Shuttle Program Organizing groups of commuters to travel together in a passenger van or employer-provided shuttle on a regular basis.
	3-5 Employer Trip Reduction Program Organizing groups that offer tax incentives or transit subsidies on a regular basis.
	3-6 Parking Management Preferential parking is a low-cost incentive that can be used to encourage the utilization of alternative commute modes, such as carpooling and vanpooling.
Strategy #4 Improve Roadway Operations	**Traffic Operational Improvements**
	4-1 Intersection Geometric Improvements Improvements to intersection geometrics to improve overall efficiency and operation.
	4-2 Intersection Channelization Infrastructure improvements that provide physical separation or delineation of conflicting traffic movements.
	4-3 Intersection Turn Restrictions Providing intersections turn restrictions to reduce conflicts and increase overall intersection performance.
	4-4 Intersection Signalization Improvements Improving signal operations through re-timing signal phases, adding signal actuation, etc.
	4-5 Coordinated Intersections Signals Improve traffic signal progression along identified corridors.
	4-6 Traffic Calming A variety of techniques used to reduce traffic speeds and increase safety.
	4-7 Intelligent Transportation Systems/Smart Traffic Centers (ITS) Utilizing the latest technology to assist in congestion mitigation, information dissemination, and traffic planning efforts. Examples include road sensors, video detection, changeable message signs, SMART Tag (electronic toll), 511 Traveler service, and Smart Travel
	4-8 Reversible Lanes Reversible Lane Systems enable the maximum use of roadways with heavy directional distribution of traffic by changing the direction of the individual travel lanes. Lane control signs, displayed well in advance of a merge, are often used to close lanes with lower traffic volume and open additional lanes for higher volume.
	Freeway Operations & Management
	4-9 Incident Management, detection, Response & Clearance Utilize traveler radio, travel alert notification (via e-mail, fax, etc.), and general public outreach to enhance incident-related information dissemination
	4-10 Elimination of Bottlenecks Eliminating high-traffic areas where one or more travel lane(s) is dropped.
	4-11 Ramp Metering Metering vehicular access to a freeway during peak periods to optimize the operational capacity of the freeway.
	Access Management
	4-12 Access Control Reduction or elimination of “side friction”, especially from driveways via traffic engineering, regulatory techniques, and purchase of property rights.
	4-13 Median Control Reduction of centerline and “side friction”, via traffic engineering and regulatory techniques.
	4-14 Frontage Roads Auxiliary roadways which provide a separated lane or lanes for access to abutting land uses along freeways or arterials.

	Addition of General Purpose Lanes
Strategy #5 Add Capacity	**5-1 Freeway Lanes** Increasing the capacity of congested freeways through additional travel lanes.
	5-2 Arterial lanes Increasing the capacity of congested arterials through additional travel lanes.
	5-3 Interchanges Improving Interchange design to allow smoother traffic flow to/from arterials.
	5-4 Improve Alternate Routes Constructing new roadways or increasing the capacity of other roadways that will decrease demand on congested existing facilities.